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Алтайский государственный университет

Хрестоматия на английском языке по прикладной математике и информационным технологиям

(для студентов бакалавриата факультета математики и информационных технологий)

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Х 917 **Хрестоматия** на английском языке по прикладной математике и информационным технологиям (для студентов бакалавриата факультета математики и информационных технологий) / Алтайский государственный университет ; сост. М.Ю. Горбухова. – Барнаул : АлтГУ, 2019. – 1 CD-R (1,2 Мб). – Систем. требования: Intel Pentium 1,6 GHz и более ; 512 Мб (RAM) ; Microsoft Windows 7 и выше ; Adobe Reader. – Загл. с титул. экрана. – Текст : электронный.

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Хрестоматия составлена из актуальных аутентичных текстов по прикладной математике и информационным технологиям. Тексты представляют собой материал для практического освоения английского языка. Подбор и содержание текстов позволяют использовать данный материал для аудиторной и самостоятельной работы студентов по развитию навыков работы с иноязычной научно-популярной и научной литературой по специальности, совершенствованию знаний по английскому языку.

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СОДЕРЖАНИЕ

ПРЕДИСЛОВИЕ

Хрестоматия представляет собой подборку актуальных аутентичных текстов по темам прикладной математики и информационных технологий. Подборка составлена на основе практики работы на занятиях по английскому языку со студентами бакалавриата факультета математики и информационных технологий.

Хрестоматия содержит две части. В первую включены тексты для аудиторной работы, направленные на развитие навыков изучающего чтения. Каждый из них снабжён словарём. В словарь включены слова и словосочетания, частью составляющие активный словарь, частью трудные для перевода и понимания текста в полном объёме.

Вторая часть хрестоматии включает тексты (научные и научно-популярные статьи, отрывки из книг, справочный материал из интернета), которые имеют целью развитие навыков самостоятельного чтения студентов. Тексты подобраны таким образом, чтобы наиболее полно раскрыть области специальности, по которым проходит обучение.

Материал хрестоматии позволяет преподавателю активно использовать его на занятиях, дополнительно снабдив необходимыми предтекстовыми, текстовыми и послетекстовыми упражнениями, которые преподаватель может подобрать на основе уровня подготовки группы и характера текста.

Работа с текстами хрестоматии позволяет пополнить лексический словарь студента, даёт возможность познакомиться с особенностями стиля научных текстов на английском языке по темам специальности. Уровень сложности текстов требует от студента кропотливой работы, как самостоятельной, так и под руководством преподавателя.

Помещённый в хрестоматию материал может служить основой для подготовки устных тем, включённых в программу, а также презентаций по темам специальности.

PART I. APPLIED MATHEMATICS AND COMPUTER SCIENCES

Text 1. Trends in mathematics today. Part 1

The three principal broad trends in mathematics today I would characterize as (i) variety of applications, (ii) a new unity in the mathematical sciences, and (iii) the ubiquitous presence of the computer. Of course, these are not independent phenomena, indeed they are strongly interrelated, but it is easiest to discuss them individually.

The increased variety of application shows itself in two ways. On the one hand, areas of science, hitherto remote from or even immune to mathematics, have become "infected". This is conspicuously true of the social sciences, but is also a feature of present-day theoretical biology.

...But another contributing factor to the increased variety of applications is the ...fact that areas of mathematics, hitherto regarded as ...pure, are now being applied. Algebraic geometry is being applied to control theory and the study of large-scale systems; combinatorics and graph theory are applied to economics; the theory of fibre bundles is applied to physics; algebraic invariant theory is applied to the study of error-correcting codes. ...There should not be a sharp distinction between the methods of pure and applied mathematics. ...The applied mathematician needs to understand very well the domain of validity of the methods being employed, and to be able to analyse how stable the results are and the extent to which the methods may be modified to suit new situations.

These last points gain further significance if one looks more carefully at what one means by "applying mathematics". Nobody would seriously suggest that a piece of mathematics be stigmatized as inapplicable just because it happens not yet to have been applied. ...However, ...applying mathematics is very often not a single-stage process. We wish to study a "real world" problem; we form a scientific model of the problem and then construct a mathematical model to reason about the scientific or conceptual model. However, to reason within the mathematical model, we may well feel compelled to construct a new mathematical model which embeds our original model in a more abstract conceptual context; for example, we may study a particular partial differential equation by bringing to bear a general theory of elliptic differential operators. Now the process of modeling a mathematical situation is a "purely" mathematical process, but it is apparently not confined to pure mathematics! Indeed, it may well be empirically true that it is more often found in the study of applied problems than in research in pure mathematics. Thus we see, first, that the concept of applicable mathematics needs to be broad enough to include parts of mathematics applicable to some area of mathematics which has already been applied; and, second, that the methods of pure and applied mathematics have much more in common than would be supposed by anyone listening to some of their more vociferous advocates. For our purposes now, ...the distinction between pure and applied mathematics should not be emphasized in the teaching of mathematics.

Источник: *«Current Trends in Mathematics and Future Trends in Mathematics Education by Peter J. Hilton, State University of New York, 1983. – C.– 11– 13.*

Words and word-combinations to understand the text better

1. ubiquitous – повсеместный, всепроникающий
2. shows itself – проявляется
3. hitherto – ранее, до этого времени
4. immune to – не подверженный, не затронутый, здесь: имеющий иммунитет к
5. conspicuously – ясно, очевидно
6. control theory – теория управления, теория автоматического регулирования
7. fibre bundles – оптоволоконный жгут
8. algebraic invariant theory – алгебраическая теория инвариантов
9. error-correcting code – исправляющий ошибки код
10. to suit – удовлетворять чему-либо
11.to stigmatize – порицать, клеймить
12. to reason about – рассуждать о чём-то
13. to feel compelled – считать настоятельно необходимым

14. to bring to bear – употреблять, использовать, задействовать
15. elliptic differential – эллиптический дифференциал
16. to be confined to – ограничиваться
17. vociferous – активный, громогласный

Text 2. Trends in mathematics today. Part 2
(Shortened)

The second trend we have identified is that of a new unification of mathematics. ...We would only wish to add to the discussion the remark that this new unification is clearly discernible within mathematical research itself. Up to ten years ago the most characteristic feature of this research was the "vertical" development of autonomous disciplines, some of which were of very recent origin. Thus the community of mathematicians was partitioned into subcommunities united by a common and rather exclusive interest in a fairly narrow area of mathematics (algebraic geometry, algebraic topology, homological algebra, category theory, commutative ring theory, real analysis, complex analysis, summability theory, set theory, etc., etc.). Indeed, some would argue that no real community of mathematicians existed, since specialists in distinct fields were barely able to communicate with each other. I do not impute any fault to the system which prevailed in this period of remarkably vigorous mathematical growth – indeed, I believe it was historically inevitable and thus "correct" – but it does appear that these autonomous disciplines are now being linked together in such a way that mathematics is being reunified. We may think of this development as "horizontal", as opposed to "vertical" growth. Examples are the use of commutative ring theory in combinatorics, the use of cohomology theory in abstract algebra, algebraic geometry, fuctional analysis and partial differential equations, and the use of Lie group theory in many mathematical disciplines, in relativity theory.

...The third trend to which I have drawn attention is that of the general availability of the computer and its role in actually changing the face of mathematics. The computer may eventually take over our lives; this would be a disaster. Let us assume this disaster can be avoided; in fact, let us assume further, for the purposes of this discussion at any rate, that the computer plays an entirely constructive role in our lives and in the evolution of our mathematics. What will then be the effects?

The computer is changing mathematics by bringing certain topics into greater prominence – it is even causing mathematicians to create new areas of mathematics (the theory of computational complexity, the theory of automata, mathematical cryptology). At the same time it is relieving us of certain tedious aspects of traditional mathematical activity which it executes faster and more accurately than we can. It makes it possible rapidly and painlessly to carry out numerical work, so that we may accompany our analysis of a given problem with the actual calculation of numerical examples.

Источник: «Current Trends in Mathematics and Future Trends in Mathematics Education by Peter J. Hilton, State University of New York, 1983. – C.– 13-14.

Words and word-combinations to understand the text better

1. discernible – явный, заметный
2. recent origin – недавнее происхождение
3. was partitioned into subcommunities – разделилось на группировки
4. homological algebra – гомологическая алгебра
5. commutative ring theory – теория абелевых колец
6. real analysis – действительный анализ
7. summability theory – теория суммируемости
8. set theory – теория множеств
9. impute any fault to – возлагать вину на
10. to reunify – воссоединяться
11. cohomology theory – теория когомологий
12. partial differential equations – дифференциальные уравнения в частных производных
13. take over – взять под контроль

14. let us assume – допустим

15. at any rate – во всяком случае, по крайней мере

16. bringing certain topics into greater prominence – выделяя, делая более заметными определённые темы

17. theory of computational complexity – теория сложности вычислений

18. theory of automata – теория автоматов

19. relieve of – освобождать от

Text 3. Applied mathematics

(Shortened)

Applied mathematics is a branch of mathematics that deals with mathematical methods that find use in science, engineering, business, computer science, and industry. Thus, applied mathematics is a combination of mathematical science and specialized knowledge. The term "applied mathematics" also describes the professional specialty in which mathematicians work on practical problems by formulating and studying mathematical models. The activity of applied mathematics is thus intimately connected with research in pure mathematics.

Historically, applied mathematics consisted of applied analysis, most notably differential equations; approximation theory; and applied probability. These areas of mathematics related directly to the development of Newtonian physics, and in fact, the distinction between mathematicians and physicists was not sharply drawn before the mid-19th century.

Today, the term "applied mathematics" is used in a broader sense. It includes the classical areas noted above as well as other areas that have become increasingly important in applications. Even fields such as number theory that are part of pure mathematics are now important in applications (such as cryptography), though they are not generally considered to be part of the field of applied mathematics.

The success of modern numerical mathematical methods and software has led to the emergence of computational mathematics, computational science, and computational engineering, which use high-performance computing for the simulation of phenomena and the solution of problems in the sciences and engineering. These are often considered interdisciplinary.

Historically mathematics was most important in the natural sciences and engineering. However since World War II, fields outside of the physical sciences have spawned the creation of new areas of mathematics, such as game theory and social choice theory, which grew out of economic considerations.

The advent of the computer has enabled new applications: studying and using the new computer technology itself (computer science) to study problems arising in other areas of science (computational science) as well as the mathematics of computation (for example, theoretical computer science, computer algebra, numerical analysis). Statistics is probably the most widespread mathematical science used in the social sciences, but other areas of mathematics, most notably economics, are proving increasingly useful in these disciplines.

Applied mathematics is closely related to other mathematical sciences. They are: Scientific computing, Computer science, Operations research and management science, Statistics, Actuarial science, Mathematical economics and others.

Источник: [Электронный ресурс] https://howlingpixel.com/i-en/Applied_mathematics

Words and word-combinations to understand the text better

1. to deal with – заниматься, быть посвящённым чему-либо
2. engineering – техника
3. to be intimately connected with – быть тесно связанным с
4. approximation theory – теория аппроксимации
5. applied probability – прикладная вероятность
6. relate directly to – быть непосредственно связанным с

7. computational mathematics – вычислительная математика

8. computational science – наука о вычислениях

9. computational engineering – вычислительная инженерия

10. high-performance computing – высокопроизводительные вычисления

11. simulation of phenomena моделирование явлений

12. to spawn – порождать

13. advent – наступление эры

14. Operations research – математические методы исследования операций

15. Actuarial science – актуарная наука

Text 4. Mathematics in Archeology

Clive Orton

To most people, the idea of connecting mathematics with archeology comes as something of surprise. Mathematics is about numbers, or triangles, or strange things one does with quadratic equations, while archeology is about digging holes, and finding things – from coins or sherds up to buildings and whole cities – but what is the link? The answer is that both of these descriptions are *caricatures:* numbers form a relatively small part of mathematics, which concerns itself with the study of patterns and relationships, while a larger part of archeology consists of interpretation of material evidence, and the actual recovery of the evidence from the ground forms a relatively small part. Now the two subjects begin to edge towards one another. How does the archeologist go about his task of interesting evidence, but by looking for patterns and relationships within it? And here he is within the realm of mathematics.

That may sound too neat, and certainly too general and abstract to be satisfying. What sort of pattern? What sort of relationships? How can mathematics help to detect patterns in archeological evidence? ...Various archeological activities [are] classifying artifacts into different types, using dating evidence, studying the source and function of the artifacts, coping with the peculiar problems of pottery and bones (which are so often broken) and looking at distribution maps – and see that there are mathematical ideas underlying this activity. Often, it seems, that archeologist ...has been speaking mathematics all his life without realizing it. If so, he may have much to gain by realizing it, and bringing in the particular aspect of mathematics explicitly. ...This does not mean that the mathematician's job is to tell the archeologist what to do – the archeologist maintains his responsibility for what he does – but to help him decide how to do it. On the other hand, mathematics does have its rules, which cannot be flouted simply because the archeologist does not like them, or finds them inconvenient. Mathematics has been described as the 'Queen and the Servant of Sciences' and it is its dual role.

Источник: Clive Orton Mathematics in Archeology – Cambridge University Press, 1980 – С. 15-16

Words and word-combinations to understand the text better

1. sherd – черепок, осколок керамики
2. to be caricature – искажать, изображать в искажённом виде
3. material evidence – вещественные доказательства
4. recovery – восстановление
5. to edge towards one another – постепенно сближаться
6. neat – складный
7. pattern – схема, образ, система, сценарий развития событий
8. dating – датировка
9. pottery – керамика
10. distribution map – карта распространения
11. to maintain responsibility for – нести ответственность за
12.to flout – игнорировать, нарушать

COMPUTER SCIENCES

Text 1. Computer science. Part 1

(Shortened)

Computer science is the scientific and practical approach to computation and its applications. It is the systematic study of the feasibility, structure, expression, and mechanization of the methodical procedures (or algorithms) that underlie the acquisition, representation, processing, storage, communication of, and access to information. A computer scientist specializes in the theory of computation and the design of computational systems.

Its fields can be divided into a variety of theoretical and practical disciplines. Some fields, such as computational complexity theory (which explores the fundamental properties of computational and intractable problems), are highly abstract, while fields such as computer graphics emphasize real-world visual applications. Still other fields focus on challenges in implementing computation. For example, programming language theory considers various approaches to the description of computation, while the study of computer programming itself investigates various aspects of the use of programming language and complex systems. Human-computer interaction considers the challenges in making computers and computations useful, usable, and universally accessible to humans.

Time has seen significant improvements in the usability and effectiveness of computing technology. Modern society has seen a significant shift in the users of computer technology.

Contributions

Despite its short history as a formal academic discipline, computer science has made a number of fundamental contributions to science and society – in fact, along with electronics, it is a founding science of the current epoch of human history called the Information. It is a driver of the Information Revolution, seen as the third major leap in human technological progress after the Industrial Revolution (1750–1850 CE) and the Agricultural Revolution (8000–5000 BC).

These contributions include:

- - The start of the "digital revolution", which includes the current Information Age and the Internet.
- - A formal definition of computation and computability, and proof that there are computationally unsolvable and intractable problems.
- - The concept of a programming language, a tool for the precise expression of methodological information at various levels of abstraction.
- - In cryptography, breaking the Enigma code was an important factor contributing to the Allied victory in World War II.
- - Scientific computing enabled practical evaluation of processes and situations of great complexity, as well as experimentation entirely by software. It also enabled advanced study of the mind, and mapping of the human genome became possible with the Human Genome Project.
- - Algorithmic trading has increased the efficiency and liquidity of financial markets by using artificial intelligence, machine learning, and other statistical and numerical techniques on a large scale.
- - Computer graphics and computer-generated imagery have become widespread in modern entertainment in television, cinema, advertising, animation and video games. Even films are usually "filmed" now on digital cameras, or edited or post-processed using a digital video editor.

- Simulation of various processes, including computational fluid dynamics, physical, electrical, and electronic systems and circuits, as well as societies and social situations (notably war games). Modern computers enable optimization of such designs as complete aircraft. Notable in electrical and electronic circuit design are SPICE (*Simulation Program with Integrated Circuit Emphasis*), as well as software for physical realization of new (or modified) designs.

