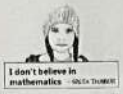
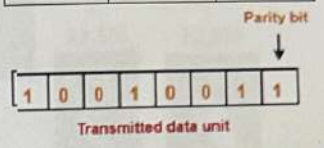
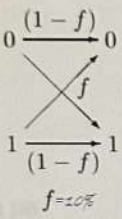
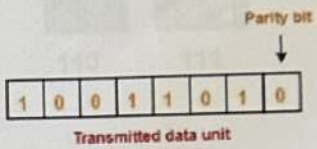
Sir **Dr. D. MacKay,**
University of Cambridge
(22 April 1967 – 14 April 2016)

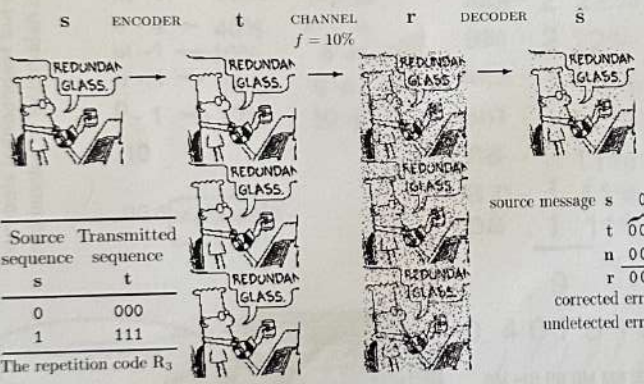
"I believe in clean energy,
but I also believe in mathematics"











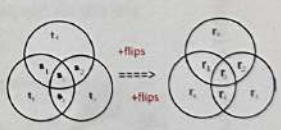
Source sequence s	Transmitted sequence t
0	000
1	111

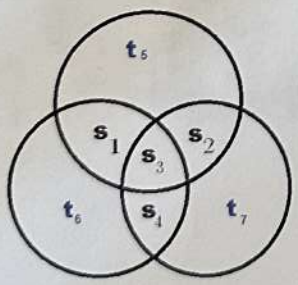
The repetition code R_3

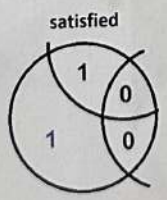
source message s	0	0	1	0	1	1	0
t	000	000	111	000	111	111	000
n	000	001	000	000	101	000	000
r	000	001	111	000	010	111	000
corrected errors		*					
undetected errors					*		

7.4. Hamming code.

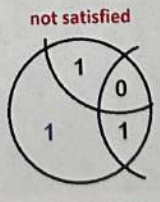
$$\frac{4}{\Sigma} \rightarrow \frac{7}{t}$$



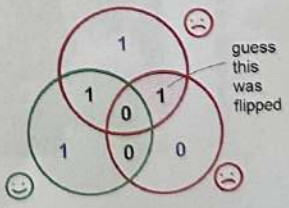




1+1+0+0=**0**



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



число = + 2 сверху

Pascal's triangle

1 → 1

1 1 → 2

1 2 1 → 4

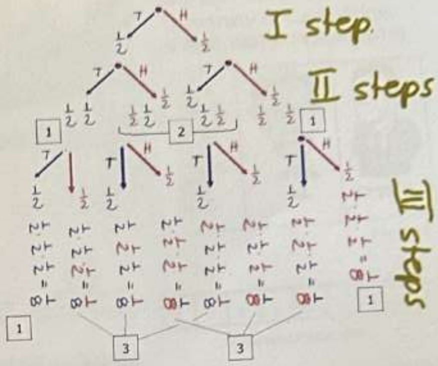
1 3 3 1 → 8

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



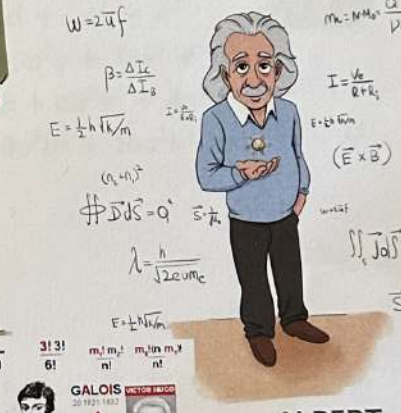
$$(a+b)^0 = 1$$
$$(a+b)^1 = a + b$$
$$(a+b)^2 = a^2 + 2ab + b^2$$
$$(a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$
$$(a+b)^4 = a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$$
$$(a+b)^5 = a^5 + 5a^4b + 10a^3b^2 + 10a^2b^3 + 5ab^4 + b^5$$

