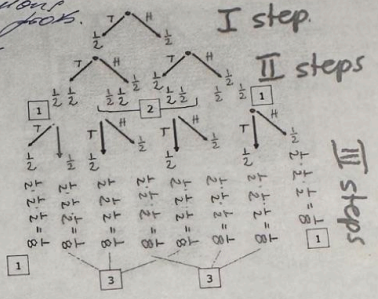
to find patterns, solve binomial expressions, answer math questions

Pascal's triangle

1								1
1	1							2
1	2	1						4
1	3	3	1					8
1	4	6	4	1				16
1	5	10	10	5	1			32
1	6	15	20	15	6	1		64
1	7	21	35	35	21	7	1	128

Each num. is the sum of the 2 nums. above it

1 8 28 56 70 56 28 8 1



$(a+b)^0 =$ 1

$(a+b)^1 =$ $a + b$

$(a+b)^2 =$ $a^2 + 2ab + b^2$

$(a+b)^3 =$ $a^3 + 3a^2b + 3ab^2 + b^3$

$(a+b)^4 =$ $a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$

$(a+b)^5 = a^5 + 5a^4b + 10a^3b^2 + 10a^2b^3 + 5ab^4 + b^5$

Newton's Binomial

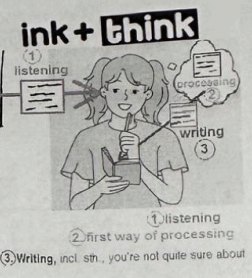
A tree diagram illustrates step-by-step construction of Pascal's triangle

The binomial theorem states that $(a+b)^n$ can be expressed explained using the coefficients from Pascal's Triangle

The general form in the expansion is given by $\binom{n}{k} a^{n-k} b^k$, where $\binom{n}{k}$ is a bin. coefficient

80% of a chance of rain in Oxford

This introduces the prob. the nature of weather prediction



The contrast of school and uni: ed. -> school = formalism, memory, at least deep understanding

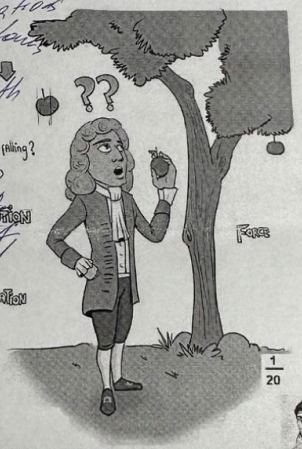
Uni = know meaning, connections, why

School ↓gravity↓ MOTION ==formalism==> University $E=mc^2$ $\oint \vec{J} d\vec{S}$

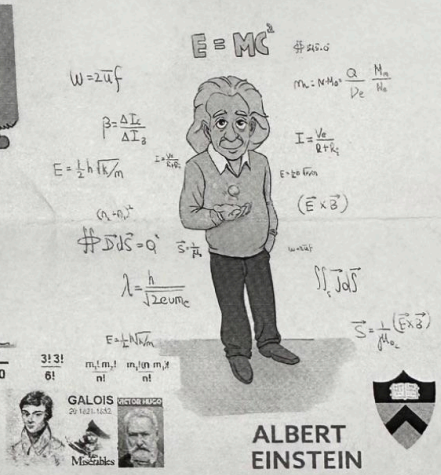
CONCRETE AND ABSTRACT THINKING

From concrete observations to abstract laws, then to ↓gravity↓ math structures

In IT abstr, why falling? always use to quantify independently of its physical form



ISAAC NEWTON

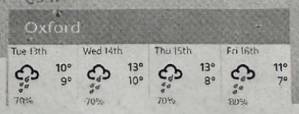


ALBERT EINSTEIN

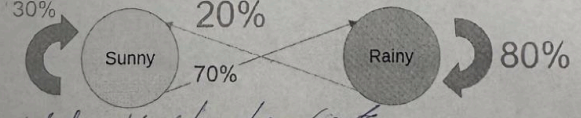
Motivation: 80% chance of rain

Let A_j be the event of rain at 9am on day j of this term, $1 \le j \le n$

Suppose the events A_j each have probability p, independently



Markoff Chain Probability Model for Oxford Weather

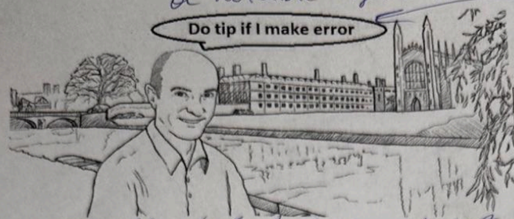


math model that predict future based only on the current state

If its rainy:
80% - stays rainy
20% - gets sunny

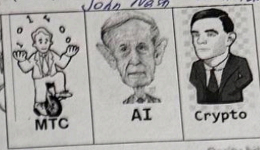
If its sunny:
30% - stays sunny
70% - rainy