Источник: [Электронный ресурс] https://wn.com/computer_science/wikipedia (дата обращения 25.11.2018)

Words and word-combinations to understand the text better

1.feasibility – возможность, обоснованность

2. acquisition – приобретение, комплектование, сбор

3. design – проектное решение

4. computational complexity theory – теория сложности вычислений

5. intractable problems – трудноредшаемые задачи

6. challenge – проблема, задача, сложная проблема, решение которой требует максимума усилий, вызов

7. usable – применимый, годный к употреблению, который может использоваться

8. usability – доступность для использования, пригодность к использованию

9. along with – наряду с

10. founding science – основополагающая наука

11. major leap – главный прорыв

12. CE – Common Era – наша эра

13. digital revolution – цифровая революция

14. computation and computability – машинное вычисление и теория вычислимости

15. intractable problems – трудноредшаемые задачи

16. allied victory – победа союзников

17. scientific computing –применение компьютеров для научных расчётов

mapping – построение

18. Human Genome Project – проект Геном человека

19. algorithmic trading – алгоритмическая торговля

20. machine learning – машинное обучение, машинное самообучение

21. computer-generated imagery – получение машинно-генерируемых изображений, формирование изображений с помощью ЭВМ, компьютерная графика

22. digital video editor – редактор цифрового видео
23. computational fluid dynamics – вычислительная гидродинамика, гидродинамическое моделирование
24. complete aircraft – самолёт с полным комплектом запасного имущества и принадлежностей
25. electronic circuit design – электронные схемы, платы
26. SPICE, Simulation Program with Integrated Circuit Emphasis) – симулятор электронных схем
27. **-**integrated circuit – интегральная микросхем

Text 2. Computer Science. Part 2.

Areas of Computer Science

(Shortened)

As a discipline, computer science spans a range of topics from theoretical studies of algorithms and the limits of computation to the practical issues of implementing computer systems in hardware and software, formerly called *Computing Sciences Accreditation Board (*CSAB) – which is made up of representatives of the Association for Computing Machinery (ACM), and the IEEE Computer Society – identifies four areas that it considers crucial to the discipline of computer science: *theory of computation*, *algorithms and data structures*, *programming methodology and languages*, and *computer elements and architecture*. In addition to these four areas, CSAB also identifies fields such as software engineering, artificial intelligence, computer networking and communication, database systems, parallel computation, distributed computation, human–computer interaction, computer graphics, operating systems, and numerical and symbolic computation as being important areas of computer science.

Theoretical computer science

Theoretical Computer Science is mathematical and abstract in spirit, but it derives its motivation from practical and everyday computation. Its aim is to understand the nature of **computation** and, as a consequence of this understanding, provide more efficient methodologies. All papers introducing or studying mathematical, logic and formal concepts and methods are welcome, provided that their motivation is clearly drawn from the field of **computing**.

Theory of computation

The fundamental question underlying computer science is, "What can be (efficiently) automated?" Theory of computation is focused on answering fundamental questions about what can be computed and what amount of resources are required to perform those computations. In an effort to answer the first question, computability theory examines which computational problems are solvable on various theoretical models of computation. The second question is addressed by computational complexity theory, which studies the time and space costs associated with different approaches to solving a multitude of computational problems.

Information and coding theory

Information theory is related to the quantification of information. Coding theory is the study of the properties of codes (systems of converting information from one form to another) and their fitness for a specific application. Codes are used for data compression cryptography, error detection and correction, and more recently also for network coding. Codes are studied for the purpose of designing efficient and reliable data transmission methods.

Algorithms and data structures

Algorithms and data structures is the study of commonly used computational methods and their computational efficiency.

Источник: [Электронный ресурс] https://wn.com/computer_science/wikipedia (дата обращения: 25.11.2018)

Further information: Outline of computer science

Words and word-combinations to understand the text better

1. Computing Sciences Accreditation Board – Представительный совет по информатике
2. Association for Computing Machinery – Ассоциация по вычислительной технике
3. IEEE Computer Society – Компьютерное общество Института по электронике и радиоэлектронике
4. computer elements and architecture – компьютерные узлы и архитектура
5. software engineering – программная инженерия / технология разработки программного обеспечения
6. computer networking and communication – компьютерные сети и обмен данными
7.to derive motivation – предпосылки, движущая сила, мотивирующий фактор лежит в
8. provided that – при условии, что
9. computability theory – теория вычислимости
10. to be addressed by – обращаться к
11. computational complexity theory – теория сложности вычислений
12. quantification of information – количественная оценка информации
13. fitness – соответствие, пригодность
14. network coding – сетевое кодирование
15. computational efficiency – вычислительная эффективность.

Text 3. Computer Science. Part 3.

Programming language theory

Programming language theory is a branch of computer science that deals with the design, implementation, analysis, characterization, and classification of programming languages and their individual features. It falls within the discipline of computer science, both depending on and effecting mathematics, software engineering, and linguistics. It is an active research area, with numerous dedicated academic journals

Formal methods

Formal methods are a particular kind of mathematically based technique for the specification, development and verification of software and hardware systems. The use of formal methods for software and hardware design is motivated by the expectation that, as in other engineering disciplines, performing appropriate mathematical analysis can contribute to the reliability and robustness of a design. They form an important theoretical underpinning for software engineering, especially where safety or security is involved. Formal methods are a useful adjunct to software testing since they help avoid errors and can also give a framework for testing. For industrial use, tool support is required. However, the high cost of using formal methods means that they are only used in the development of high-integrity and life-critical systems, where safety or security is of utmost importance. Formal methods are best described as the application of a fairy broad variety of theoretical computer science fundamentals, in particular logic calculi, formal languages, automata theory and program semantics, but also type systems and algebraic data types to problems in software and hardware specification and verification.

Applied computer science

Applied computer science aims at identifying certain computer science concepts that can be used directly in solving real world problems.

Artificial intelligence

Artificial intelligence (AI) aims to or is required to synthesize goal-oriented processes such as problem-solving, decision-making, environmental adaption, learning and communication found in humans and animals. From its origins in cybernetics artificial intelligence research has been necessarily cross-disciplinary, drawing on areas of expertise such as applied mathematics, symbolic logic, semiotics, electrical engineering, philosophy of mind, neurophysiology, and social intelligence. AI is associated in the popular mind with robotic development, but the main field of practical application has been as an embedded component in areas of software development, which require computational understanding. The starting-point in the late 1940s was Alan Turing's question "Can computers think?", and the question remains effectively unanswered although the Turing test is still used to assess computer output on the scale of human intelligence. But the automation of evaluative and predictive tasks has been increasingly successful as a substitute for human monitoring and intervention in domains of computer application involving complex real-world data.

Источник:[Электронный ресурс] *https://wn.com/computer_science/wikipedia* *(дата обращения: 25.11.2018)*

Words and word-combinations to understand the text better

1. to deal with – заниматься чем-либо, быть чему-либо посвящённым
2. implementation – практическая реализация, ввод
3. to fall within –относится к чему-либо
4. specification– технические характеристики, функциональные требования
5. to be motivated by быть обусловленным
6. appropriate – соответствующий, надлежащий
7. robustness – надёжность в эксплуатации, прочность
8. theoretical underpinning – теоретическое обоснование
9. safety – безопасность, сохранность
10. security – безопасность, защита
11. adjunct – дополнение, приложение
12. framework– структура, основа, общие принципы
13. tool support – инструментальная поддержка
14. high-integrity system – система с высоким уровнем полноты безопасности
15. life-critical system – система, от которой зависит жизнь людей
16. automata theory – теория автоматов
17. type systems – системы типов
18. goal-oriented – ориентированные на достижение цели

19. drawing on – опираясь на
20. symbolic logic – формальная логика, символьная логика
21. social intelligence – социальные навыки, социальный интеллект
22. popular mind – в представлении людей
23. predictive tasks – задачи прогнозирования

Text 4. Computer Science. Part 4.

Computer architecture and engineering

(Shortened)

Computer architecture, or digital computer organization, is the conceptual design and fundamental operational structure of a computer system. It focuses largely on the way by which the central processing unit performs internally and accesses addresses in memory. The field often involves disciplines of computer engineering and electrical engineering, selecting and interconnecting hardware components to create computers that meet functional, performance, and cost goals.

Computer performance analysis

Computer performance analysis is the study of work flowing through computers with the general goals of improving throughput, controlling response time, using resources efficiently, eliminating bottlenecks, and predicting performance under anticipated peak loads.

Computer graphics and visualization

Computer graphics is the study of digital visual contents, and involves synthesis and manipulation of image data. The study is connected to many other fields in computer science, including computer vision, image processing, and computational geometry, and is heavily applied in the fields of special effects and videogames.

Computer security and cryptography

Computer security is a branch of computer technology, whose objective includes protection of information from unauthorized access, disruption, or modification while maintaining the accessibility and usability of the system for its intended users. Cryptography is the practice and study of hiding (encryption) and therefore deciphering (decryption) information. Modern cryptography is largely related to computer science, for many encryption and decryption algorithms are based on their computational complexity.

Computational science

Computer science (or scientific computing) is the field of study concerned with constructing mathematical models and quantitative analysis techniques and using computers to analyze and solve scientific problems. In practical use, it is typically the application of computer simulation and other forms of computation to problems in various scientific disciplines.

Computer networks

This branch of computer science aims to manage networks between computers worldwide.

Concurrent, parallel and distributed systems

Concurrency is a property of systems in which several computations are executing simultaneously, and potentially interacting with each other. A number of mathematical models have been developed for general concurrent computation including Petri nets, process calculi and the Parallel Random Access Machine model. A distributed system extends the idea of concurrency onto multiple computers connected through a network. Computers within the same distributed system have their own private memory, and information is often exchanged among themselves to achieve a common goal.

Databases

A database is intended to organize, store, and retrieve large amounts of data easily. Digital databases are managed using database management systems to store, create, maintain, and search data, through database models and query languages.

Software engineering

Software engineering is the study of designing, implementing, and modifying software in order to ensure it is of high quality, affordable, maintainable, and fast to build. It is a systematic approach to software design, involving the application of engineering practices to software. Software engineering deals with the organizing and analyzing of software-it doesn't just deal with the creation or manufacture of new software, but its internal maintenance and arrangement. Both computer applications software engineers and computer systems software engineers are projected to be among the fastest growing occupations from 2008 to 2018.

Источник: [Электронный ресурс] https://enacademic.com/dic.nsf/enwiki/2868 (дата обращения: 24.11.2018)

Words and word-combinations to understand the text better

1. digital computer organization – устройство / организация цифрового компьютера
2. focus on – сосредоточиться на
3. central processing unit – центральный процессор
4. access – осуществляет доступ к
5. meet the goals –соответствовать требованиям
6. performance – функциональные характеристики / эксплуатационные показатели
7. computer performance analysis – анализ производительности компьютера
8. flow through – перекачивать (зд.: выполнять)
9. throughput– пропускная способность, производительность
10. response time– время реакции системы
11. eliminating – устранение
12. bottlenecks – узкие места
13. anticipated peak loads – предполагаемая пиковая нагрузка
14. manipulation of – операции с
15. image data – изображения, видеоданные
16. computer vision – машинное зрение
17. disruption – сбой

18. accessibility – расширенный доступ
19. usability – применимость, простота использования
20. encryption – криптографическое закрытие, защита (информации)
21. deciphering – декодирование, дешифровка
22. largely – в значительной степени
23. computational science – наука о вычислениях
24. quantitative analysis techniques – методы количественного анализа
25. computer networks

Text 5. Big Data

Big data is a term that describes the large volume of data – both structured and unstructured – that ***inundates*** *a business* ***on a day-to-day basis****. But it's not the amount of data that's important. It's what organizations do with the data that* ***matters****. Big data can be analyzed for* ***insights*** *that lead to better decisions and strategic* ***business moves*****.**

Big Data History and Current Considerations

While the term "big data" is relatively new, the act of gathering and storing large amounts of information for **eventual analysis** is ages old. The concept gained momentum in the early 2000s when industry analyst Doug Laney articulated the **now-mainstream** definition of big data as the three Vs:

Volume. Organizations collect data from a variety of sources, including business transactions, **social media** and information from sensor or **machine-to-machine data**. In the past, storing it would've been a problem – but new technologies (such as **Hadoop**) have **eased the burden**.

Velocity. Data streams in at an unprecedented speed and must be dealt with **in a timely manner.**

Variety. Data comes in all types of formats – from structured, **numeric data** in traditional databases to unstructured text documents, email, video, audio, **stock ticker data** and financial transactions.

We consider two additional dimensions when it comes to big data:

Variability. In addition to the increasing velocities and varieties of data, data flows can be highly **inconsistent** with periodic peaks. Is something **trending** in social media? Daily, seasonal and **event-triggered** peak data loads can be **challenging to manage.** Even more so with unstructured data.

Complexity. Today's data comes from multiple sources, which makes it difficult to **link**, **match**, **cleanse** and transform data **across systems**. However, it's necessary **to connect and correlate relationships**, hierarchies and multiple **data linkages** or your data can quickly **spiral out of control**.

Why Is Big Data Important?

The importance of big data doesn't **revolve around** how much data you have, but what you do with it. You can take data from any source and analyze it to find answers that enable 1) cost reductions, 2) time reductions, 3) new product development and optimized offerings, and 4) **smart decision making**. When you combine big data with high-powered analytics, you can **accomplish business-related tasks** such as:

• Determining **root causes** of failures, issues and defects in near-real time.

• **Generating coupons** at the point of sale based on the customer's buying habits.

• Recalculating entire **risk portfolios** in minutes.

• Detecting **fraudulent behavior** before it affects your organization.

Источник: [Электронный ресурс]: https://www.sas.com/en_us/insights/big-data/what-is-big-data.html (дата обращения 15.09.2018)

Words and word-combinations to understand the text better

1. inundate – наводнять, наполнять

2. on a day-to-day basis – ежедневно

3. matter – иметь значение

4. insight – понимание, проникновение в сущность явлений

5. business moves – предпринимаемые шаги

6. eventual analysis – последующий анализ

7. now-mainstream – общепринятый в настоящее время

8. machine-to-machine data – межкомпьютерная передача данных

9. Hadoop (High-availability distributed object-oriented platform) – распределённая файловая система Hadoop

10. ease the burden – облегчить бремя

11. in a timely manner – оперативно, своевременно

12. numeric data – численные данные

13. stock ticker data – биржевые данные / сводки

14. Variability – изменчивость, вариабельность, способность к изменению

15. inconsistent – противоречивый, бессистемный, непоследовательный

16. trend – иметь тенденцию, изменяться в каком-нибудь направлении

17. event-triggered – инициированные каким-либо событием

18. challenging to manage – сложный в управлении, трудный для решения

19. complexity – сложность, комплексность

20. to link – соединять, компоновать, связывать между собой

21. to match – сочетать, сопоставлять, согласовывать

22. to cleanse – очищать

23. across systems – в различных системах

24. to connect and correlate relationships – устанавливать соотношения и связи

25. data linkages – увязка баз данных, взаимосвязи данных

26. spiral out of control – выходить из-под контроля

27. revolve around – быть сосредоточенным на

28. smart decision making – принятие продуманных решений

29. high-powered analytics – авторитетная, компетентная аналитика

30. accomplish business-related tasks – решать задачи, связанные с бизнесом

31. root causes – коренные причины

32. Generating coupons – выпуск купонов на скидки

33. risk portfolios – портфель рисков
34. fraudulent behavior – мошенническое поведение

Text 6. Who uses big data?

Big data affects organizations across practically every **industry**. See how each industry can benefit from this **onslaught** of information.

Banking

With large amounts of information streaming in from countless sources, banks are faced with finding new and innovative ways to manage big data. While it's important to understand customers and **boost** their satisfaction, it's equally important to minimize risk and **fraud** while maintaining **regulatory compliance**. Big data brings big insights, but it also requires financial institutions to **stay one step ahead of the game** with **advanced analytics**

Education

Educators armed with **data-driven insight** can make a significant impact on school systems, students and curriculums. By analyzing big data, they can identify **at-risk students**, make sure students are making **adequate progress**, and can implement a better system for evaluation and support of teachers and principals.

Government

When government agencies are able **to harness** and apply analytics to their big data, they **gain significant ground** when it comes to managing **utilities**, running **agencies**, dealing with **traffic congestion** or **preventing crime**. But while there are many advantages to big data, governments must also address issues of transparency and **privacy**.

Health Care

Patient records. Treatment plans. **Prescription information**. When it comes to health care, everything needs to be done quickly, accurately – and, in some cases, with enough transparency to satisfy stringent **industry regulations**. When big data is managed effectively, health care providers can uncover **hidden insights** that improve patient care.

Manufacturing

Armed with insight that big data can provide, manufacturers can boost quality and **output** while **minimizing waste** – processes that are key in today's highly **competitive market**. More and more manufacturers are working in an analytics-based culture, which means they can solve problems faster and make more agile business decisions

Retail

Customer relationship building **is critical to** the retail industry – and the best way to manage that is to manage big data. Retailers need to know the best way to market to customers, the most effective way to **handle transactions**, and the most strategic way to bring back lapsed business. Big data remains at the heart of all those things.