Биноми. к-ты

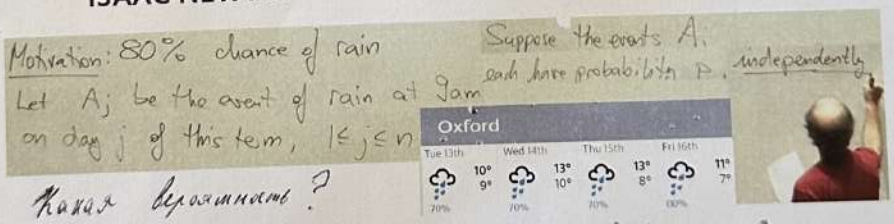
School gravity MOTION ==formalism==> University

CONCRETE AND ABSTRACT THINKING

ISAAC NEWTON

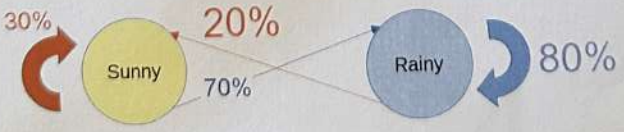


ALBERT EINSTEIN



Какая вероятность?

Markoff Chain Probability Model for Oxford Weather



Massachusetts Institute of Technology (MIT)

Lecture by Pr. Bob Gallagher

Boole (1815-1864) & **Shannon** (1916-2001)

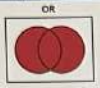
Logical addition (disjunction)

A	B	F=A∨B
0	0	0
0	1	1
1	0	1
1	1	1

A	B	$A \vee B$
True	True	True
True	False	True
False	True	True
False	False	False

Logical disjunction

OR



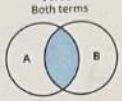
Definition $x + y$

Truth table (0111)

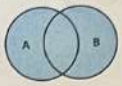
Logic gate

BOOLEAN LOGIC

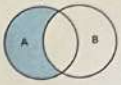
AND Both terms



OR Either term



NOT Only one term



Good logic

Socrates

Socrates was a philosopher

$S \in \Phi$

Socrates

Plato

Aristotle

philosophers are men

$\Phi \in A$

Socrates was a man

$S \in A$

Bad logic

Socrates was a man

$S \in A$

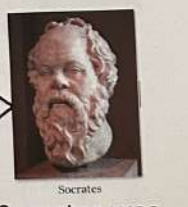
Socrates

Plato

Aristotle

philosophers are men

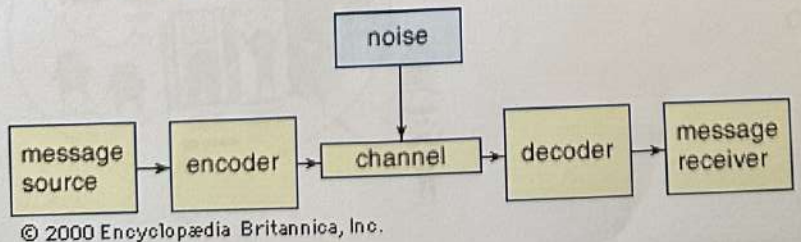
$\Phi \in A$



Socrates

Socrates was a philosopher

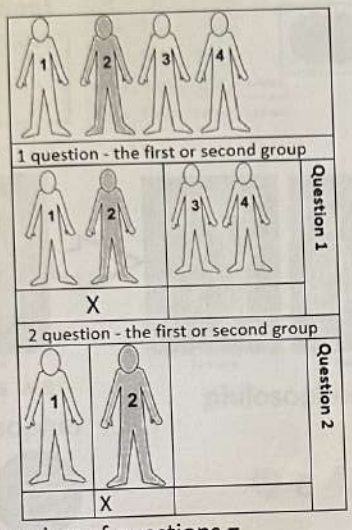
$S \in \Phi$



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



Average number of questions =

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

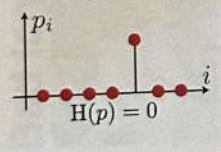
Average number of questions =

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

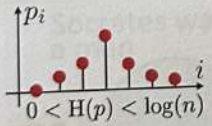
Question 1. Is this Zuckerberg?	 50%	1*0.5
Question 2. Is this Sergey Brin?	 25%	2*0.25
Question 3. Is this Stefan from BMW?	 12,5%	3*0,125
So Prince Saud	 12,5%	3*0,125
Average number of questions =**1,75**		

