

Math & Programmings

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PREFACE TO THE MATH & PROGRAMMING TO GENERAL PUBLIC

Until a few decades ago, it was said that Mathematics was not science. The most natural sciences are targeting in areas which of entities they can see and touch by hands. So math having no entities like thinking process or scholasticism would not be object. Therefore, there were no mathematics exhibits on science museums. However, contemporary sciences cannot progress a step forward without math. It doesn't go for it, unless it doesn't talk in math as a language in a different field of every science whether it is in aerospace, elementary particle, new material development, new drug development. If you insist that such as the result calculated by the computer is not real, withdraw cash from your bank account right now. The computer once solved the proof of the mathematical conjecture of the four-color theorem. Without numerical calculation, weather forecasting is impossible; rockets are not allowed to fly, and clarification of the universe, even discovery of new elementary particles is impossible. So, what is mathematics? I will tell you in the course from now, in a word, "Mathematics is the art of giving the same name to different things." Mathematics is a language of science to understand the nature. And calculation is to enumerate according to the algorithm. Programming is the language for its computation.

Well, next year 2018, there is the International Information Olympiad in Tsukuba. It's like annual mathematical Olympiad. Since it is an international convention, it will be noticed as a major event of science education even if it does not go to the G-7 Science Ministers' Meeting in Tsukuba in 2016. So, in order to allow excellent challengers to participate in the Tsukuba area, the Tsukuba Expo Center science museum has opened a science introductory course called "The Math & Programming" for two years. Programming is acquired math and language skills. In kids class, C, C ++, Ruby, Python and so on are taught. Python seems to have excellent features to treat math problems. Teaching children to math training and full-fledged programming does not seem to be easier, however children come with us than expectedly. The discourse is aimed at experiencing, not mastering. I am convinced that a programming experience dealing with numbers will foster a sense of mathematical brains.

Meanwhile, this math & programming course for adults is aiming to enjoy discrete math and computer science, not able to encode programming. I am convinced that you could learn what math is fun, what programming works are. The course will mention math and computer science written in technical terms. The theories of topics would be difficult for ordinary people who has no math knowledge, However I'll try to describe the concept **as easy as possible**, and then I will **make you comprehend more deeply**. I hope that you will get a good impression of the new math disciplines. And I'd like you to enjoy discrete math riddles and algorithm.

The lecture is for not only math geek but also those who had not ever interested in math so far will also be able to be familiar with, those who want to learn mathematics again after retirement will get each heading. We are also welcome those who parents having children want to know about programmings required in computer era. I will always talk about discussions while adding verifications and proofs of those problems by through programming which would not be mentioned in other public math classes to general public.

May 14, 2017, Сейджиро Кусафуса

[Math & Programmings]

■ 1st, Accessible and interesting Math

★ Movie clips in which Math appears

★ Computer is good at recurrence relation, e.g., Pizza Cut Theorem

★ Computing figures of Pi (π)

Computing Pi with Archimedes' algorithm in EXCEL (programming)

Power series expansion, Arc-tangent definition, PYTHON is good at Math (programming)

Gauss–Legendre algorithm in RUBY (programming)

Challenge 1 million figures using gmp.h library and Chudnovsky algorithm in C (programming)

Significant figures of Pi for Planet journey

★ Computing Napier (e) and Euler's formula

e is natural, not natural number

Computing e with EXCEL, C-language (EXCEL programming)

Doc beloved Euler's formula, Drawing formula on UHS (practice)

★ Magic Square in Calendar, 9 is not magic number

Ternary number of alien with 5 fingers, digital root

★ Perfect numbers and Mersenne numbers in Binary

< ☕ Coffee break >

★ What is the Math? Math greats' words

"Mathematics is the art of giving the same name to different things" - H. Poincaré

★ Number game, by Binary polynomial (practice)

★ Big Soap Bubble, hyperboloid structures made of Ruled surfaces (practice)

★ Elliptical Billiards, Envelope and Klein's Singularity in tea cup (practice)

Footnote:

Liouville Numbers are transcendental number, polynomials

Chebyshev polynomials are recurrence equation

Mandelbrot set is recurrence equation

2nd. Curious and Paradoxical Math

★ Paradox of triangular inequality, limit and infinity

★ Summation of finite natural numbers, Odd and Even numbers (programming)

★ Summation of finite natural numbers, Odd and Even numbers (programming)

Fake golden ratio whatever anything , Fibonacci sequence (practice)

3 Fibonacci programmings (programming)

Binet formula, Find n-th Fibonacci number (programming)

★ Universe is made of prime numbers ?

Prime numbers in Kaleidoscope, Gaussian integer, Extension (practice)

Find prime numbers through Sieve of Eratosthenes (programming), Python (programming)

Prime numbers and triangle, Class field theory Japanese (programming),

Ogg's prime number

★ Can number be approximately rational?