Источник: [Электронный ресурс]: https://www.sas.com/en_us/insights/big-data/what-is-big-data.html (дата обращения 15.09.2018)

Words and word combinations to understand the text better

1. industry – отрасль
2. onslaught – натиск
3. boost – способствовать (повышению уровня), усиливать
4. fraud – мошенничество
5. regulatory compliance – нормативно-правовое соответствие
6. stay one step ahead of the game – действовать на опережение, опережать на шаг
7. advanced analytics – расширенная аналитика, передовые средства анализа данных
8. data-driven insight – выводы из анализа данных, результаты аналитической обработки данных

9. at-risk students – ученик / студент, входящий в группу риска

10. adequate progress – достаточные успехи

11. to harness – использовать возможности

12. gain ground – укреплять свои позиции / своё положение

13. utilities – коммунальный комплекс, предприятия коммунального хозяйства

14. agencies – государственные учреждения

15. traffic congestion – транспортные робки

16. preventing crime – предотвращение преступлений

17. privacy – неприкосновенность личной информации, неприкосновенность частной жизни, защита персональных данных

18.health care – здравоохранение

19. patient records – история болезни, карта больного, медицинская карточка

20. prescription information – информация о предписаниях врача

21. industry regulations – отраслевые нормативные положения

22. health care providers – медицинские работники

23. hidden insights – неявная ценная информация

24. output – выпуск продукции

25. waste – потери, отходы производства

26. competitive market – конкурентный рынок

27. retail – розничная торговля

28. to be critical to – быть крайне важным длч

29. to handle transactions – осуществлять контроль за операциями

PART II. TEXTS ON VARIOUS THEMES OF APPLIED MATHEMATICS AND COMPUTER SCIENCES

SUPPLEMENTARY READING

Text 1. Difference Between Mathematics and Applied Mathematics Mathematics vs Applied Mathematics

Mathematics first emerged from the daily necessity of the ancient people to count. Trading, referring to time, and measuring the crop or land required numbers and values to represent them. Search of creative ways of solving above problems resulted in the basic form of mathematics, which resulted in natural numbers and their computations. Further development in the field led to the introduction of zero, then negative numbers.

Through thousands of years of developments mathematics have left the fundamental form of computation and transformed into more abstract study of the mathematical entities. Most interesting aspect of this study is that these concepts can be used in the physical world for prediction and for countless other uses. Therefore, mathematics has a very important position in any developed civilization in the world. The abstract study of the mathematical entities can be considered as pure mathematics while the methods describing their application for specific cases in the real world can be considered as applied mathematics.

Mathematics

Simply put, mathematics is the abstract study of quantity, structure, space, change, and other properties. It has no strict universal definition. Mathematics originated as a means of calculating, though it has developed into a field of study with a wide variety of interests.

Mathematics is governed by logic; supported by the set theory, category theory and theory of computation give structure to the understanding and investigating mathematical concepts.

Mathematics is basically divided into two fields as pure mathematics and applied mathematics. Pure mathematics is the study of entirely abstract mathematical concepts. Pure mathematics has sub fields concerning the quantity, structure, space, and change. Arithmetic and number theory discuss the computations and quantities. Larger, higher structures in the quantities and numbers are investigated in the fields such as algebra, number theory, group theory, order theory, and combinatorics.

Geometry investigates the properties and objects in the space. Differential geometry and topology give a higher level understanding of space. Trigonometry, fractal geometry, and measure theory also involve the study of space in a general and abstract manner.

The change is the core interest of the fields like calculus, vector calculus, differential equations, real analysis and complex analysis, and chaos theory.

Applied Mathematics

Applied mathematics focus on the mathematical methods used in real life applications in engineering, sciences, economics, finance, and many more subjects.

Computational mathematics and statistical theory with other decision sciences are the major branches of applied mathematics. Computational mathematics investigates the methods for solving mathematical problems difficult for ordinary human computational capacity. Numerical analysis, game theory, and optimization are among several of the important computational mathematics fields.

Fluid mechanics, mathematical chemistry, mathematical physics, mathematical finance, control theory, cryptography, and optimization are fields enriched by methods in computational mathematics. The computational mathematics extends into computer science too. From internal data structures of large databases and performance of algorithms to very design of computers rely on sophisticated computational methods.

What is the difference between Mathematics and Applied Mathematics?

• Mathematics is the abstract study of the quantity, structure, space, change, and other properties. It is generalized in most cases, to represent the higher structure in the mathematical entities and, therefore, sometimes difficult to comprehend.

• Mathematics is based on mathematical logic, and some fundamental concepts are described using the set theory and category theory.

• Calculus, Differential equations, algebra etc. provide means of understanding the structure and properties of quantity, structure, space, and change in abstract ways.

• Applied mathematics describes the methods in which mathematical concepts can be applied in the real world situations. Computational sciences such as optimization and numerical analysis are fields in applied mathematics.

Источник: [Электронный ресурс]: https://www.differencebetween.com/difference-between-mathematics-and-vs-applied-mathematics/ (дата обращения: 20.11.2018)

Text 2. What is Biomathematics?

Biomathematics is the use of mathematical models to help understand phenomena in biology. Modern experimental biology is very good at taking biological systems apart (at all levels of organization, from genome to global nutrient cycling), into components simple enough that their structure and function can be studied in isolation. Dynamic models are a way to put the pieces back together, with equations that represent the system's components, processes, and the structure of their interactions.

Mathematical models are important tools in basic scientific research in many areas of biology, including physiology, ecology, evolution, toxicology, immunology, natural resource management, and conservation biology. The result obtained from analysis and simulation of system models are used to test and extend biological theory, and to suggest new hypotheses or experiments. Models are also widely used to synthesize available information and provide quantitative answers to practical questions. What measures can be used to reverse the decline in sea turtle populations, and how soon can we tell if they are working? How can laboratory experiments on chemical carcinogenicity be scaled up to set safe exposure limits on humans? For questions like these, where it is desirable to predict the outcome accurately before action is taken, quantitative modeling is essential.

Thus, while mathematical biology may sound like a narrow discipline, in fact it encompasses all of biology and virtually all of the mathematical sciences, including statistics, operations research, and scientific computing.

Источник : [Электронный ресурс] : http://bma.math.ncsu.edu/what-is-biomathematics/

Text 3. Mathematical Biology Modules Based on Modern Molecular Biology and Modern Discrete Mathematics

Raina Robeva, Robin Davies, Terrell Hodge, Alexander Enyedi

INTRODUCTION

In the last decade, the field of life sciences has undergone revolutionary changes spanning remarkable discoveries at all levels of biological organization–molecules, cells, tissues, organs, organisms, populations, and communities. A salient trait of these advances is the increased need for statistical, computational, and mathematical modeling methods. Scientific instruments are now, by orders of magnitude, more sensitive, more specific, and more powerful. The amounts of data collected and processed by these new-generation instruments have increased dramatically, rendering insufficient the traditional methods of statistical data analysis. Nowhere, however, have the problems of amassing huge amounts of data been more clearly demonstrated than in attempts to unravel the secrets of genetic mechanisms.

For example, automated DNA sequencing has given rise to an information explosion, and the challenge now is to extract meaning from all of this sequence information. The quest to better understand temporal and spatial trends in gene expression has led us to search for DNA sequences that have been conserved over time in a large number of species. The existence of such conserved strings in different species suggests that these sequences may perform fundamental functions in the genome and thus be critical to our understanding of life on earth. However, determining candidates for DNA sequences that have been conserved over time across different species is a tremendous task, because the human genome alone is approximately 3 billion base pairs. Comparing across species then requires comparisons of further billions of sequences, over thousands of species. The sheer size of the data sets suggests that appropriate use of mathematical models coupled with statistical methods for data analysis and inference will play an irreplaceable role in contemporary biology. Frequent announcements of the sequencing of additional organisms, such as the rhesus macaque and the domestic horse demonstrate that the complexity of the data sets is continually growing; thus, future advances in molecular biology will need to rely even more heavily on the use of mathematical methods.

Similarly, the field of molecular systems biology has emerged as equally mathematically driven. Broadly defined, this is a field that examines how "… large numbers of functionally diverse, and frequently multifunctional, sets of elements interact selectively and nonlinearly to produce coherent behavior". ...A recent proposal for a new national initiative (toward "the New Biology") identifies health issues as one of four key areas where a systems biology approach and improvements in mathematical and statistical modeling will be prerequisites for progress.

The challenge is to combine the rich but disparate insights of molecular biology into a conceptual framework that better allows us to see the overall structure of molecular (and other) mechanisms. Mathematical models have proved to be indispensable in this regard. Indeed, ...the main push in biology during the coming decades will be toward an increasingly quantitative understanding of biological functions. ...the traditional segregation in higher education of biology from mathematics and physics presents challenges and requires an integration of these subjectsare now widely accepted and a range of diverse mathematical methods are now routinely used to seek answers to questions from systems biology.

...Aspects of modern discrete mathematics and algebraic statistics have recently made a significant impact on molecular biology, much as calculus-empowered population biology and epidemiology have had in the early 20th century. Examples include finite dynamical systems models of the metabolic network in Escherichia coli and the abscisic acid signaling pathway, methods from algebraic geometry applied in evolutionary biology to develop new approaches to sequence alignment , new modeling of viral capsid assembly developed using geometric constraint theory, and algorithms based on algebraic combinatorics used to study RNA secondary structures.

Источник : [Электронный ресурс] : CBE Life Sci Educ. 2010 Fall; 9(3): 227–240.

Text 4. Computer Models and Automata Theory In Biology and Medicine

Ion C. Baianu

The applications of computers to biological and biomedical problem solving goes back to the very beginnings of computer science, automata theory, and mathematical biology. With the advent of more versatile and powerful computers, biological and biomedical applications of computers have proliferated so rapidly that it would be virtually impossible to compile a comprehensive review of all developments in this field. Limitations of computer simulations in biology have also come under close scrutiny, and claims have been made that biological systems have limited information processing power. Such general conjectures do not, however, deter biologists and biomedical researchers from developing new computer applications in biology and medicine. Microprocessors are being widely employed in biological laboratories both for automatic data acquisition/processing and modeling; one particular area, which is of great biomedical interest, involves fast digital image processing and is already established for routine clinical examinations in radiological and nuclear medicine centers, Powerful techniques for biological research are routinely employing dedicated, on-line microprocessors or array processors; among such techniques are: Fourier-transform nuclear magnetic resonance (NMR), NMR imaging (or tomography), x-ray tomography, x-ray diffraction, high performance liquid chromatography, differential scanning calorimetry and mass spectrometry.

Networking of laboratory microprocessors linked to a central, large memory computer is the next logical step in laboratory automation. Previously unapproachable problems, such as molecular dynamics of solutions, many-body interaction calculations and statistical mechanics of biological processes are all likely to benefit from the increasing access to the new generation of "supercomputers". In view of the large number, diversity and complexity of computer applications in biology and medicine; ...fundamental aspects of computer applications ...are likely to continue to make an impact on biological and biomedical research. ...[In this connection] a number of basic biological questions [are as follows]:

(1) What are the essential characteristics of a biological organism as opposed to an automaton?

(2) Are biological systems recursively computable?

(3) What is the structure of the simplest (primordial) organism?

(4) What are the basic structures of neural and genetic networks?

(5) What are the common properties of classes of biological organisms?

(6) Which system representations are adequate for biodynamics?

(7) What is the optimal strategy for modifying an organism through genetic engineering?

(8) What is the optimal simulation of a biological system with a digital or analog computer?

(9) What is life?

Источник: [Электронный ресурс]: Mathematical Modelling, Vol. 7, pp. 1513-1577,1986

http://cogprints.org/3687/1/COMPUTERMODELSAUTOMATA_THEORYCOGNITIVEBIOLOGYMEDminOK.htm

Text 5. Modelling of Neurons and Carcinogenesis

Confocal microscope images showing the relationship between a neuron (green) and the locations of a particular class of inputs. This neuron has been selectively stained and represents one of a large population of neurons in the same area.

An understanding of the behaviour and function of the neuron – the basic building block of the central nervous system – provides a good example of the character of Mathematical Biology. A neuron ...has a complex shape and consists of a thin membrane separating an intracellular fluid, rich in potassium ions, from an extracellular fluid containing an abundance of sodium ions. It has been well known for over 100 years that neurons exhibit a vast range of geometries, and although its widely accepted that this geometry is important, its role in shaping the behaviour of a neuron is at best poorly understood. This behaviour is best understood in terms of the biophysical properties of neurons, including, for example, how ionic species inside and outside the neuronal membrane interact to generate the electrical activity characteristic of all neurons.

The prevailing mathematical model for these ionic interactions is due to the Nobel Prize winning work of Hodgkin and Huxley (1953). An important task of the mathematician is to reveal how the complex geometry and biophysical properties of a neuron are combined to determine its function. The analytical and numerical techniques required to achieve this objective are diverse and need to be developed through a detailed understanding of all aspects of the neuron.

This is a complex task. Neuronal growth is stochastic; the inputs to and outputs from a neuron are best described as stochastic processes. Furthermore, the neuronal membrane behaves in a nonlinear fashion. Consequently the task of connecting neuron geometry, neuron biophysical properties and function for a single neuron and a network of neurons lies firmly in the domain of the applied mathematician, physicist and electrical engineer.

While neural networks have been used widely as information processing devices, its interesting to note that perhaps Nature's greatest creation, the human brain, does not resemble a neural network as it is currently understood. To understand the function of collections of neurons (a brain), and how such a collection processes information, is one of the outstanding problems in biological mathematics of the 21st century.

An advantage of the concentration in tumour cells of radionuclides with long range emissions (e.g. 131 l) is the presence of a radiological bystander effect. That is, the bombardment of untargeted cells by beta decay particles emanating from neighbouring, successfully targeted cells which have actively accumulated 131 l-labelled drug

The modelling of carcinogenesis is another, very different, area in which Applied Mathematics contributes to the developement of biological research and medicine. Complex biological organisms such as mammals develop through cell differentiation. This is a process in which primitive cells (stem cells) with a high reproductive capacity generate a cascade of progressively more complex cell types which become increasingly particularised to specific bodily tasks (e.g. liver cells), but in so doing lose their ability to divide. The process of cell division, however, is inherently risky and can go wrong in various ways. Normally mutations in DNA are detected by guardian genes which then prevent the cell dividing to allow derair of lesions or to set in motion cell suicide (Apoptosis).

However, on the odd occasion, a damaged cell will divide successfully and in the process produce more similarly damaged cells as futher cell division occurs. As time evolves, a spectrum of cells with varying degrees of damage will develop until a malignant transformation takes place in a particular cell. This malignant cell can become the ancestor of a colony of malignant cells (a tumour). It is axiomatic that tumour cells do not recognize the body's control mechanisms and so grow uncontrollably. The number of separate mutations needed for malignant transformation is an important question as is the inheritability of these mutations. Mathematical models of carcinogenesis can answer these questions. ...Mathematical models of carcinogenesis also provide insight into biological mechanisms by enabling them to be simulated and comparisons drawn between the results of the simulation and observation.

... Mathematical models also play a dominant role in modelling the carcinogenic risk of chemicals and radiation either as tools to control of tumours or as carcinogenic in the environment. For example, the assocation between the presence of radiation and increased risk of cancer in conjunction with the association between nuclear facilities and local increases in cancer incidence might suggest that radiation from nuclear facilities causes an increase in the local incidence of cancer. Interestingly, however, high local incidences of cancer are often experienced in remote areas devoid of nuclear facilities but with a high influx of itinerant workers. Another possible explanation for the local increase in cancer incidence is that continuous population mixing causes infections which in turn lead to increased levels of immune cell division, thereby increasing the risk of cell mutation. This important question is one that can only be answered satisfactorily by mathematics.

Источник: :[Электронный ресурс]
http://www.maths.gla.ac.uk/research/groups/biology/kal.htm

Text 6. The History of Applied Mathematics And the History of Society

Michael Stolz

The historiography of mathematics is a field of research which incorporates several divergent traditions or methodological stances. It has proven convenient to divide the field roughly into an “internalist” and an “externalist” approach. The internalist one, for which Eberhard Knobloch’s contribution to the present volume may serve as an example, aims at reconstructing the development of mathematical concepts in the work of a particular mathematician or in the discussions of a certain group of mathematicians. A history of that kind is sometimes bound to presuppose on the part of the reader a thorough understanding of the relevant mathematical subject matter. On the other hand, the externalist approach is characterized by an attempt to place a certain aspect of mathematics within a relevant extramathematical context.