a notable figure in IT and error correction
Willingness to be corrected



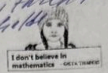
Sir **Dr. D. MacKay**,
University of Cambridge
(22 April 1967 – 14 April 2016)

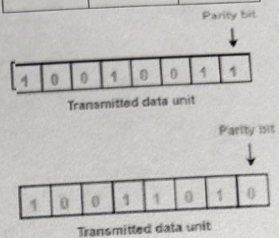
John Nash Alan Turing



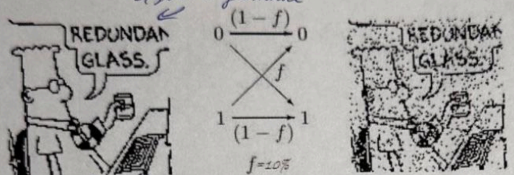
He had dual commitment to both fields

"I believe in clean energy, but I also believe in mathematics"

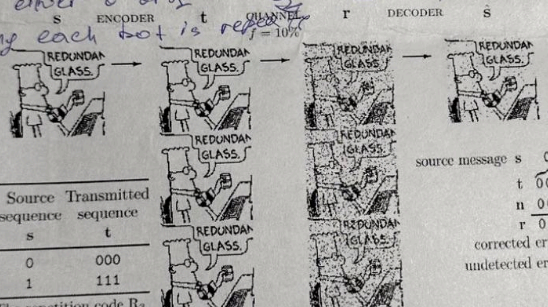




изобр. формула



1) source code: the original data either 0 or 1 ③ ④ Reception 5) Decoding
2) Encoding each bit is repea...



The process of error corrections

Source sequence s	Transmitted sequence t
0	000
1	111

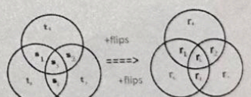
The repetition code R_3

repeat each bit multiple times to create redun...

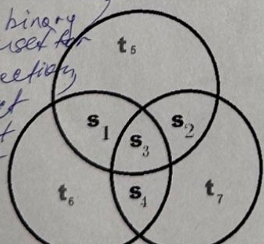
source message s	0	0	1	0	1	1	0
t	000	000	111	000	111	111	000
n	000	001	000	000	101	000	000
r	000	001	111	000	010	111	000
corrected errors		⋆					
undetected errors					⋆		

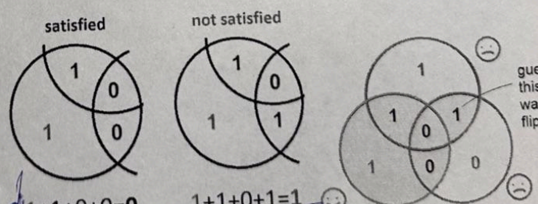
7.4. Hamming code.

$$\frac{4}{\Sigma} \rightarrow \frac{7}{t}$$



A type of binary code used for error correction, can detect and correct single-bit errors





1+1+0+0=**0**

1+1+0+1=1

represents diff sets of parity bits. The intersections the state bits being protected by the parity bits

When the parity check results in even parity sum of bits is even

when the parity check results in odd parity

shows how the overlaps happen from the errors

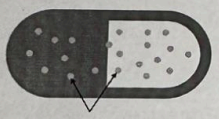
Lab 0

This is the program we need to write today

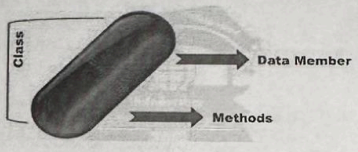
```
class ABBA
 {
 static void Main(string[] args)
                    // Here's a method called Main.
 {
     System.Console.WriteLine("ABBA!");
  }
 }
```

So there's the keyword class. Unlike C++, in C# all code must be placed in a class.