Through the Looking-Glass, and What Alice Found There

Recurring decimal, Can rational number be distinguished with a calculator?

Computing Primitive root and recurring decimal with EXCEL (EXCEL)

Computing F17 Primitive root by EXCEL and C-programming (programming)

Beautiful Continued fraction recurring decimal of irrational number

The Artin conjecture

★ ζ Riemann zeta function

Complex numbers in PYTHON, Summation of a finite series

Ramanujan's functions, Summation of natural numbers is $-1/12$

Why does ζ -function not diverge to infinity ?

★ p-adic number = A new number's world

Far as closer distance, Extension, p-adic number and Multi-verse = Hasse principle

★ Symmetry and Invariant

Golden ratio in Icosahedron, Euler's Characteristic, Riemann-Roch Theorem

(practice)

★ Reflection_Coxeter_group (practice)

Dodecahedron and Icosahedron 3with 3 mirrors (Weyl's chamber)

< ☕ Coffee break >

★ Mathematical experiment 1

★ Year 2017 equals sum of three cube of prime numbers (excel)

★ Grothendieck's prime number (programming)

★ The Elements of polyhedron, external link, (practice)

★ Play with Tangram, Transformation Equilateral triangle to square (practice)

Hilbert's 3rd question, Dehn Invariant & Hill's Tetrahedra (practice)

Alchemy? Banach–Tarski paradox

3rd. Algorithms and Math

- ★ Modal logic, math, and languages
 - FOPL to HOPL、 (syntax to semantics)
 - Program semantics and topology
- ★ Category theory is a language that connect different field of science
 - Category theory, Awodey
- ★ The world is made of residue、 6 arithmetic operations in RUBY (programming)
- ★ Euclidean Algorithm and Billiard theorem
 - What is algorithm?
 - Algorithm with triangular billiards theorem and Arithmetics
 - Solving jug puzzle in the movie "Die hard with a Vengeance"
 - Euclidean Algorithm and lemma (programming)
 - Euclidean Algorithm and Continued Fraction of rational number (practice)
- ★ Euler's totient function $\phi(n)$ (programming)
 - Euler's Theorem and applications
- ★ Collatz's conjecture, even elementary students can understand (programming)
- ★ Matthew Frank's recurrence relation appears¹ and prime numbers (programming)
- ★ Monty Hall problem solved by women with IQ228 (programming)
- ★ Old maid game with two jokers (programming)
- ★ Solving Rubik Cube with permutation group (practice). Sage
 - Transposition、 Permutation、 Parity、 Cyclic group of prime order
 - Solvability
- ★ Group structure on elliptic curve
- ★ Monster and Symmetry
 - Finite simple groups classification, Modular curve and Supersingular Prime
 - Monstrous Moonshine、 Enumerate Monster group of order 8×10^{53} (programming)

< ☕ Coffee break >

- ★ Zero is volume, not number
- ★ Mathematical experiment 2
- ★ 4x4x4 Rubik's Revenge and Prity (practice)
- ★ Nash equilibrium, in the movie: Beautiful Mind , Fix point & ramification theory
 - 1994 Nobel Prize in Economic Sciences with Game theory, 2015 Abel Prize with Partial differential equation theory.
 - Ramification theory is common to both above studies,
 - Mr. Mrs Nash died in the taxi accident on the way home after the award ceremony trip in 2016.

4th. Computing science and Math

- ★ Cryptographic system supporting the Internet societies, Elliptic curve Cryptography (Magma)
Encryption of internal love email with Caesars shift is recommended (programming)
- ★ Don't be afraid of large numbers (Factorial of power) (programming).
- ★ Computing very large Congruent numbers (programming)
Congruent numbers, Elliptic curves and Torus
Congruent number n , $y^2 = x^3 - n^2x$ is Elliptic curves
- ★ Fractional Binary Conversion and Calculation Error (programming)
Convert Decimal to Binary, & vice versa (programming)
- ★ Baker's map (Baker's transformation) (programming)
- ★ Challenge 1 million disits using gmp.h library and Chudnovsky algorithm in C (programming]
- ★ 1-demension Logistic map, Examination Chaos by recurrence formula (programming)
- ★ Solving simultaneous equations using RUBY (programming)
- ★ Math toolbox, Automated theorem proving,
Wolfram Alpha. iPhone / iPad application
Symbolic Math Toolbox MATLAB Chebyshev Polynomial
Coq, Mizar, syntax library, Equation processing Risa/Asir
- ★ What is P-value? The quantity distinguishes the quality
You can access to Big data through a smartphone or tablet terminal.
- ★ Jacobs' Staff, Triangulation, Surveying Earth as Tadataka Ino 1745 -1818 (programming)
- ★ Computing of Astronomy and aerospace engineering
Sun Rise / Sun Set Time / Culmination (programming)
Computing Water Rocket Projection With Python (c, Python programming)
Planetary orbit and the escape velocity of the planetary probe (programming)
Computing sunorbit of Intercontinental Ballistic Missile (programming)
Apollonius' circle and Gravity zone
Computing the day of the week with Zeller's formula (programming)
Creating a million-year calendar (programming)
- < ☕ Coffee break >
- ★ AI-singularity will come in 2045?
- ★ P versus NP problem
- ★ Philosophy of space recognition, Math required by cosmologists
Lie group stems from manifold and group
"See a tree, know the forest", Cohomology, Nitpicking is not science, really? (curvature)
ζ-world, Fox's repayment
"From global to local" (Coherent sheaves), Calabi–Yau manifold (6 dimensions),
Mirror symmetry, category theory
Claster algebra, Exterior algebra & Super string theory