Since there are, of course, several kinds of context which might be deemed relevant, studies in the history of mathematics which are written in the externalist vein possibly do not have very much in common. So it is the first aim of the present paper to convey an idea of the variety of social contexts into which the history of mathematics can be set. Whatever differences there may be, the externalist historiography of mathematics usually tends to present a relatively low level of technicality and thus to be accessible to the non-specialist. In particular,1 general historians, who are chiefly interested in the history of society or of political ideas, and whose speciality may be the history of trade unions or of anti-communist intellectuals, can read studies of this kind without any insurmountable difficulties. It is the second aim of this paper to show that they might even consider this reading worthwhile.

More specifically, it will be argued that several themes in the historiography of 20th century applied mathematics fit in with some recent research trends in general contemporary history and that a closer cooperation between historians of mathematics and general historians might favor the integration of externalist and internalist approaches in the historiography of mathematics. By way of a case study, the paper focusses on those parts of 20th century applied mathematics which have entered into the toolkit of economics and management science. The main examples are statistics and operations research (OR). No attempt is made to elucidate the complex social dimensions of applied mathematics as a whole – a field whose demarcation as opposed to pure mathematics and to the natural and engineering sciences is in itself thoroughly social and historical. Nevertheless, the question whether OR belongs to the province of the historian of mathematics deserves some comment. In fact, the practitioners of OR show a tendency toward stressing its interdisciplinary character, especially the close connection between OR and the social sciences (cf., e.g., Lesourne (1990)). What is more, if the history of mathematics was confined to nontrivial theoretical achievements, the quantitative methods employed in management would to a considerable extent have to be excluded from this history. An illuminating discussion of these points can be found in the text of an address, given in 1982 not by a historian, but by a research mathematician, J. Barkley Rosser (Rosser 1982, 509–

510). His retrospective views of his work in wartime OR deserve to be quoted at some length: What is mathematics? I take the entirely pragmatic view that if a person's associates thought the problem he or she was solving was a mathematical problem, then it was. Many of you will disagree with this. Indeed, many of the mathematicians involved in such enterprises during the War privately did not accept this definition. The attitude of many with the problems they were asked to solve was that the given problem was not really mathematics but, since an answer was needed urgently and quickly, they got on with it. And there was another aspect. Problems that purported to require mathematical treatment were often not clearly formulated. A discussion between the person with the problem and a mathematician could result in a major reformulation. This usually resulted in a simplification. I shall count this also as mathematics. . . . Is OR (operations research) mathematics?

Nowadays, the practiitioners insist that it is a separate discipline, and I guess by now [1982] it is. It is certainly not now taught in departments of mathematics. But, it grew out of mathematics. At the beginning of OR, during the war, it was mathematics according to my definition above, although some of the very good operators were physicists and chemists. The Air Force Generals and Navy Admirals thought it was wonderful stuff. You could not have convinced one of them that it was not mathematics.

Источник: Stolz M. The History of Applied Mathematics and the History of Society. *// Kluwer Academic Publishers. Printed in the Netherlands. – 2002 :[Электронный ресурс]:*
https://link.springer.com/article/10.1023%2FA%3A1020823608217?LI=true

Text 7. "Review: Theory of Games and Economic Behavior by John von Neumann and Oskar Morgenstern"

Copeland, A. H.

BOOK REVIEW

Posterity may regard this book as one of the major scientific achievements of the first half of the twentieth century. This will undoubtedly be the case if the authors have succeeded in establishing a new exact science–the science of economics. The foundation which they have laid is extremely promising. Since both mathematicians and economists will be needed for the further development of the theory it is in order to comment on the background necessary for reading the book. The mathematics required beyond algebra and analytic geometry is developed in the book.

On the other hand the non-mathematically trained reader will be called upon to exercise a high degree of patience if he is to comprehend the theory. The mathematically trained reader will find the reasoning stimulating and challenging. As to economics, a limited background is sufficient. The authors observe that the give-and-take of business has many of the aspects of a game and they make an extensive study of the strategy of games with this similarity in mind (hence the title of this book).

In the game of life the stakes are not necessarily monetary; they may be merely utilities. In discussing utilities the authors find it advisable to replace the questionable marginal utility theory by a new theory which is more suitable to their analysis. They note that in the game of life as well as in social games the players are frequently called upon to choose between alternatives to which probabilities rather than certainties are attached.

The authors show that if a player can always arrange such fortuitous alternatives in the order of his preferences, then it is possible to assign to each alternative a number or numerical utility expressing the degree of the player's preference of or that alternative. The assignment is not unique but two such assignments must be related by a linear transformation. The concept of a game is formalized by a set of postulates.

Even the status of information of each player on each move is accounted for and is characterized by a partition of a certain set.

Источник: [Электронный ресурс] http://www.ams.org/journals/bull/1945-51-07/S0002-9904-1945-08391-8/S0002-9904-1945-08391-8.pdf
From Nobel Lectures, Economics 1969-1980, Editor Assar Lindbeck, World Scientific Publishing Co., Singapore, 1992

Text 8. Mathematical Linguistics

Geoffrey K. Pullum and Andr´as Kornai

MATHEMATICAL LINGUISTICS is the study of mathematical structures and methods that are of importance to linguistics. As in other branches of applied mathematics, the influence of the empirical subject matter is somewhat indirect: theorems are often proved more for their inherent mathematical value than for their applicability. Nevertheless, the internal organization of linguistics remains the best guide for understanding the internal subdivisions of mathematical linguistics, and we will survey the field following the traditional division of linguistics into → Phonetics, → Phonology, → Morphology, → Syntax, and → Semantics, looking at other branches of linguistics such as → Sociolinguistics or → Language Acquisition only to the extent that these have developed their own mathematical methods.

Phonetics

The key structures of both mathematical and phonetic interest are → Hidden Markov Models (HMMs). Their importance stems from the way their structure is set up: discrete, psychologically relevant underlying units as hidden states coupled with continuous, physically relevant output. Though phoneticians routinely use the mathematical apparatus of ACOUSTICS ever since the pioneering work of Helmholtz (1859), neither DIFFERENTIAL EQUATIONS nor HARMONIC ANALYSIS are considered part of mathematical linguistics, because they enter the picture only indirectly, as part of the physics of the medium carrying the linguistic signal. HMMs, on the other hand, remain equally applicable if the modality is changed from spoken to written or signed language.The HMM idea of discrete structural units (typically → Phonemes or → Words) coupled with continuous phonetic phenomena inspired the LAFS (Lexical Access From Spectra) model (Klatt 1980), the first explicit → Psycholinguistic model incorporating the modern apparatus of SIGNAL PROCESSING. Without the additional expense of adding recurrence neural nets can only deal with inputs and outputs of a fixed dimension, and once recurrence is added, neural net training becomes extremely complex. HMMs, on the other hand, assume a Markovian underlying structure, which is, for the most part, ideally suited for modeling the succession of linguistic units, having been developed by Markov (1913) for this very purpose.

Phonology and Morphology Starting with Bloomfield's (1926) postulates, the basic conceptual apparatus of mathematical linguistics – in particular, the idea of hierarchical structures composed of relatively stable recurrent items – was developed primarily on the basis of phonological and morphological phenomena. Chomsky (1956, 1959) formulated three theoretical models for the description of linguistic structure, one based on → FiniteState Automata (FSA), one based on → Context-Free Grammars (CFGs), and one on context-sensitive grammars (CSGs) and/or the even more powerful Unrestricted Rewriting Systems (URSs). The relation between these is investigated under the heading → Generative Capacity, and was the basis of much further work on formal language theory within computer science. Regarding mathematical work on phonology, there were some logicians and linguists ...who worked on phonemic theory from a set-theoretic standpoint in the 1960s and 1970s, but such work had little impact on linguistic practice. The definitive formalization of theoretical phonology and morphology was that proposed by Chomsky and Halle (1968), using URSs. By that time, it was well known that ordered sets of CSG or URS rules provide a good mathematical reconstruction of Panini's (morpho)phonological rules, and are superior to the neogrammarian SOUND LAWS both in descriptive detail and in predictive power.

...Until the mid-1970s, the internal structure of phonological representations, based on Distinctive Features, could be formalized by embedding it in an n-dimensional cube. With the advent of → Autosegmental and → Metrical phonology, a considerably more involved formalism became necessary. While the representations retained this additional complexity, in the 1990s the whole notion of rules operating on such representations in sequence was abandoned in favor of → Optimality Theory which describes the relationship between underlying and surface units in terms of rank-ordered constraint systems.

A number of mathematical linguists (including Jason Eisner, Robert Frank, Markus Hiller, Lauri Karttunen, Giorgio Satta) have shown that this mode of description need not imply an increase in generative capacity, inasmuch as FSTs, under various sets of assumptions, have sufficient power to model the interaction of systems of ranked constraints. Markov's pioneering work is a contribution both to phonology and to → Statistical Linguistics, given the near-phonemic nature of Russian orthography. Historically, the development of Markov models took place largely in isolation from mainstream phonology and morphology, largely because these offer a rich storehouse of LONG DISTANCE and NON-CONCATENATIVE phenomena, which in a segmental framework appear as violations of the Markovian assumption.

...Chomsky's first significant technical contribution to linguistics was his formalization of IMMEDIATE CONSTITUENT ANALYSIS by means of → Context Free Grammars (Chomsky 1956, 1959). Though in the definition of CFGs he sacrificed some of the detail of the earlier work, from a mathematical perspective CFGs hit on a particularly sweet spot: just as FSA correspond to the rationals, CFGs correspond to algebraic numbers (see Eilenberg 1974). CFGs found an immediate application in the design of PROGRAMMING LANGUAGES, where they retain a central position to this day, in spite of the fact that it can be shown that a number of widely used programming languages go beyond the context-free in some respects. ...In fact, much of the early work in mathematical linguistics concerned with efficient methods of parsing eventually found a better home in COMPILER DESIGN → Parsing. The key idea of CFGs was to replace the symmetrical (equational) notation used in earlier formulations by the asymmetrical notion of string rewriting that had, up to that point, been applied only by logicians, and only in settings of considerably broader generality, recursively enumerable or recursive. ...The resulting theory can be expressed in terms of finite TREE AUTOMATA. In a CSG, both hierarchical and linear context plays a role, and the resulting theory turns out to be equivalent to Turing machines with workspace linear in the size of the input. → Automata Theory.

Источник: [Электронный ресурс]: https://www.kornai.com/MatLing/matling3.pdf

Text 9. The Mathematics of Language

Marcus Kracht
September 16, 2003

(From the *Introduction*)

This book is – as the title suggests – a book about the mathematical study of language, that is, about the description of language and languages with mathematical methods. It is intended for students of mathematics, linguistics, computer science, and computational linguistics, and also for all those who need or wish to understand the formal structure of language. It is a mathematical book; it cannot and does not intend to replace a genuine introduction to linguistics. ...No linguistic theory is discussed here in detail. This text only provides the mathematical background that will enable the reader to fully grasp the implications of these theories and understand them more thoroughly than before. ...On the linguistic side the emphasis is on syntax and formal semantics, though morphology and phonology do play a role.

...The main mathematical background is algebra and logic on the semantic side and strings on the syntactic side. In contrast to most introductions to formal semantics we do not start with logic – we start with strings and develop the logical apparatus as we go along. ...Thus we have decided to introduce logical tools only when needed, not as overarching concepts. We do not distinguish between natural and formal languages. These two types of languages are treated completely alike. I believe that it should not matter in principle whether what we have is a natural or an artificial product. Chemistry applies to naturally occurring substances as well as artificially produced ones. All I will do here is study the structure of language.

Noam Chomsky has repeatedly claimed that there is a fundamental difference between natural and nonnatural languages. Up to this moment, conclusive evidence for this claim is missing. ...To the contrary, the methods established here might serve as a tool in identifying what the difference is or might be. The present book also is not an introduction to the theory of formal languages; rather, it is an introduction to the mathematical theory of linguistics.

...On the other hand, this book does treat subjects that are hardly found anywhere else in this form. The main characteristic of our approach is that we do not treat languages as sets of strings but as algebras of signs. This is much closer to the linguistic reality. We shall briefly sketch this approach. ...A sign σ is defined here as a triple e c m – , where e is the exponent of σ, which typically is a string, c the (syntactic) category of σ, and m its meaning. By this convention a string is connected via the language with a set of meanings. Given a set Σ of signs, e means m in Σ if and only if (= iff) there is a category c such that e c m – Σ. Seen this way, the task of language theory is not only to say which are the legitimate exponents of signs ...but it must also say which string can have what meaning. The heart of the discussion is formed by the principle of compositionality, which in its weakest formulation says that the meaning of a string (or other exponent) is found by homomorphically mapping its analysis into the semantics. ...We shall also deal with Montague Semantics, which arguably was the first to implement this principle. Once again, the discussion will be rather abstract, focusing on mathematical tools rather than the actual formulation of the theory.

... A system of signs is a partial algebra of signs. This means that it is a pair Σ M – , where Σ is a set of signs and M a finite set, the set of so–called modes (of composition). Standardly, one assumes M to have only one nonconstant mode, a binary function !, which allows one to form a sign σ1 ! σ2 from two signs σ1 and σ2 . The modes are generally partial operations. The action of ! is explained by defining its action on the three components of the respective signs. ...The key construct is the free algebra generated by the constant modes alone. This algebra is called the algebra of structure terms. The structure terms can be generated by a simple context free grammar. However, not every structure term names a sign. Since the algebras of exponents, categories and meanings are partial algebras, it is in general not possible to define a homomorphism from the algebra of structure terms into the algebra of signs. All we can get is a partial homomorphism. In addition, the exponents are not always strings and the operations between them not only concatenation. Hence the defined languages can be very complex.

...Before one can understand all this in full detail it is necessary to start off with an introduction into classical formal language theory using semi Thue systems and grammars in the usual sense. ...we have added some sections containing basics from algebra, ...We shall deal with the recognizability of these languages by means of automata, recognition and analysis problems, parsing, complexity, and ambiguity. ...we shall discuss semilinear languages and Parikh's Theorem. ...we shall begin to study languages as systems of signs. ...Then we shall concentrate on the system of categories and the so–called categorial grammars.

...We shall study these types of grammars in depth. ...we shall return to the question of compositionality in the light of Leibniz' Principle, and then propose a new kind of grammars, de Saussure grammars. ...This is very far away from the tradition of generative grammar advocated by Chomsky, who always insisted that language contains a generating device (though on the other hand he characterizes this as a theory of competence). However, it turns out that there is a method to convert descriptions of syntactic structures into syntactic rules. ...However, the reverse problem, extracting principles out of rules, is actually very hard, and its solvability depends on the strength of the description language. This opens the way into a logically based language hierarchy, which indirectly also reflects a complexity hierarchy.

Источник: [Электронный ресурс] https://linguistics.ucla.edu/people/Kracht/courses/compling2-2007/formal.pdf

Text 10. Literature and Mathematics

Masahiko Fujiwara

The French poet Paul Valéry once expressed his great admiration for mathematics, saying, "I worship this most beautiful subject of all and I don't care that my love remains unrequited." Valéry is not the only writer with this enthusiasm for mathematics–just as there are many lovers of mathematics in the world of literature, so are there many lovers of literature in the world of mathematics despite the thick brick wall that seems to stand between the two disciplines. At a glance, mathematics and literature have no reciprocity as subjects and no one to date has been successful in both fields, yet some mysterious magnetic force draws them together. The question is: What comprises this brick wall; what creates this magnetic force? Mathematics is generally categorized as a science, but I don't think it is only that. I admit that mathematics has contributed to the realms of physical science, and has itself been reinforced by its interactions with them, but mathematical discoveries are made regardless of their applicability or utility to the physical world.

Mathematics has evolved purely for itself, with the greatest contributions to the field being those theories that put value on the beauty of the adopted logic. A theory contrived for purposes other than itself lacks natural beauty. What is mysterious is that a great theory possessed of inherent beauty transcends the subject and finds applicability in other fields.

It is impossible to put in words the intrinsic grace of a theorem. It is highly abstract and complex. I can only describe it as being akin to a perfect piece of music in which each note is irreplaceable or to a haiku in which no syllable can be changed. The beauty I speak of is like the exquisite tension that holds together aspects of a work of art; a fragile serenity that cements its perfection. And so the magnetic force that draws art–and therefore literature–to mathematics is the dignified beauty of its pure logic.