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

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

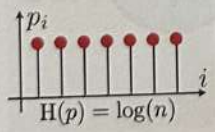


Quantifying information



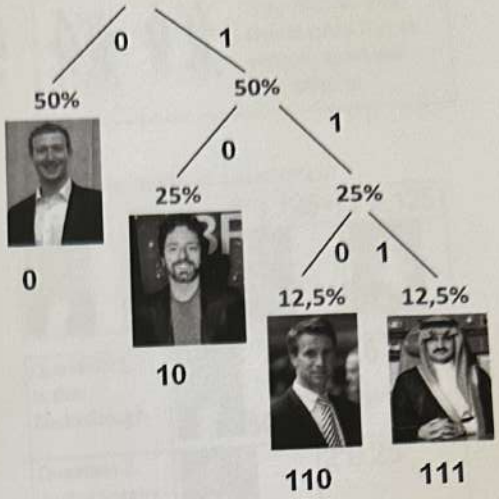
$$I(x_i) = \log_2\left(\frac{1}{p_i}\right)$$

number of bits required to encode choice



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

50 billion	25 billion	12.5 billion	12.5 billion
			
Mark Zukerberg P(1)= **50%**	Sergey Brin P(2)= **25%**	Stefan Quandt P(3)= **12,5%**	Prince Al Saud P(4)= **12,5%**



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		

лла мамма р

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
а р - 1	11%	8	ар
ра - 1	11%	9	ра
	9		

0. 4 6 7 3 1 9 1 6 7 3 5

ам ыл ла ам ма ра ма ыл ла ам мы

мылла рама

Resume of Lecture by Pr. Bob Gallagher from MIT

Massachusetts Institute of Technology (MIT)

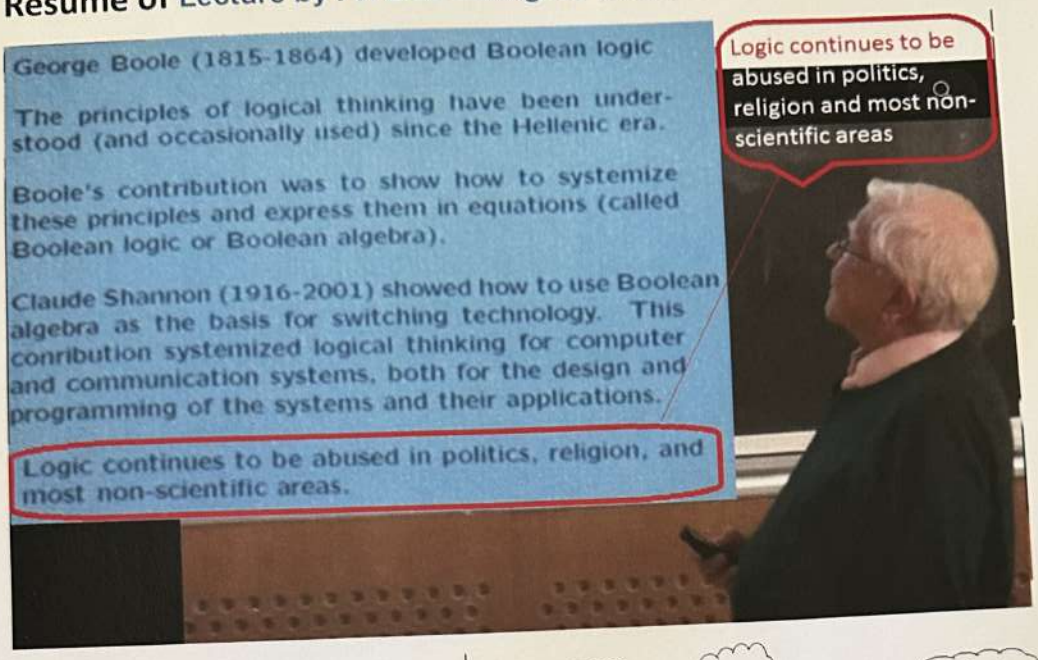
George Boole (1815-1864) developed Boolean logic

The principles of logical thinking have been understood (and occasionally used) since the Hellenic era.