References:

<Introductory books to learn math >

Mathematical Omnibus: Thirty Lectures on Classic Mathematics by Dmitry Fuchs Serge Tabachnikov, ©American Mathematics Society

Mathematical Proofs A Transition to Advanced Mathematics Gary Chartrand, Albert D. Polimeni, Ping Zhang

Adventures in Group Theory Rubik's Cube, Merlin's Machine & Other Mathematical Toys 2ed., David Joyner, Johns Hopkins University Press, 2008

数学の言葉で世界を見たら 大栗博司、幻冬社

不変量と対称性 現代数学の心 今井淳、寺尾宏明、中村博昭、ちくま学芸文庫

数論への招待 加藤和也、シュプリンガー数学クラブ 第23巻、丸善

数学の研究を始めよう (I) (II) 飯高茂 現代数学社

プログラムで愉しむ数理パズル 伊庭斎志、コロナ社

実験数学読本 矢崎成俊、日本評論社

パズルの国のアリス1, 2 坂井公、日経サイエンス社

<https://projecteuler.net> Project Euler

<http://www.dimensions-math.org/>, Jos Leys, Étienne Ghys, Aurélien Alvarez

無限に見られた天才数学者たち、アミール・D・アクゼル、早川書房

バナッハ=タルスキーの密室、瀬山士郎、日本評論社

<http://www.theory.caltech.edu/~ooguri/mathuniverse.pdf> 宇宙の数学とは何か 大栗博司

<https://www.wolframalpha.com/examples/Math.html> WolframAlpha Computational Knowledge engine

<https://jp.mathworks.com> Symbolic Math Toolbox

<Good books for those who want to learn math further>

圏論の歩きかた、日本評論社

Category theory, Awodey, Oxford

表現論入門セミナー、平井、山下、遊星社

Galois Theory 2nd Edition, Joseph Rotman, Springer-Verlag New York Inc.

Introduction to Elliptic Curves and Modular Forms, Neal Koblitz, Springer-Verlag New York Inc.

Rational Points on Elliptic Curves, J. H. Silverman & John Tate, Springer-Verlag New York Inc.

選択公理と数学、田中尚夫、遊星社

コホモロジー、安藤哲哉、日本評論社

現代数学の源流 上下巻、左武一郎、朝倉書店

数学の現在 π , e , i 、斎藤毅、河東泰之、小林俊行、東京大学出版界

<Books with respect to Computer science and languages>

Good Math A Geek's Guide to the Beauty of Numbers, Logic, and Computation, Mark C. Chu-Carroll

From Mathematics to Generic Programming Alexander A. Stepanov, Daniel E. Rose

初めてのRUBY Yugu, O'Leilly

The Ruby Programming Language: Everything You Need to Know, Matz, David Flanagan, O'Leilly

Doing math with Python Amit Saha, no starch press

Java入門、瀬戸雅彦、株式会社SCC

The C Programming Language 2nd edition, Brian W. Kernighan, Dennis M. Ritchie, Englewood Cliffs, NJ: Prentice Hall.

ISBN 0-13-110362-8 (March 1988)

数学基礎論 前原昭二、竹内外史、ちくま学芸文庫

オートマトン・言語理論の基礎 米田政明、近代科学社

<https://inventwithpython.com/chapters/> Invent with Python

IBM Watson Analysis

What is p-value anyway?, Andrew Vickers Stories to help you actually understand statistics

Computation of 2700 billion decimal digits of Pi using Desktop Computer, Fabrice Belland Feb 11, 2011

ideone.com ideone is an online compiler and debugging tool.