Encapsulated in a class.



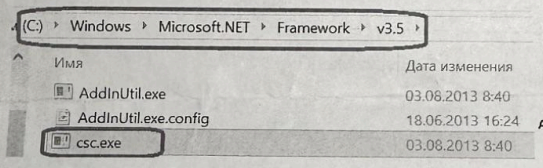
Medicines Inside Capsule



A ≠ a

C# is case sensitive

C:\WINDOWS\Microsoft.NET\Framework\v3.5\ csc.exe



ABBA.cs => csc.exe = ABBA.exe

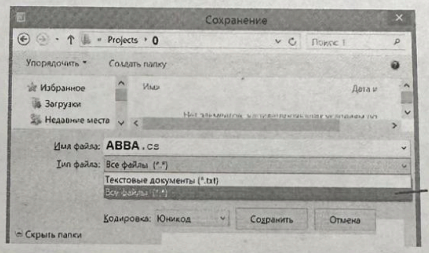
C# Compiler

Step 1. And on my HDD, I also make a folder with the same name D:\ IT

Step 2. In the folder **E:** IT\ we make the folder of the **Projects** - **E:\ IT\Projects**

And in the **Project** folder make folder **0 - E:\ IT\Projects\0** where our today's practical work will be stored

Step 3. As I mentioned above, C# is a built-in language of Windows. Notepad is enough to write a program



You need to switch from *.txt (Text documents) to *.* (all files)

Otherwise, notepad with *.txt extension

Step 4.Entering command mode

Start=>Run=>cmd

cd E: - After that go to the folder IT/Projects/0/

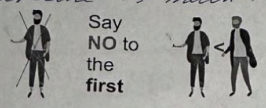
cd IT -Then go to the folder Projects

cd projects - Then go to the folder 0

cd 0 –

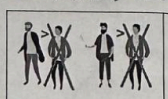
```
E:\>cd IT

E:\IT>cd Projects

E:\IT\Projects>cd 0

E:\IT\Projects\0>
```

- If every outcome is equally likely => Entropy is high (lots of uncertainty)
- If outcome is much more likely than others => Entropy is low



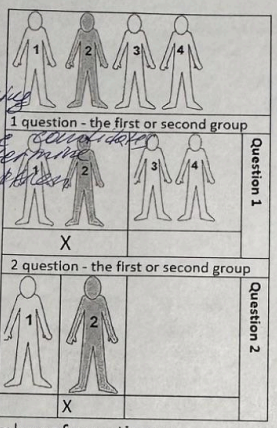
Say **NO** to the **first**

Say **YES** to the **second** if it is better than the first



Say **NO** to the **third** only if it is worse than all the others

The decision-making process involves comparing these candidates in pairs to determine the best option.



Average number of questions =

2*0.25+ 2*0.25+ 2*0,25+ 2*0,25 =2

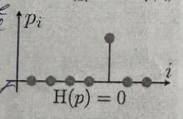
Average number of questions =

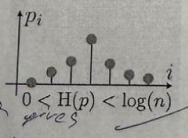
1*0.5+	2*0.25+	3*0,125+	3*0,125
			

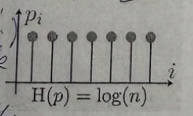
Question 1. Is this Zuckerberg?	 50%	1*0.5
Question 2. Is this Sergey Brin?	 25%	2*0.25
Question 3. Is this Stefan from BMW?	 12,5%	3*0,125
So Prince Saud	 12,5%	3*0,125
Average number of questions =		1,75

This formula calculates the entropy, which is the measure of uncertainty or the content

$$H(X) = \sum_{i=1}^{n} p(x_i) \log_b \frac{1}{p(x_i)}$$







This formula gives the info from content $I(x_i)$ of a single event x_i, which is the number of bits required to encode that event