...a writer, sitting at his desk round the clock, would have made some progress, some scribbles on paper. No matter the pace, he can see the page slowly fill with words. His creative process becomes visible to him and he is comforted by it; he is strengthened to go on.

Mathematics is an all-or-nothing business: either one can prove one's theorem or one cannot. There is no grey area. One cannot 'almost prove' or 'nearly resolve' anything. No compromise is permitted. The completed theory must be free of ambiguity. Nothing but the absolute–and therefore beautiful–proof is of any value to mathematics. In literature, however, it is not important that everything be explained. ...This might suggest that literature is more flexible, somehow easier to tackle than mathematics.

In mathematics, no one assures you that you will definitely achieve something after striving for a long period. If his attempted theorem transcends the standards of modern mathematics or is beyond the mathematician's resources, it may never be proven, regardless of the amount of work invested. Worse, the theorem to which he dedicates himself for so long might prove, in the end, to be mercilessly wrong. The fear of this uncertain result can swell into a terror so numbing, it chips away at the mathematician's ambition. On top of this, he has to endure the pressures of academia. A mathematician must therefore be a man of patience and of courage.

...I know of a mathematician who went through great difficulty to produce a work of extraordinary genius. Professor S. now works at MIT, but he was once attached to the University of Michigan as an assistant professor. While at Michigan, he challenged himself to work on a particularly difficult classical problem. ...His devotion to the problem was so great that he failed to write the thesis expected of him and was therefore dismissed from his post at the university. But not long after that, he found a ground-breaking solution to the problem. ...As a result of his success, Professor S. was offered a post as full professor at MIT. But this is a rare case. Most mathematicians would not have had the tremendous self-reliance and confidence it took to risk a job for such an uncertain goal.

Writers, on the other hand, have clearer goals, as long as they dedicate themselves to the task. The knowledge that I can complete a task to the extent my talents afford assures and encourages me. There is, however, in literature the hurdle of the deadline, particularly when writing for a magazine or newspaper column.

The defining feature of a mathematician's stress is the fear that he will produce nothing, even after suffering 'birth pangs.' For a writer, it is the pressure of having to complete a work within a certain period of time. What is common to both is the struggle to sleep free of concerns.

...Having writers in my family and being a mathematician myself, I thought I had a good sense of what they were about when I began to enter both fields. But I was too optimistic. Although both literature and mathematics involve creativity and both evaluate beauty and harmony, their methodologies are poles apart. Mathematics is based on a universal logic pursued by the mathematician's instinct and aesthetic sensitivity whereas literature demands originality and sensitivity to words. So, for a few days after working in mathematics, I find it impossible to produce anything literary, and vice versa. I need some time to switch from one mode to the other and during this period of transition, things go round and round, and I spend most of my time fretting away

...In my opinion, the essence of all literature, no matter the form it takes, is the realization of one's own mortality. Without the notion of death, almost all our sorrows, our desperation and loneliness would disappear. If we were phoenixes with eternal life, we would never experience dark days or broken hearts, nor would we be capable of absolute joy or delight–all vital components of literature.

Literature is deeply bound to the notion of death and writers consciously and unconsciously weave strands of human destiny into their stories. Masterpieces ...study the transience of human life. This awareness of one's mortality can be seen in contemporary literature.

...Writers and mathematicians both long for eternity, the difference between them being that the former seek it in their own lives while the latter look for it beyond individual human life. When a mathematician begins to explore universal truth, he must abandon his inner chaos.

...It must be clear now how demanding it is to come and go between literature and mathematics. It does not involve merely the techniques of each field, but a total qualitative transformation of the mind. I have yet to master a smooth transformation.
Translated from the Japanese by Sayuri Okamoto

Источник: [Электронный ресурс]: https://www.asymptotejournal.com/nonfiction/masahiko-fujiwara-literature-and-mathematics/

Text 11. Marcus du Sautoy explains how mathematical proofs are like narratives, with plots, thrills and 'whodunnit' reveals

Sept 2017

Mathematicians are storytellers. Our characters are numbers and geometries. Our narratives are the proofs we create about these characters.

Many people believe that doing maths is a question of documenting all the true statements about numbers and geometry – the irrationality of the square root of two, the formula for the volume of the sphere, a list of the finite simple groups. According to one of my mathematical heroes, Henri Poincaré, doing maths is something very different:

"*To create consists precisely in not making useless combinations. Creation is discernment, choice. …The sterile combinations do not even present themselves to the mind of the creator.*"

Mathematics, just like literature, is about making choices. What then are the criteria for a piece of mathematics making it into the journals that occupy our mathematical library? Why is Fermat's Last Theorem regarded as one of the great mathematical opuses of the last century while an equally complicated numerical calculation is regarded as mundane and uninteresting. After all, what is so interesting about knowing that an equation like $xn+yn=zn$ has no whole number solutions when $n>2$. What I want to propose is that it is the nature of the proof of this Theorem that elevates this true statement about numbers to the status of something deserving its place in the pantheon of mathematics. And that the quality of a good proof is one that has many things in common with act of great storytelling.

My conjecture, if I was to put it into a mathematical equation, is that:
proof = narrative

A proof is like the mathematician's travelogue. Fermat gazed out of his mathematical window and spotted this mathematical peak in the distance, the statement that his equations do not have whole number solutions. The challenge for subsequent generations of mathematicians was to find a pathway leading from the familiar territory that mathematicians had already navigated to this foreign new land. Like the story of Frodo's adventures in Tolkien's Lord of the Rings, a proof is a description of the journey from the Shire to Mordor.

Within the boundaries of the familiar land of the Shire are the axioms of mathematics, the self-evident truths about numbers, together with those propositions that have already been proved. This is the setting for the beginning of the quest. The journey from this home territory is bound by the rules of mathematical deduction, like the legitimate moves of a chess piece, prescribing the steps you are permitted to take through this world. At times you arrive at what looks like an impasse and need to take that characteristic lateral step, moving sideways or even backwards to find a way around. Sometimes you need wait for new mathematical characters like imaginary numbers or the calculus to be created so you can continue your journey.

The proof is the story of the trek and the map charting the coordinates of that journey: The mathematician's log.

A successful proof is like a set of signposts that allow all subsequent mathematicians to make the same journey. Readers of the proof will experience the same exciting realisation as its author that this path allows them to reach the distant peak. Very often a proof will not seek to dot every i and cross every t, just as a story does not present every detail of a character's life. It is a description of the journey and not necessarily the re-enactment of every step. The arguments that mathematicians provide as proofs are designed to create a rush in the mind of the reader. The mathematician GH Hardy described the arguments we give as "gas, rhetorical flourishes designed to affect the psychology, pictures on the board in the lecture, devices to stimulate the imagination of pupils".

The joy of reading and creating mathematics comes from the exciting "aha!" moment we experience when all the strands seem to come together to resolve the mathematical mystery. It is like the moment of harmonic resolution in a piece of music or the revelation of whodunnit in a murder mystery.

The element of surprise is an important quality of exciting mathematics. Here is mathematician Michael Atiyah talking about the qualities of mathematics that he enjoys:

"*I like to be surprised. The argument that follows a standard path, with few new features, is dull and unexciting. I like the unexpected, a new point of view, a link with other areas, a twist in the tail.*"

When I am creating a new piece of mathematics the choices I will make will be motivated by the desire to take my audience on an interesting mathematical journey full of twists and turns and surprises. I want to tease an audience with the challenge of why two seemingly unconnected mathematical characters should have anything to do with each other. And then as the proof unfolds there is a gradual realisation or sudden moment of recognition that these two ideas are actually one and the same character.

This quality of finding unexpected connections is key to one of the reasons that I love talking about one of my own contributions to the mathematical canon. Some years ago I discovered a new symmetrical object whose contours have hidden in them the complexities of solutions to elliptic curves, one of the great unsolved problems of mathematics. The proof I weave during a seminar or in the journal article I wrote shows how to connect these two very disparate areas of the mathematical world. …

Discovering new symmetrical objects in itself is not so difficult. I can get my computer endlessly to churn out new examples of symmetrical objects never contemplated before. The art of the mathematician is to select the ones that tell a surprising story. This is the role of the mathematician, as Poincaré said: to make choices.

Источник: [Электронный ресурс]
https://www.theguardian.com/books/2015/jan/23/mathematicians-storytellers-numbers-characters-marcus-du-sautoy

Text 12. The Connection Between Music and Mathematics

The famous Greek philosopher and mathematician Pythagoras once said, "there is geometry in the humming of the strings, there is music in the spacing of the spheres." Although some may interpret this statement as mere poetry, Pythagoras was actually making a direct statement on the relationship between music and mathematics. You see, music is entirely intertwined with mathematics, so much so that even a basic major chord can be described mathematically. To further highlight the connection between music and mathematics, lets examine the mathematics in common musical concepts, such as wave frequencies, scales, intervals and tones.

History of Studying Music & Mathematics

It's common knowledge that music has long played for performance and pleasure, yet the study of music, particularly its relation to mathematics, has been going on for equally as long as music for performance. From Greeks to Egyptians to Indians to Chinese, nearly every ancient civilized culture has examined the connection between music and mathematics. Famous philosopher Plato was known to have an extreme interest in music, particularly harmonies, and helped highlight their importance within both an individual and society. Plato wasn't the only philosopher who found the importance of studying the relationship between music and mathematics – ancient

Chinese philosopher Confucius is said to have stated that within music are a number of fundamental truths.

Wave Frequencies

When we listen to music, we assume that we are hearing a song or a collection of notes, but what our brains are actually processing are sound waves. For example, when a note is played, sound waves travel from an instrument or amplifier and reverberates on our ear drums, and it's the frequency of this sound wave that tells our brain which pitch or note is being played (e.g. the E above middle C reverberates at approximately 329.63 Hz). Understanding sound waves, particularly the difference between octave notes, requires a bit of mathematics and physics. To find the frequency of a given note, take a constant note (which traditionally is the A above middle C, which contains a frequency of 440Hz) and multiply it by the twelfth root of 2 to the power of the amount of half steps away your desired note is from middle A (if the note is below middle A, make the power a negative). If that confuses you, don't worry! Below is an example of how to find the frequency of middle C:

1. Frequency of Middle C
    1. = 440Hz * 2 (1/12) to the negative 9th power (middle C is 9 half steps below A)
        1. =440Hz * 0.59460
            1. = ~261.625

Intervals & Tones

If you were wondering why certain notes or intervals sound pleasing when played together, there is a mathematical explanation for this as well! As shown above, each note has a unique frequency, yet when combined, not all of these frequencies will make a beautiful harmonic chord. In fact, some note combinations can sound quite piercing and harsh. So what gives? Well, intervals that make a beautiful sounding chord tend to have sound waves that reverberate in similar patterns. Let's look at a middle A major interval, which is A (440 Hz) and E (659.25 Hz). If examining each sound wave, with A on the bottom and E on the top, it will become clear that the frequency of E is approximately 3/2 larger than that of A, making an easy, digestible fraction. This simple mathematically relationship is largely why the two notes sound so pleasing together, whereas a more abstract fraction would result in a more dissonant, less pleasing sound.

Источник: [Электронный ресурс] https://musicedmasters.kent.edu/the-connection-between-music-and-mathematics/

Music and Mathentatics From Pythagoras to Fractals

Edited by John Fauvel Raymond Flood and Robin Wilson
OXFORD UNIVERSITY PRESS, 2003

Text 13. Music and mathematics: an overVIew Susan Wollenberg

c. 1-11

The invitation to write an introduction to this collection offered a welcome opportunity to reflect on some of the historical, scientific, and artistic approaches that have been developed in the linking of mathematics and music. The two have traditionally been so closely connected that it is their separation that elicits surprise. During the late sixteenth and early seventeenth centuries when music began to be recognized more as an art and to be treated pedagogically as language and analyzed in expressive terms, it might have been expected to lose thereby some of its scientific connotations; yet in fact the science of music went on to develop with renewed

This introduction sets out to explore, via a variety of texts, some of the many historical and compositional manifestations of the links between mathematics and music. ...In contemplating the two disciplines, mathematics and music (and taking music here essentially to mean the Western 'Classical' tradition), it is clear to the observer from the outset that they share some of their most basic properties. Both are primarily (although not exclusively) dependent on a specialized system of notation within which they are first encoded by those who write them, and then decoded by those who read (and, in the case of music, perform) them.

Their notations are both ancient and modern, rooted in many centuries of usage while at the same time incorporating fresh developments and newly-contrived systems to accommodate the changing patterns of mathematical and musical thought. Musical notation can be traced back to the ancient Greek alphabet system. A series of significant stages came in the development of notations within both the Western and Eastern churches during the medieval period. In the eleventh to thirteenth centuries more precise schemes were codified, including Guido d'Arezzo's new method of staff notation and the incorporation of rhythmic indications. By the time of the late sixteenth and the seventeenth centuries, most of the essential features of musical notation as it is commonly understood today were in place within a centrally established tradition. ...The twentieth century, with its emphasis on experimental music, saw a precipitate rise in new forms of notation.

In a comparable way, mathematical notation has developed over a period of at least 2500 years and, in doing so, has inevitably drawn from various traditions and sources. In music, the relationship between notation and the content it conveys is sometimes more complex than might at first appear. Notation has not invariably fulfilled the role merely of servant to content. While it is generally true that notational schemes evolved in response to the demands posed by new ideas and new ways of thinking. ...In mathematics, too, the relationship has subtle nuances. Notation developed in one context could prove extremely useful in another (seemingly quite different) context. ...In one notable case, notation formed part of the focus of a professional dispute, when a prolonged feud developed between Newton and Leibniz as to which of them invented the differential calculus, together with the different notation used by each.

In the course of their history, mathematics and music have been brought together in some curious ways. The Fantasy Machine demonstrated in 1753 by the German mathematician Johann Friedrich Unger to the Berlin Academy of Sciences, under Leonhard Euler's presidency, was designed to preserve musical improvisations.

...Throughout the history of mathematical science, mathematicians have felt the lure of music as a subject of scientific investigation; an intricate network of speculative and experimental ideas has resulted. ...At the period when music was changing from science to art (retaining a foot in both camps), science itself was moving from theoretical to practical. The seventeenth century has been seen by historians as a crucial turning-point, with the emergence of a 'recognizable scientific community' and the institutionalization of science. The founding of the Royal Society of London in 1660 formed a key point in the development

Text 14. Musical cosmology: Kepler and his readers

J. V Field

c. 29-44

In its more developed form, the mathematical cosmology of Johannes Kepler (1571-1630) presents musical harmony, itself determined by geometry, as a factor in explaining the structure of the Universe. However, his two most influential readers, Marin Mersenne and Athanasius Kircher, recognized the inadequacies of current music theory. Mersenne turns away from the idea of celestial music, but Kircher accepts it, though music itself is perceived not as determined by mathematics but rather as a property built into the Cosmos by its Creator.

In the opening lines of his Songfor Saint Cecilia's Day John Dryden wrote *From Harmony, from heavenly Harmony This universal frame began:* ... The poem was first published in 1687-making it an exact contemporary of Isaac Newton's Mathematical principles of natural philosophy-but is now probably best remembered in the magnificent musical setting by Handel, which was given its first performance on Saint Cecilia's Day (22 November, New Style) in 1738. By then, and indeed at the time Dryden wrote, the reference to celestial music was no more than a literary device. The main body of the poem is concerned with other matters, but cosmology reappears in the final 'Grand Chorus': *As from the power of sacred lays The spheres began to move, And sung the great Creator's praise To all the blest above; So when the last and dreadful hour This crumbling pageant shall devour The trumpet shall be heard on high, The dead shall live, the living die, And Music shall untune the sky*. As any good Dictionary of Saints will reveal, it is a case of least said soonest mended about the probable connections of the historical Cecilia with music. The connection of music with the origin and structure of the cosmos has a much greater historical credibility. Music theory had been a recognized part of mathematics since Ancient times. Its origins were traced back to the shadowy figure of Pythagoras who, if he was indeed a real person, may have lived in the sixth century Be. Thus, in Ancient, medieval and Renaissance times, to claim that the order of the universe was 'musical' was to claim that it was expressible in terms of mathematics. We still believe this now.

Indeed, mathematical cosmology has proved so powerful that it is perhaps difficult to take a sufficiently cold hard look at the metaphysical basis on which it rests. On the other hand, the explicitly musical cosmologies derived more directly from the Ancient tradition seem sufficiently fantastic to invite instant questioning of their underlying metaphysics-except, of course, in a poetic context such as that provided by Dryden. In his day, those inclined to be unpoetical about cosmology could turn to Isaac Newton for a mathematical explanation of a kind more acceptable in natural philosophy.