<Own writings and blogs with respect to relevant materials >

離散数学パズル(ピリアードの定理) ISBN978-4-99053238

プロペラに棲む魔物 Daemon on the Prop ISBN978-4-990532325

<http://imetrics.co.jp/mathematics/Newsletter.pdf> Math letters Prog collections

<http://imetrics.co.jp/opinion/Blog1.pdf> Blog with respect to Math and science

<http://imetrics.co.jp/mathematics/ApplePie.pdf> 3.14 is Pi day
<http://imetrics.co.jp/math2/Eulers-formula-slide0612.pdf> Euler's formula
<http://imetrics.co.jp/mathematics/CanNumberbeAploximatelyRational.pdf> Can Number be Aploximately Rational
<http://imetrics.co.jp/mathematics/三角ビリャードと等差配列で解く.pdf> Algorithm with triangular billiards theorem and Arithmetics
http://imetrics.co.jp/mathematics/Billiard_EuclideanAlgorithm.pdf Euclidean Algorithm and Billiard theorem
<http://imetrics.co.jp/mathematics/EulerCharacteristic.pdf> Euler's polyhedron theorem
<http://imetrics.co.jp/mathematics/FibonacciSeries.pdf> Fibonacci and goldernratio
<http://imetrics.co.jp/academy/自然数の総和について.pdf> Ramanujan's functions, Summation of natural numbers is $-1/12$
http://imetrics.co.jp/mathematics/Reflection_Coxeter_group.pdf Reflection_Coxeter_group
<http://imetrics.co.jp/mathematics/SymmetryMonster.pdf> Monster and Symmetry
<http://imetrics.co.jp/mathematics/ModernMathTerms.pdf> Modern Math Terminology
<http://imetrics.co.jp/mathematics/EllipticCurves&ModularForms.pdf> Elliptic Curves and ModularForms
<http://imetrics.co.jp/academy/Automaton.pdf> Introduction to Computer science
<http://imetrics.co.jp/academy/計算の科学セミナー.pdf> Computing seminar (programming)
<http://imetrics.co.jp/mathematics/MatheProgrammingForIOI2018.pdf> Gor for Mathe Programming IOI2018
<http://imetrics.co.jp/math2/合同数.pdf> Congruent numbers, Elliptic curves and Torus
<http://imetrics.co.jp/math2/楕円曲線上の加群構造.pdf> Elliptic Curve and Group
<http://imetrics.co.jp/math2/LiouvilleNumber.pdf> Liouville numbers are dense
imetrics.co.jp/math3/アポロニウスの円.pdf Apollonius' circle and Gravity zone
imetrics.co.jp/math2/agenda.pdf Math & programming in Japanese
<http://imetrics.co.jp/mathematics/extension.pdf> Extension of numbers
<http://imetrics.co.jp/math2/LiouvilleNumber.pdf> Liouville's numbers are transcendental number
imetrics.co.jp/opinion/数学キーワードクイズ.pdf Math Keywords Quiz

EPILOGUE

Up to now, education in our country was "ability = equalityism" that everyone can do. However, this meritocracy has already begun to collapse in the early 1970s in Western countries. It is because the reproduction theory that the meritocracy in school education contributes not only to equalization of society but also social inequality and disparity reproduction has come to be cast. Domestically, fluctuations began to appear in scenarios trying to embrace people in meritocracy due to the end of high growth since the 1990s and the expansion of globalization. In other words, it is no longer possible to encompass the abilities of all children in Melitocracy.

The United States President's election in November 2016 shows that the disparity that divided the country among the middle classes was spreading in the United States, the richest country and the source of globalization. The disparity is caused by changes in the industrial structure according to the progress of science and technology. The influence of immigration is not the cause. To solve this problem, we need adaptability to adapt to change and continuity of capacity development for that. We also need social functions that constantly bias self-development. Science museums must have exhibits and educational activities that can take part in their social functions.

In March of the same year as the presidential election in the US, former President Obama appealed in the White House statement that STEM education, especially the fundamental power of mathematics, is important to maintain industrial competitiveness as a developed industrial country. This news was not reported much in our country. In the advanced technology industry even in the front runner in the United States, we must pay attention to strategies that are trying to focus more on mathematics education which is the basis of science. Incidentally, as the Internet society advances, it is becoming possible to develop individual abilities. Even if you are a society, you will have the opportunity to learn. For

example, Western universities offer famous lectures through the year such as iTunes University. It is a useful opportunity for those who do not attend lectures in English. In other words, except for children, adults still do not have the stereo-typed education given to them, but that is the almost time to select and learn curriculums by themselves. However, if there is no literacy about the suitability of information in the Internet society, It is a little dangerous.

By the way, everyone who participates in the "The Math & Programming" course and who is reading this afterword must be active in each field as a society and already have formed knowledge. I think that people who have curiosity to new knowledge that was not in school education that I once received. However, due to the busy works of the each ordinary life or business, it may be overshadowed from where to start learning. Some may want to start retrofitting by changing math that they loved before. I do not think that there are not moms who are eager to consider mathematical science education for their children. We hope to continuously respond to this need for this math course.

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(Note)