$$\sum_{i=1}^{n} p(i) \log_2 \frac{1}{p(i)}$$

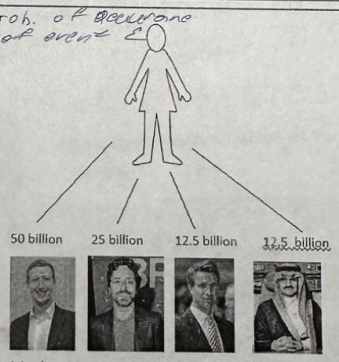
Prob. of occurrence of event i

Quantifying information

$$I(x_i) = \log_2\left(\frac{1}{p_i}\right)$$

number of bits required to encode choice

$$\sum_{i=1}^{n} p(x_i)\, I(x_i)$$



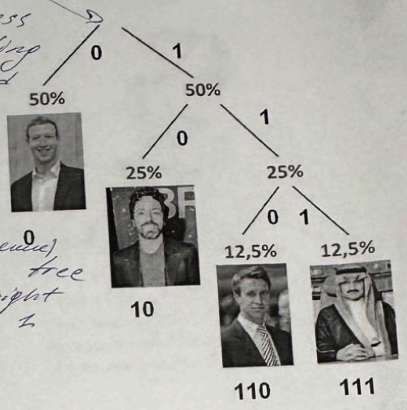
32 -> f(x) -> 5

64 -> f(x) -> 6

128 -> f(x) -> 7

Huffman tree

The tree shows the process of creating a Huffman coding tree. Each char. is assigned a binary code based on freq. Char. with higher freq. are closer to the root resulting in shorter codes. The binary codes are created by traversing (переходить) the tree left branches are 0 and right are 1.



First-order approximation (symbols independent but with frequencies of Belarusian txt).

Мама мыла ра

М - 3	30%	1-3 М
а - 4	40%	4-7 а
ы -1	10%	8 -ы
л - 1	10%	9 -л
р - 1	10%	10 -р

10

лламаммар

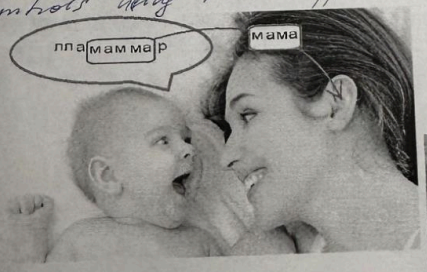
Second-order approximation (digram (2-symbols) structure as in Belarusian)

Мама мыла ра

Ма - 2	22%	1-2	ма
ам - 2	22%	3-4	ам
мы - 1	11%	5	мы
ыл - 1	11%	6	ыл
ла - 1	11%	7	ла
ар - 1	11%	8	ар
ра - 1	11%	9	ра

9 number positions represented in the text

breaks down the text into symbols using 1-order approximation



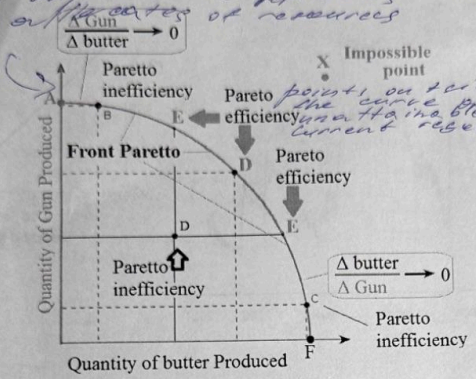
0.467319167 35

ам ыл ла ам ма ра ма ыл ла ам мы

мылла рама

Considers pairs of symbols when the prob of a symbol appearing depends on the previous symbol

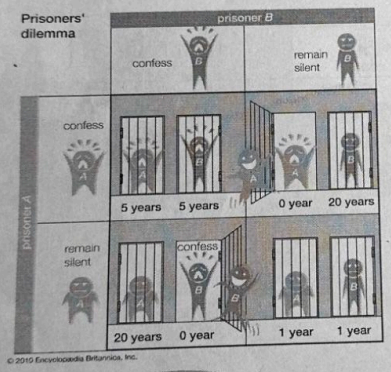
The tradeoff between two goods (guns and butter) - Point on the curve represents efficient allocation of resources



by Vilfredo Pareto

1848-1923

The orange sector E-D-E is the most Pareto efficient - since an increase in one indicator leads to a decrease in another.



Game Theory

Nash Equilibrium

** => Nash equilibrium

$H_2(x)$ / $H_1(x)$	Player 2	Recognition;	Non-recognition;
Player 1		1	2
Recognition;	1	-5 *	* -5 / -20 / 0
Non-recognition;	2	-20 / 0	-1 / -1

-1-1 Pareto Optimality