Curiously enough, the only natural philosopher to have left a fully worked out mathematical cosmology that uses music theory was the astronomer who supplied the laws from which Newton derived his mathematical theory of gravitation, namely Johannes Kepler. Since Kepler had a high opinion of his cosmological work, it is rather ironic that his own astronomical work did so much to put it out of date. In any case, Kepler saw his cosmological ideas as drawn from an Ancient tradition, essentially from the work of Plato, particularly his dialogue Timarus, and from the Harmonica of the Alexandrian astronomer Claudius Ptolemy. Ptolemy's treatise is mainly about the theory of music, but it does also contain a sketch of a musical cosmologygeocentric and much simpler than Kepler's fully worked-out heliocentric one. It is, however, the only surviving Ancient text to give a coherent account of what is often called the music of the spheres. Recent research has shown that the complicated combinations of spheres used to explain planetary motion in medieval astronomical texts can in fact be traced back to Ptolemy, and it seems possible that he did believe in solid spheres. Kepler did not. In his first cosmological work, the Secret of the Universe (Mysterium cosmographicum), he refers to such spheres as 'absurd and monstrous', and he later asks to be shown the shackles that bind the Earth to the sphere that causes its motion. (Since Kepler was a Copernican, he believed that the Earth was one of the planets.) From the point of view of the historian,

Kepler is conveniently given to laying his opinions on the line. One is never in doubt, from his first work onwards, that he was a profoundly religious Christian, a totally convinced Copernican, and a devout believer that the Universe is mathematical and to be explained in terms of mathematics. To Kepler, the natural world expresses the nature of its Creator, who is a Geometer, and Man, being made in the image of God, is capable of understanding it in mathematical terms. Indeed, it is his Christian duty to do so.

The first sign of Kepler's interest in music theory is found in connection with cosmology, and it seems likely that this was in fact how it arose. He had presumably become familiar in his youth with the music used in the Lutheran liturgy, but it is difficult to decide what music he might have heard in his later life at the court of the Holy Roman Emperor Rudolf II in Prague. Rudolf had an established taste for all things Italian and italianate, which seems to have extended to music, but the little specific evidence known to historians suggests that while the performers and composers whom he employed were indeed Italian, their music was up to date without being notably avant garde.

Since in our own time it is precisely the music of the avant garde-in particular, that of Claudio Monteverdi-that seems important, one is left with the impression that Kepler may not actually have heard any of the music that, with today's brand of hindsight, can be seen as pointing the way forward. Kepler's music theory is certainly entirely conventional in its emphasis upon consonance as the sole foundation for music. His earliest references, in the Secret of the Universe, are indeed merely to the simple ratios of small whole numbers that define the string lengths corresponding to the standard consonances. Here, Music very clearly takes second place to Geometry, which provides the explicit basis of the cosmological model by which the work is now best known, the system of nested polyhedra and planetary orbs (Kepler defines the orbs as spherical shells that exactly contain the path of the planet). This model is shown at the beginning of this chapter. None the less, with the characteristic Renaissance faith in the wisdom of the Ancients,

Kepler expresses the hope that he will be able to improve his rather clumsy theory of the connection between planetary motion and music once he has read Ptolemy's Harmonica. He was apparently unaware that the work was already available in a Latin version by Antonio Gogava, published in Venice in 1562. However, when he did come across this edition, Kepler decided that it was based on a corrupt text-in which today's scholars agree with him. He eventually obtained a Greek manuscript of the work. Kepler had hoped that his astronomical calculations of more accurate planetary orbits, using the observations made by Tycho Brahe, would confirm the correctness of the polyhedral cosmology described in his Secret of the Universe. In the event, the new more accurate orbits did not agree more closely with the theory, which Kepler had in any case already begun to modifY. The result was his Five books of the harmony of the world (Harmonices mundi libri V), published in Linz in 1619.

Источник: Music and Mathentatics From Pythagoras to Fractals. Edited by John Fauvel Raymond Flood and Robin Wilson. - OXFORD UNIVERSITY PRESS, 2003.

Text 15. A mathematical theory proposed by Alan Turing in 1952 can explain the formation of fingers

Alan Turing, the British mathematician (1912-1954), is famous for a number of breakthroughs, which altered the course of the 20th century. In 1936 he published a paper, which laid the foundation of computer science, providing the first formal concept of a computer algorithm. He next played a pivotal role in the Second World War, designing the machines which cracked the German military codes, enabling the Allies to defeat the Nazis in several crucial battles. And in the late 1940's he turned his attention to artificial intelligence and proposed a challenge, now called the Turing test, which is still important to the field today.

His contribution to mathematical biology is less famous, but was no less profound. He published just one paper (1952), but it triggered a whole new field of mathematical enquiry into pattern formation. He discovered that a system with just 2 molecules could, at least in theory, create spotty or stripy patterns if they diffused and chemically interacted in just the right way.

His mathematical equations showed that starting from uniform condition (ie. a homogeneous distribution – no pattern) they could spontaneously self-organise their concentrations into a repetitive spatial pattern. This theory has come to be accepted as an explanation of fairly simple patterns such as zebra stripes and even the ridges on sand dunes, but in embryology it has been resisted for decades as an explanation of how structures such as fingers are formed.

Now a group of researchers from the Multicellular Systems Biology lab at the CRG, led by ICREA Research Professor James Sharpe, has provided the long sought-for data which confirms that the fingers and toes are patterned by a Turing mechanism. "It complements their recent paper (Science338:1476, 2012), which provided evidence that Hox genes and FGF signaling modulated a hypothetical Turing system. However, at that point the Turing molecules themselves were still not identified, and so this remained as the critical unsolved piece of the puzzle. The new study completes the picture, by revealing which signaling molecules act as the Turing system" says James Sharpe, co-author of the study.

The approach taken was that of systems biology – combining experimental work with computational modelling. In this way, the two equal-first authors of the paper were able to iterate between the empirical and the theoretical: the lab-work of Jelena Raspopovic providing experimental data for the model, and the computer simulations of Luciano Marcon making predictions to be tested back in the lab.

By screening for the expression of many different genes, they found that two signalling pathways stood out as having the required activity patterns: BMPs and WNTs. They gradually constructed the minimal possible mathematical model compatible with all the data, and found that the two signalling pathways were linked through a non-diffusible molecule – the transcription factor Sox9. Finally, they were able to make computational predictions about the effects of inhibiting these 2 pathways – either individually, or in combination – which predicted how the pattern of fingers should change. Strikingly, when the same experiments were done on small pieces of limb bud tissue cultured in a petri dish the same alterations in embryonic finger pattern were observed, confirming the computational prediction.

This result answers a long-standing question in the field, but it has consequences that go beyond the development of fingers. It addresses a more general debate about how the millions of cells in our bodies are able to dynamically arrange themselves into the correct 3D structures, for example in our kidneys, hearts and other organs. It challenges the dominance of an important traditional idea called positional information, proposed by Lewis Wolpert which states that cells know what to do because they all receive information about their "coordinates" in space (a bit like longitude and latitude on a world map). Today's publication highlights instead that local self-organising mechanisms may be much more important in organogenesis than previously thought.

Arriving at the correct understanding of multicellular organization is essential if we are to develop effective strategies for regenerative medicine, and one day to possibly engineer replacement tissues for various organs. In the shorter term, these results also explain why polydactyly – the development of extra fingers or toes – is such a common birth defect in humans: Turing systems are mathematically known to have slightly lower precision in regulating the number of "stripes" than alternative models.

At first glance, the question of how an embryo develops seems unrelated to the problems of computing and algorithms with which Turing is more commonly associated. In reality however, they were both expressions of his interest in how complex and clever biological "machines" arise in nature. In a sense, he sought the algorithms by which life builds itself. It is fitting that this study, which has confirmed Turing's 62 year-old theory on embryology, required the development of a serious computer model. It brings together two of his major life achievements into one satisfying result.

Источник: [Электронный ресурс] https://phys.org/news/2014-07-mathematical-theory-alan-turing-formation.html

Text 16. Benefits of using technology in the learning context

We can talk of many benefits and criticism related to the use of technology in education. First we are going to deal with few advantages of making use of technology in the learning context.

Technology in the learning process can increase students' motivation. Computer based education can give immediate feedback to student and the right answers. Moreover a computer can give student motivation to continue learning, since a computer is patient and non-judgemental. According to James Kulik, who studies the effectiveness of computers used for leaning, students usually gain more in less time when receiving computer-based instructions and they build up more positive approach to the subject learned. [3] The American educator, Cassandra B. Whyte thought that successful academic performance in the future will depend on how computer usage and information technology would become important in the education experience of the future. [4]

Educational technology provides the way for students to be active participants in their learning and to present differentiated questioning approaches. It expands individualized education and encourages the progress of personalized learning plans. Students are encouraged to use multimedia components and to integrate the knowledge they achieved in innovative ways. [5]

2. Criticism to Learning Technology

Although technology in the classroom does have many benefits, there are clear shortcomings as well. Not having proper training, limited access to enough quantities of a technology, and the additional time required for many running of technology are just a few reasons that technology is often not used widely in the classroom.

Similar to learning a new task, special training is vital to ensure effectiveness when using things like technology. Training is a must when dealing with technology and education. Since technology is not the end goal of technology, but a means to be more effective in learning, educators must have a good grasp of the technology they can use or they are using. ...If there is a lack of training, the use of technology will not give ...good results that are given when technology is being used correctly.

3. Conclusion

The use of ...available technologies ...can make our teaching more effective and interesting. This use of old textbooks and methods of learning are a bit out of this world, since students are all surrounded by this new technologies which are developing very fast. This does not mean that we have to trash all old methods and textbooks but it is important to incorporate technology to make lessons more enjoyable, creative and effective.

Источник: Essays, UK. (November 2018). The Benefits of Information Technology in Education. Retrieved from : [Электронный ресурс] https://www.ukessays.com/essays/education/the-benefits-of-information-technology-in-education-education-essay.php?vref=1

PART III. OUTSTANDING SCIENTISTS IN THE FIELD OF APPLIED MATHEMATICS AND COMPUTER SCIENCES

Text 1. Leonard Adleman

In today's fast paced world we rarely get a chance to find out how and why things happen, instead we just hear about the results. In almost all events today, there is someone who is working in the shadows, from the people who prompt lines in plays, to those who organize charity events. But the people who do all these things, without whom the events would fall apart, aren't recognized publically as being important. That's why my hero is someone who has worked in the shadows to benefit science, knowing that while technologies are never forgotten, the people whose hard work provided them to man, are.

Born on December 31, 1945, Leonard Adleman was to become a theoretical computer scientist who would eventually unlock one of the many secrets of DNA. He went to college at the University of Southern California at Berkley. He received his bachelor's degree in 1968, and later his Ph.D. in 1976. He has given us two important discoveries during his work so far, which consist of his RSA cryptosism and his major work where, by using DNA, he can produce the solution of any "traveling salesman" problem.

Adleman worked on the RSA cryptosism in the year 1977. The name RSA is the last initials of three partners, Rivest, Shamir, and Adleman. Rivest and Shamir had been attempting to create an encryption which hackers would be unable to break. However, they needed someone who would be able to test how hard it was to break the encryptions, and that is where Adleman came in. After Rivest and Shamir wrote the codes, they would have Adleman try to crack them. The three continued that process until there was a code that Adleman couldn't figure out. The RSA encryption that they created is still used today in our everyday e-mails. However, RSA requires more time to encrypt the message, so in situations, such as war, when information needs to be transferred rapidly, RSA is not used, but rather a faster and less effective encryption is used. In 2002, they were awarded the AMC Turing Award.

Adleman's other work was with DNA and the "traveling salesman" problem. The "traveling salesman" problem is when you have a series of cities and the traveling salesman wants to pass through all the cities, but only each city once. Adleman came up with an idea to use DNA as a sequence to create the path between the cities. Adleman would give each city a random sequence of six nucleotides (A, T, C, and G, representing Adenine, Thymine, Cytosine, and Guanine) and then by running DNA through several elimination style tests, would produce the correct sequence of nucleotides and thus the correct path. This work has shown researchers everywhere that DNA can be used to solve problems, and may soon become a key component in problem solving strategies.

Many people who are reading this right now have never even heard of Leonard Adleman – but he has been hard at work to develop the things that influence our everyday lives. A major part of many American lives today is e-mail, which has to be encrypted so that terrorists and other countries will be unable to get information from our country. Leonard Adleman is my hero because he has worked to improve our everyday lives ...I suppose that ultimately we see a part of ourselves in our heroes, a part that makes us feel like we could be like them, and that, just maybe, we too are remembered as heroes to someone else – because as long as you are remembered, you live forever.

1/9/2017

Источник: : [Электронный ресурс] https://myhero.com/adleman_fredericksburg_04

Text 2. Clifford Cocks

Born 28 December,1950.

Mathematician and Cryptographer

Clifford Christopher Cocks is a British mathematician and cryptographer at Government Communications Headquarters, who discovered the widely used encryption algorithm now commonly known as RSA. He has not been generally recognised for this achievement because his work was classified information, and therefore not released to the public at the time.

In 1968, Cocks won Silver at the International Mathematical Olympiad while at Manchester Grammar School. Cocks went on to study mathematics as an undergraduate at King's College, Cambridge, and was then a postgraduate student at the University of Oxford, where he specialized in number theory. ...Cocks was told about James H. Ellis' "non-secret encryption", an idea which had been suggested in the late 1960s but never successfully implemented. Cocks was intrigued, and in 1973 he developed what later became known as the RSA encryption algorithm. ...In 1977 the algorithm was independently rediscovered and published by Rivest, Shamir, and Adleman, who named it after their initials, but Cocks' prior achievement remained secret until 1997.

In 2001, Cocks developed one of the first secure identity based encryption (IBE) schemes, based on assumptions about quadratic residues in composite groups. The Cocks IBE scheme is not widely used in practice due to its high degree of ciphertext expansion. However, it is currently one of the few IBE schemes which do not use bilinear pairings, and rely for security on more well-studied mathematical problems. ...in 2008 Cocks was awarded an honorary degree from Bristol University.

Источник: : [Электронный ресурс]: http://www.edubilla.com/inventor/clifford-cocks/

Text 3. Secret coding inventors finally win recognition

by Georgina Prodhan

OCTOBER 5, 2010

LONDON (Reuters)

"I thought it was quite neat," is how Clifford Cocks describes his invention, kept secret for decades, that eventually helped make secure e-commerce possible. "It was a little ahead of its time."

Cocks, along with James Ellis and Malcolm Williamson, developed public key cryptography in the early 1970s, a revolutionary method of encoding and decoding messages that was far more secure than previous encryption methods.

But because they worked for the British Government Communications Headquarters (GCHQ) intelligence agency, the three mathematicians had to keep quiet about their discovery for two decades while U.S. researchers independently developed similar methods and published their results.

...For decades, the credit for the invention had fallen to Massachusetts Institute of Technology cryptographers Ron Rivest, Adi Shamir and Leonard Adleman who published the first public, practical asymmetric cryptography algorithm – RSA, named after their initials.

Peter Hill, a cryptographer and executive committee member of the IEEE, ...compares the invention to James Clerk Maxwell's electromagnetic equations that underpin all modern information and communications technologies, or John Ambrose Fleming's valve, which laid the foundation for the field of electronics.

Before the invention of public key cryptography, it had always been assumed that the same key used to encrypt a message must be used to decrypt it, meaning that the key was always vulnerable to interception during the transfer between parties.

"The dogma that encryption and decryption are intrinsically equal and opposite had remained absolutely the given wisdom, unchallenged over centuries," says Ralph Benjamin, ...who originally assessed the public key technique and coordinated its invention.

With the realization that the encryption and decryption keys could be different, a new level of secure transmission of messages through asymmetric cryptography – and eventually mass e-commerce – became possible.

Ellis wrote a paper proving the concept in 1969, but it took another four years until the 22-year-old Cocks, ...came up with a way of implementing it.

Only the creator of the key knows the original prime factors – which are near impossible to derive from the published number – and uses them to decrypt the message.

...Asked how long it had taken him to figure out, he says: “It was basically that evening. I’d been talking about it in the afternoon, I went home, and it happened to be an evening when I hadn’t got much to do.”

Today, the RSA algorithm is one of the basic components of the SSL technology used on most ecommerce websites. RSA Security was bought by computer storage giant EMC in 2006 for $2.1 billion.

Источник: [Электронный ресурс]:
https://www.reuters.com/article/idUSLDE69328S20101004

Text 4. Computer Scientists Honored As Outstanding Young Investigators

AUSTIN, Texas – In recognition of their contributions to the field of computer science, Doug Burger and Stephen Keckler will receive a 2010 Edith and Peter O’Donnell Award from The Academy of Medicine, Engineering and Science of Texas (TAMEST).

The award honors outstanding young Texas researchers in medicine, engineering, science and technology innovation.

TAMEST will present the awards during its annual conference Jan. 7 at the Westin Riverwalk Hotel in San Antonio, Texas.

Keckler, co-director of the Computer Architecture and Technology Laboratory, is a professor of computer science and electrical and computer engineering at The University of Texas at Austin. His research interests include computer architecture, parallel processors, high-performance computing, VLSI design and the relationship between technology trends and computer architectures. He co-led the TRIPS project, which has developed and prototyped high-performance adaptive computer systems. Keckler's research has been supported by more than $20 million in funding from DARPA, the National Science Foundation, IBM and Intel. He is an Alfred P. Sloan Research Fellow, the 2003 winner of the Association of Computing Machinery (ACM) Grace Murray Hopper Award, recipient of a National Science Foundation CAREER Award and a winner of the 2007 President's Associates Teaching Excellence Award.

Burger is an adjunct professor of computer science at The University of Texas at Austin and is also a principal researcher at Microsoft Research where he manages a research group in computer architecture. His research efforts span computer architecture, new computing technologies, power-efficient computing, mobile computing, data center design, cloud computing services and compilers. He co-led the TRIPS project with Keckler while at the university.

Burger's research has been recognized with several awards, including more than $20 million in funding, a National Science Foundation CAREER Award, a Sloan Foundation Fellowship and the 2006 ACM Maurice Wilkes Award.

The Edith and Peter O'Dollel Awards – were established to recognize and promote outstanding scientific achievements of the state's most promising researchers. The awards were named in honor of Edith and Peter O'Donnell for their steadfast support of TAMEST, and include a $25,000 honorarium, a citation and an inscribed statue

Источник: [Электронный ресурс]: https://www.cs.utexas.edu/news/2010/computer-scientists-honored-outstanding-young-investigators

Text 5. John Horton Conway

John Horton Conway (born December 26, 1937, Liverpool, England) is a prolific mathematician active in the theory of finite groups, knot theory, number theory, combinatorial game theory and coding theory. He has also contributed to many branches of recreational mathematics, notably the invention of the Game of Life (the cellular automaton, not the board game).

Conway is currently professor of mathematics at Princeton University. He studied at Cambridge, where he started research under Harold Davenport. He has an Erdős number of one. He received the Berwick Prize (1971), was elected a Fellow of the Royal Society (1981), and was the first recipient of the Pólya Prize (LMS) (1987).

Biography

...John became interested in mathematics at a very early age and his mother Agnes recalled that he could recite the powers of two when aged four years. John's young years were difficult for he grew up in Britain at a time of wartime shortages. At primary school John was outstanding and he topped almost every class. At the age of eleven his ambition was to become a mathematician.

After leaving secondary school, Conway entered ...Cambridge to study mathematics. He was awarded his BA in 1959 and began to undertake research in number theory supervised by Harold Davenport. Having solved the open problem posed by Davenport on writing numbers as the sums of fifth powers, Conway began to become interested in infinite ordinals. It appears that his interest in games began during his years studying at Cambridge, where he became an avid backgammon player spending hours playing the game in the common room. He was awarded his doctorate in 1964 and was appointed as Lecturer in Study at the University of Cambridge.

He left Cambridge in 1986 to take up the appointment to the John von Neumann Chair of Mathematics at Princeton University.

Game theory

...Among amateur mathematicians, he is perhaps most widely known for his contributions to combinatorial game theory, a theory of partisan games.

...He is also one of the inventors of Sprouts, as well as Philosopher's Football. He developed detailed analyses of many other games and puzzles, such as the Soma Cube, Peg Solitaire, and Conway's Soldiers. He came up with the Angel problem, which was solved in 2006.

He invented a new system of numbers, the surreal numbers, which are closely related to certain games...He also invented a nomenclature for exceedingly large numbers, the Conway chained arrow notation.

He is also known for the invention of the Game of Life, one of the early and still celebrated examples of a cellular automaton.

Geometry

In the mid-1960s with Michael Guy ...he established that there are sixty-four convex uniform polychora excluding two infinite sets of prismatic forms. Conway has also suggested a system of notation dedicated to describing polyhedra called Conway polyhedron notation.

Group theory

He worked on the classification of finite simple groups and discovered the Conway groups. He was the primary author of the Atlas of Finite Groups giving properties of many finite simple groups.

Algebra

He has also done work in algebra particularly with quaternions.

Algorithmics

For calculating the day of the week, he invented the Doomsday algorithm. The algorithm is simple enough for anyone with basic arithemetic ability to do the calculations mentally.

Theoretical Physics

In 2004, Conway and Simon Kochen, another Princeton mathematician, proved the Free will theorem, a startling version of the No Hidden Variables principle of Quantum Mechanics. It states that given certain conditions, if an experimenter can freely decide what quantities to measure in a particular experiment, then elementary particles must be free to choose their spins in order to make the measurements consistent with physical law. Or, in Conway's provocative wording, if experimenters have free will, then so do elementary particles.

Источник: [Электронный ресурс]: https://mancala.fandom.com/wiki/John_Horton_Conway

Text 6. Carl Gauss (1777-1855)

Isaac Newton is a hard act to follow, but if anyone can pull it off, it's Carl Gauss. If Newton is considered the greatest scientist of all time, Gauss could easily be called the greatest mathematician ever. Carl Friedrich Gauss was born to a poor family in Germany in 1777 and quickly showed himself to be a brilliant mathematician. He published "Arithmetical Investigations," a foundational textbook that laid out the tenets of number theory (the study of whole numbers). Without number theory, you could kiss computers goodbye. Computers operate, on a the most basic level, using just two digits – 1 and 0, and many of the advancements that we've made in using computers to solve problems are solved using number theory. Gauss was prolific, and his work on number theory was just a small part of his contribution to math; you can find his influence throughout algebra, statistics, geometry, optics, astronomy and many other subjects that underlie our modern world.

Источник: 5 brilliant mathematicians and their impact on the modern world. : [Электронный ресурс] https://fabpedigree.com/james/mathmen.htm#Newton

Text 7. William Timothy Gowers

Born: 20 November 1963 in Marlborough, Wiltshire, England.

...Tim Gowers was sent to King's College School, Cambridge where he was a boarder as his parents were living in London at the time. ...Gowers is extremely musical and was a chorister at the School. He had some excellent mathematics teaching at the School from Mary Briggs, who had studied under Mary Cartwright at Girton College. He won a King's scholarship to Eton College.

...another inspirational teacher,Norman Routledge ...had been a fellow of King's. He did not allow himself to be limited to the syllabus but ranged far more widely. ... it was a very valuable experience.

After completing his school education at Eton, Gowers matriculated at Trinity College, Cambridge. It was while he was an undergraduate that Gowers decided that he wanted to become a professional mathematician.

In 1990 Gowers was awarded his doctorate for his thesis Symmetric Structures in Banach Spaces written with Béla Bollobás as his thesis advisor. His first paper *Symmetric block bases in finite-dimensional normed spaces* was published in 1989 and in the same year he gave a survey lecture *Symmetric sequences in finite-dimensional normed spaces* to the conference 'Geometry of Banach spaces' held in Strobl, Austria. He was appointed as a Research Fellow at Trinity College in 1989, holding this position until 1993. He was appointed as a Lecturer at University College, London, in 1991 and spent four years there. However, in some sense he never left Cambridge.

...During the four years he spent at University College he continued to work on Banach spaces and he was awarded the 1995 Junior Whitehead Prize by the London Mathematical Society for this work.

In 1995 Gowers was appointed as a lecturer at the University of Cambridge.

...William Timothy Gowers' work has made the geometry of Banach spaces look completely different. ...The techniques he uses are highly individual.

...William Timothy Gowers has provided important contributions to functional analysis, making extensive use of methods from combination theory. These two fields apparently have little to do with each other, and a significant achievement of Gowers has been to combine these fruitfully.

...further innovative project in which Gowers has been involved is ...the book *The Princeton Companion to Mathematics* (2008) with Gowers as editor, ...an immensely rich and valuable reference work that covers almost all aspects of modern mathematics today.

Источник:[Электронный ресурс] [*https://www-history.mcs.ac.uk/Biographies/Gowers.htmlTimothy*](https://www-history.mcs.ac.uk/Biographies/Gowers.htmlTimothy)

Text 8. Leonid Vitalyevich Kantorovich Autobiography

(Shortened)

I was born in Petersburg (Leningrad) on 19th January 1912. My father, Vitalij Kantorovich, died in 1922 and it was my mother, Paulina (Saks), who brought me up. Some of the first events of my childhood were the February and the October Revolutions of 1917, and a one-year trip to Byelorussia during the Civil War.

My first interest in sciences and the first displays of self-dependent thinking manifested themselves about 1920. On entering the Mathematical Department of the Leningrad University in 1926, I was mainly interested in sciences (but also in political economy and modern history, thanks to the most vivid lectures of academician E. Tarle.

...My scientific activities started in my second university year covering the rather more abstract fields of mathematics. I think my most significant research in those days was that connected with analytical operations on sets and on projective sets (1929-30) where I solved some N.N. Lusin problems. I reported these results to the First All-Union Mathematical Congress in Kharkov (1930).

My participation in the work of the Congress was an important episode in my life; here I met such outstanding Soviet mathematicians as S.N. Bernstein, P.S. Alexandrov, A.N. Kolmogorov, A.O. Gelfond, *et al*, and some foreign guests, among whom were J. Hadamard, P. Montel, W. Blaschke.

The Petersburg mathematical school combined theoretical and applied research. On graduating from the university in 1930, simultaneously with my teaching activities at the higher school educational institutions, I started my research in applied problems. The ever expanding industrialization of the country created the appropriate atmosphere for such developments. It was precisely at that time such works of mine, *A New Method of Approximate Conformal Mapping*, and *The New Variational Method* were published. This research was completed in *Approximate Methods of Higher Analysis*, a book that I wrote with V.I. Krylov (1936). By that time I was a full professor confirmed in this rank in 1934, and in 1935, when the system of academic degrees was restored in USSR, I received my doctoral degree. At that time I worked at the Leningrad University and in the Institute of Industrial Construction Engineering.
The Thirties was a time of intensive development of functional analysis which became one of the fundamental parts of modern mathematics.

My own efforts in this field were concentrated mainly in a new direction. It was the systematical study of functional spaces with an ordering defined for some of pairs of elements. This theory of partially-ordered spaces turned out to be very fruitful and was being developed at approximately the same time in the USA, Japan and the Netherlands. On this subject I contacted J. von Neumann, G. Birkhoff, A.W. Tucker, M. Frechet and other mathematicians whom I met at the Moscow Topological Congress (1935).

...In those days, my theoretical and applied research had nothing in common. But later, especially in the postwar period, I succeeded in linking them and showing broad possibilities for using the ideas of functional analysis in Numerical Mathematics. This I proved in my paper, the very title of which, *Functional Analysis and Applied Mathematics*, seemed, at that time, paradoxical. In 1949, the work was awarded the State Prize.

...The Thirties was also important for me as I began my first economics.... it was a problem of distributing some initial raw materials in order to maximize equipment productivity under certain restrictions. Mathematically, it was a problem of maximizing a linear function on a convex polytope.

...this accidental problem turned out to be very typical. I found many different economic problems with the same mathematical form: work distribution for equipment, the best use of sowing area, rational material cutting, use of complex resources, distribution of transport flows. This was reason enough to find an efficient method of solving the problem. The method was found under influence of ideas of functional analysis as I named the "method of resolving multipliers".

In 1939, the Leningrad University Press printed my booklet called *The Mathematical Method of Production Planning and Organization*, ...a sketch of the solution method, and the first discussion of its economic sense. In essence, it contained the main ideas of the theories and algorithms of linear programming. The work remained unknown for many years to Western scholars. Later, Tjalling Koopmans, George Dantzing, *et al*, found these results and, moreover, in their own way. But their contributions remained unknown to me until the middle of the 50s.

I recognized the broad horizons offered by this work at an early stage. It could be carried forward in three directions:

...The studies were interrupted by the war. During the war, I worked as Professor of the Higher School for Naval Engineers. But even then I found time to continue my deliberations in the realm of economics. It was then that I wrote the first version of my book. Having returned to Leningrad in 1944, I worked at the University and at the Mathematical Institute of the USSR Academy of Sciences, heading the Department of Approximate Methods. At that time, I became interested in computation problems, with some results in the automation of programming and in computer construction.

My economics studies progressed as well. I particularly wish to mention the work done in 1948-1950 at the Leningrad Carriage-Building Works. ...Here the optimal use of steel sheets was calculated by linear programming methods and saved material.

...In the middle of the 50s, the interest in the improvement of economic control in the USSR increased significantly, and conditions for studies in the use of mathematical methods and computers for general problems of economics and planning became more favourable. ...Precisely at that time, I contacted foreign scholars in this field. As a particular result, thanks to the initiative of Tjalling Koopmans, my 1939 booklet was published in *Management Science*, and, somewhat later, the 1959 book was translated as well.

Some of the Soviet economists met the new methods guardedly.

...The field attracted a number of young talented scientists, and the preparation of such hybrid specialists (mathematician-economist) began in Leningrad, Moscow, and some other cities. It is worth noting that in the newly-organized Siberian Branch of the Academy of Sciences, conditions for new scientific directions were especially favourable. A special laboratory on the application of mathematics in economics headed by Nemchinov V.S. and me was created.

...I was elected Corresponding-Member of the Academy in 1958 and came to Novosibirsk in 1960. Out of my group in Novosibirsk, a number of talented mathematicians and economists emerged.

In spite of continual discussions and some critique, the scientific direction gained recognition more and more by both the scientific community and governmental bodies. The token of this recognition was the Lenin Prize which I was awarded in 1965.

Now I head the Research Laboratory at the Institute of National Economy Control, Moscow, where high-ranking executives are introduced to new methods of control and management. I act as consultant to various governmental bodies.

(*Leonid Kantorovich shared the 1975 Nobel Prize for Economics with Tjallind Koopmans for their work on the optimal allocation of scarce resources.*
L.V. Kantorovich died on April 7, 1986.).

Источник: [Электронный ресурс] https://www.nobelprize.org/prizes/economic-sciences/1975/kantorovich/25950-autobiography-1975/

Text 9. Andrey Nikolaevich Kolmogorov

(1903-1987) Russia

Kolmogorov had a powerful intellect and excelled in many fields. As a youth he dazzled his teachers by constructing toys that appeared to be "Perpetual Motion Machines." At the age of 19, he achieved fame by finding a Fourier series that diverges almost everywhere, and decided to devote himself to mathematics. He is considered the founder of the fields of intuitionistic logic, algorithmic complexity theory, and (by applying measure theory) modern probability theory. He also excelled in topology, set theory, trigonometric series, and random processes. He and his student Vladimir Arnold proved the surprising Superposition Theorem, which not only solved Hilbert's 13th Problem, but went far beyond it. He and Arnold also developed the "magnificent" Kolmogorov-Arnold-Moser (KAM) Theorem, which quantifies how strong a perturbation must be to upset a quasiperiodic dynamical system.

Kolmogorov's axioms of probability are considered a partial solution of Hilbert's 6th Problem. He made important contributions to the constructivist ideas of Kronecker and Brouwer. While Kolmogorov's work in probability theory had direct applications to physics, Kolmogorov also did work in physics directly, especially the study of turbulence. There are dozens of notions named after Kolmogorov, such as the Kolmogorov Backward Equation, the Chapman-Kolmogorov equations, the Borel-Kolmogorov Paradox, and the intriguing Zero-One Law of "tail events" among random variables.ong historic importance.

Источник: Greatest Mathematicians born between 1860 and 1975 A.D. : [Электронный ресурс] https://fabpedigree.com/james/grmatm6.htm

Text 10. Benoit Mandelbrot (1924-2010)

Benoit Mandelbrot landed on this list thanks to his discovery of fractal geometry. Fractals, often-fantastical and complex shapes built on simple, self-replicable formulas, are fundamental to computer graphics and animation. Without fractals, it's safe to say that we would be decades behind where we are now in the field of computer-generated images. Fractal formulas are also used to design cellphone antennas and computer chips, which takes advantage of the fractal's natural ability to minimize wasted space.

Mandelbrot was born in Poland in 1924 and had to flee to France with his family in 1936 to avoid Nazi persecution. After studying in Paris, he moved to the U.S. where he found a home as an IBM Fellow. Working at IBM meant that he had access to cutting-edge technology, which allowed him to apply the number-crunching abilities of electrical computer to his projects and problems. In 1979, Mandelbrot discovered a set of numbers, now called the described by science-fiction writer Arthur C. Clarke as Mandelbrot set, that were "one of the most beautiful and astonishing discoveries in the entire history of mathematics."(To learn more about the technical steps behind drawing the Mandelbrot set, click over to the infographic I made last year for a class that I'm taking.)

Benoit Mandelbrot died of pancreatic cancer in 2010.

Источник: [Электронный ресурс]
https://fabpedigree.com/james/mathmen.htm#Newton

Text 11. John von Neumann (1903-1957)

John von Neumann was born János Neumann in Budapest a few years after the start of the 20th century, a well-timed birth for all of us, for he went on to design the architecture underlying nearly every single computer built on the planet today. Right now, whatever device or computer that you are reading this on, be it phone or computer, is cycling through a series of basic steps billions of times over each second; steps that allow it to do things like render Internet articles and play videos and music, steps that were first thought up by John von Neumann.

Von Neumann received his Ph.D in mathematics at the age of 22 while also earning a degree in chemical engineering to appease his father, who was keen on his son having a good marketable skill. Thankfully for all of us, he stuck with math. In 1930, he went to work at Princeton University with Albert Einstein at the Institute of Advanced Study. Before his death in 1957, von Neumann made important discoveries in set theory, geometry, quantum mechanics, game theory, statistics, computer science and was a vital member of the Manhattan Project.

Источник: 5 brilliant mathematicians and their impact on the modern world. : [Электронный ресурс] https://fabpedigree.com/james/mathmen.htm#Newton

Text 12. 5 brilliant mathematicians and their impact on the modern world

by Shea Gunther

We owe a great debt to scores of mathematicians who helped lay the foundation for our modern society with their discoveries. Here are some of the most important.

Math. It's one of those things that most people either love or hate. Those who fall on the hate side of things might still have nightmares of showing up for a high school math test unprepared, even years after graduation. Math is, by nature, an abstract subject, and it can be hard to wrap your head around it if you don't have a good teacher to guide you.

But even if you don't count yourself a fan of mathematics, it's hard to argue that it hasn't been a vital factor in our rapid evolution as a society. We reached the moon because of math. Math allowed us to tease out the secrets of DNA, create and transmit electricity over hundreds of miles to power our homes and offices, and gave *rise to computers and all that they do for the world. Without math, we'd still be living in caves getting eaten by cave tigers.*

Isaac (Sir) Newton
(1642-1727) England

Newton was an industrious lad who built marvelous toys (e.g. a model windmill powered by a mouse on treadmill). At about age 22, on leave from University, this genius began revolutionary advances in mathematics, optics, dynamics, thermodynamics, acoustics and celestial mechanics. He is famous for his Three Laws of Motion (inertia, force, reciprocal action) but, as Newton himself acknowledged, these Laws weren't fully novel: Hipparchus, Ibn al-Haytham, Descartes, Galileo and Huygens had all developed much basic mechanics already; and Newton credits the First Law to Aristotle. However Newton was apparently the first person to conclude that the ordinary gravity we observe on Earth is the very same force that keeps the planets in orbit.

His Law of Universal Gravitation was revolutionary and due to Newton alone. (Christiaan Huygens, the other great mechanist of the era, had independently deduced that Kepler's laws imply inverse-square gravitation, but he considered the action at a distance in Newton's theory to be "absurd.") Newton published the Cooling Law of thermodynamics. He also made contributions to chemistry, and was the important early advocate of the atomic theory. His writings also made important contributions to the general scientific method. His other intellectual interests included theology, and mysticism. He studied ancient Greek writers like Pythagoras, Democritus, Lucretius, Plato; and claimed that the ancients knew much, including the law of gravitation.

Although this list is concerned only with mathematics, Newton's greatness is indicated by the huge range of his physics: even without his Laws of Motion, Gravitation and Cooling, he'd be famous just for his revolutionary work in optics, where he explained diffraction, observed that white light is a mixture of all the rainbow's colors, noted that purple is created by combining red and blue light and, starting from that observation, was first to conceive of a color hue "wheel." (The mystery of the rainbow had been solved by earlier mathematicians like Al-Farisi and Descartes, but Newton improved on their explanations.

Most people would count only six colors in the rainbow but, due to Newton's influence, seven – a number with mystic importance – is the accepted number. Supernumerary rainbows, by the way, were not explained until the wave theory of light superseded Newton's theory.) He noted that his dynamical laws were symmetric in time; that just as the past determines the future, so the future might, in principle, determine the past.

Newton almost anticipated Einstein's mass-energy equivalence, writing "Gross Bodies and Light are convertible into one another... [Nature] seems delighted with Transmutations." Ocean tides had intrigued several of Newton's predecessors; once gravitation was known, the Moon's gravitational attraction provided the explanation – except that there are *two* high tides per day, one when the Moon is farthest away. With clear thinking the second high tide is also explained by gravity but who was the first clear thinker to produce that explanation? You guessed it! Isaac Newton. (The theory of tides was later refined by Laplace.) Newton's earliest fame came when he discovered the problem of chromatic aberration in lenses, and designed the first reflecting telescope to counteract that aberration; his were the best telescopes of that era. He also designed the first reflecting microscope, and the sextant.

Although others also developed the techniques independently, Newton is regarded as the "Father of Calculus" (which he called "fluxions"); he shares credit with Leibniz for the Fundamental Theorem of Calculus (that integration and differentiation are each other's inverse operation). He applied calculus for several purposes: finding areas, tangents, the lengths of curves and the maxima and minima of functions. Although Descartes is renowned as the inventor of analytic geometry, he and followers like Wallis were reluctant even to use negative coordinates, so one historian declares Newton to be "the first to work boldly with algebraic equations." In addition to several other important advances in analytic geometry, his mathematical works include the Binomial Theorem, his eponymous interpolation method, the idea of polar coordinates, and power series for exponential and trigonometric functions.

…He contributed to algebra and the theory of equations; he was first to state Bézout's Theorem; he generalized Descartes' rule of signs. (The generalized rule of signs was incomplete and finally resolved two centuries later by Sturm and Sylvester.) He developed a series for the arcsin function. He developed facts about cubic equations (just as the "shadows of a cone" yield all quadratic curves, Newton found a curve whose "shadows" yield all cubic curves). He proved, using a purely geometric argument of awesome ingenuity, that same-mass spheres (or hollowed spheres) of any radius have equal gravitational attraction: this fact is key to celestial motions. (He also proved that objects *inside* a hollowed sphere experience zero net attraction.)

He discovered Puiseux series almost two centuries before they were re-invented by Puiseux. (Like some of the greatest ancient mathematicians, Newton took the time to compute an approximation to $\boldsymbol{\pi}$; his was better than Vieta's, though still not as accurate as al-Kashi's.)

Newton is so famous for his calculus, optics, and laws of gravitation and motion, it is easy to overlook that he was also one of the very greatest geometers. He was first to fully solve the famous Problem of Pappus, and did so with pure geometry. Building on the "neusis" (non-Platonic) constructions of Archimedes and Pappus, he demonstrated cube-doubling and that angles could be k-sected for any k, if one is allowed a conchoid or certain other mechanical curves. He also built on Apollonius' famous theorem about tangent circles to develop the technique now called hyperbolic trilateration.

Despite the power of Descartes' analytic geometry, Newton's achievements with synthetic geometry were surpassing. Even before the invention of the calculus of variations, Newton was doing difficult work in that field, e.g. his calculation of the "optimal bullet shape." His other marvelous geometric theorems included several about quadrilaterals and their in- or circumscribing ellipses. He constructed the parabola defined by four given points, as well as various cubic curve constructions. (As with Archimedes, many of Newton's constructions used non-Platonic tools.) He anticipated Poncelet's Principle of Continuity. An anecdote often cited to demonstrate his brilliance is the problem of the *brachistochrone*, which had baffled the best mathematicians in Europe, and came to Newton's attention late in life. He solved it in a few hours and published the answer anonymously. But on seeing the solution Jacob Bernoulli immediately exclaimed "I recognize the lion by his footprint."

In 1687 Newton published *Philosophiae Naturalis Principia Mathematica*, surely the greatest scientific book ever written. The motion of the planets was not understood before Newton, although the *heliocentric* system allowed Kepler to describe the orbits. In *Principia* Newton analyzed the consequences of his Laws of Motion and introduced the Law of Universal Gravitation. With the key mystery of celestial motions finally resolved, the Great Scientific Revolution began. (In his work Newton also proved important theorems about inverse-*cube* forces, work largely unappreciated until Chandrasekhar's modern-day work.) Newton once wrote "Truth is ever to be found in the simplicity, and not in the multiplicity and confusion of things." Sir Isaac Newton was buried at Westminster Abbey in a tomb inscribed "Let mortals rejoice that so great an ornament to the human race has existed."

Newton ranks #2 on Michael Hart's famous list of the Most Influential Persons in History. (Muhammed the Prophet of Allah is #1.) Whatever the criteria, Newton would certainly rank first or second on any list of physicists, or scientists in general, but some listmakers would demote him slightly on a list of pure mathematicians: his emphasis was physics not mathematics, and the contribution of Leibniz (Newton's rival for the title *Inventor of Calculus*) lessens the historical importance of Newton's calculus. One reason I've ranked him at #1 is a comment by Gottfried Leibniz himself: "Taking mathematics from the beginning of the world to the time when Newton lived, what he has done is much the better part."

Источник: [Электронный ресурс]:
https://fabpedigree.com/james/mathmen.htm#Newton

Text 13. Alan Mathison Turing

(1912-1954) Britain

Turing developed a new foundation for mathematics based on computation; he invented the abstract Turing machine, designed a "universal" version of such a machine, proved the famous Halting Theorem (related to Gödel's Incompleteness Theorem), and developed the concept of machine intelligence (including his famous *Turing Test* proposal). He also introduced the notions of *definable number* and *oracle* (important in modern computer science), and was an early pioneer in the study of neural networks. For this work he is called the Father of Computer Science and Artificial Intelligence. Turing also worked in group theory, numerical analysis, and complex analysis; he developed an important theorem about Riemann's zeta function; he had novel insights in quantum physics. During World War II he turned his talents to cryptology; his creative algorithms were considered possibly "indispensable" to the decryption of German Naval Enigma coding, which in turn is judged to have certainly shortened the War by at least two years.

Although his clever code-breaking algorithms were his most spectacular contributions at Bletchley Park, he was also a key designer of the Bletchley "Bombe" computer. After the war he helped design other physical computers, as well as theoretical designs; and helped inspire von Neumann's later work. He (and earlier, von Neumann) wrote about the Quantum Zeno Effect which is sometimes called the Turing Paradox. He also studied the mathematics of biology, especially the *Turing Patterns* of morphogenesis which anticipated the discovery of BZ reactions. Turing's life ended tragically: charged with immorality and forced to undergo chemical castration, he apparently took his own life. With his outstanding depth and breadth, Alan Turing would qualify for our list in any event, but his decisive contribution to the war against Hitler gives him unusually strong historic importance.

Источник: [Электронный ресурс] Greatest Mathematicians born between 1860 and 1975 A.D. - URL: https://fabpedigree.com/james/grmatm6.htm

Text 14. Andrew Wiles

Sir Andrew Wiles is a British mathematician. He is best known for providing a proof of Fermat's Last Theorem, something which had eluded science for more than three centuries. Wiles is a specialist in number theory, and he is a research professor at the University of Oxford. He was knighted in 2000 in recognition of his achievements, and Oxford's Mathematical Institute building is named in his honor.

Wiles has also received many other awards and honors.

...Wiles was born on April 11, 1953, in Cambridge, England. He had an academic background from the start: his father held the post of Oxford's Regius Professor of Divinity

Andrew was educated in Cambridge, first at King's College School and later at The Leys. His fascination with Fermat's Last Theorem dates back to his school days. When he was just ten, he found a book about it in his local public library. Even at that age, he could understand the theorem itself, which states that for an equation in which a, b, and c are raised to the same power, n, the sum of the first two, cannot equal the third for any integer above two.

Wiles' attention was caught by the fact that such a simple-sounding equation remained unsolved after more than 300 years, despite Pierre Fermat's famous claim that he had found a proof in the 17th century – but had no space in the margin of his notebook to set it down.

Nevertheless, Wiles quickly came to realize that his mathematical knowledge was not sufficient to solve the problem and for more than two decades, it lay dormant in his mind. In 1986, however, he noted the proof of the related epsilon conjecture by Ken Ribet. At the age of 33, Wiles resolved to restart his work on Fermat's Last Theorem.

By 1986 ...Wiles became convinced that it was possible to prove Fermat's Last Theorem. He was particularly well placed to do so, as the modularity theorem he needed to employ was itself connected with the study of elliptic curves.
In the 1980s, most mathematicians felt that Fermat's Last Theorem, despite its im-

portance, was extremely hard to prove. Coates himself used the word “impossible” at one point when discussing the idea of proving it. Wiles himself was among a small minority who believed that a proof was realistic.

For more than six years, he spent all the time he had available for research on this one problem. He was very careful not to let anyone else know what he was doing, and told only his wife the full story of his research. ...So at a cjnference in Cambridge in 1983, Wiles went public for the first time, causing a sensation which reached even the general public. However, a flaw in yis reasoning was demonstrated a few month later. He admitted that he was close to abandoning the search in September 1994, when he finally realized howto get around the flaw in his original paper.

Источник: [Электронный ресурс] http://totallyhistory.com/andrew-wiles/

Text 15. Stephen Wolfram

Stephen Wolfram is the creator of Mathematica, Wolfram|Alpha and the Wolfram Language; the author of *A New Kind of Science*; and the founder and CEO of Wolfram Research. Over the course of nearly four decades, he has been a pioneer in the development and application of computational thinking–and has been responsible for many discoveries, inventions and innovations in science, technology and business. Born in London in 1959, Wolfram was educated at Eton, Oxford and Caltech. He published hisfirst scientific paper at the age of 15, and had received his PhD in theoretical physics from Caltech by the age of 20. Wolfram's early scientific work was mainly in high energy physics, quantum field theory and cosmology, and included several now-classic results. Having started to use computers in 1973, Wolfram rapidly became a leader in the emerging field of scientific computing, and in 1979 he began the construction of SMP – the first modern computer algebra system–which he released commercially in 1981.

In recognition of his early work in physics and computing, Wolfram became in 1981 the youngest recipient of a Mac Arthur Fellowship. Late in 1981 Wolfram then set out on an ambitious new direction in science aimed at understanding the origins of complexity in nature. Wolfram's first key idea was to use computer experiments to study the behavior of simple computer programs known as cellular automata. And starting in 1982, this allowed him to make a series of startling discoveries about the origins of complexity. The papers Wolfram published quickly had a major impact, and laid the groundwork for the emerging field that Wolfram called coplex system research.

Through the mid-1980s, Wolfram continued his work on complexity, discovering a number of fundamental connections between computation and nature, and inventing such concepts as computational irreducibility. Wolfram's work led to a wide range of applications – and provided the main scientific foundations for such initiatives as complexity theory and artificial life. Wolfram himself used his ideas to develop a new randomness generation system and a new approach to computational fluid dynamics – both of which are now in widespread use.

Following his scientific work on complex systems research, in 1986 Wolfram founded the first journal in the field, Complex Systems, and its first research center. Then, after a highly successful career in academia–first at Caltech, then at the Institute for Advanced Study in Princeton and finally as Professor of Physics, Mathematics and Computer Science at the University of Illinois – Wolfram launched Wolfram Research.

...The first version of Mathematica was released on June 23, 1988, and was immediately hailed as a major advance in computing. In the years that followed, the popularity of Mathematica grew rapidly, and Wolfram Research became established as a world leader in the software industry, widely recognized for excellence in both technology and business. From its beginnings as a technical computing system, Mathematica has grown dramatically in scope over the years–and ...has been responsible for many important inventions and discoveries in a vast range of fields and industries, as well as being a central tool in the education of generations of students. In

2014 Wolfram made another breakthrough, building on Mathematica and Wolfram|Alpha to create the Wolfram Language. ...the Wolfram Language introduces the new concept of a knowledge-based language, in which immense knowledge about computation and the world is integrated, ...that both enables more sophisticated applications ...and opens up programming to a much broader range of people.

Wolfram has been involved with education for many years.

Источник: [Электронный ресурс] https://www.stephenwolfram.com/about/