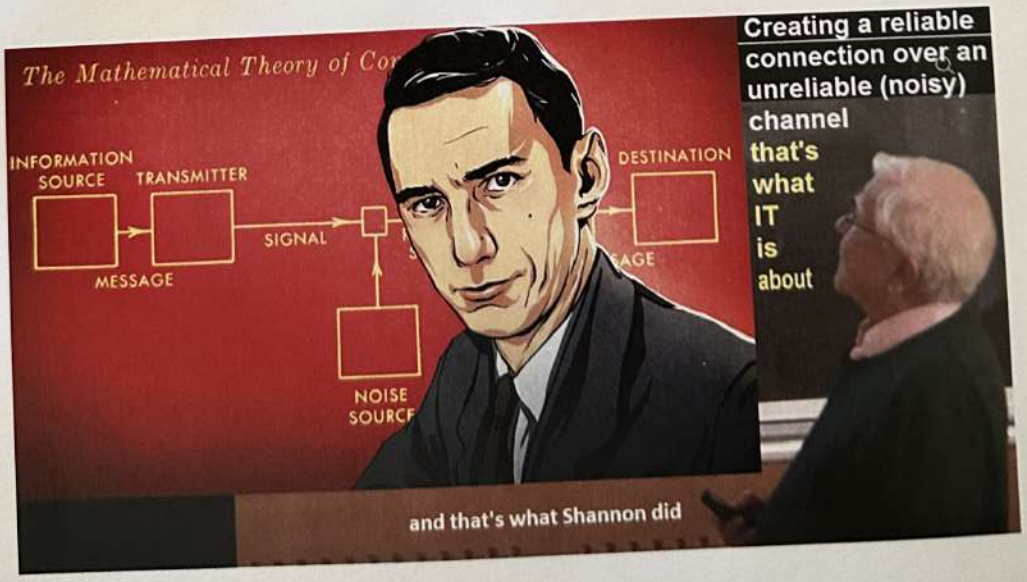
Boole's contribution was to show how to systemize these principles and express them in equations (called Boolean logic or Boolean algebra).

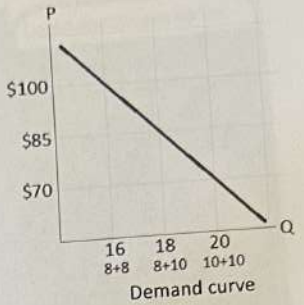
Claude Shannon (1916-2001) showed how to use Boolean algebra as the basis for switching technology. This conribution systemized logical thinking for computer and communication systems, both for the design and programming of the systems and their applications.

Logic continues to be abused in politics, religion, and most non-scientific areas.

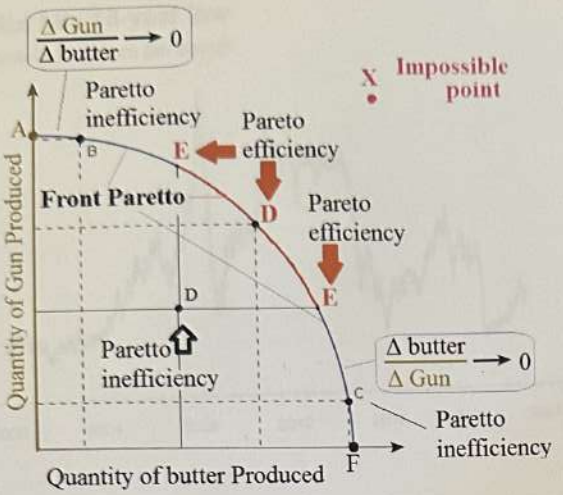


Bad logic (abuse of logic)





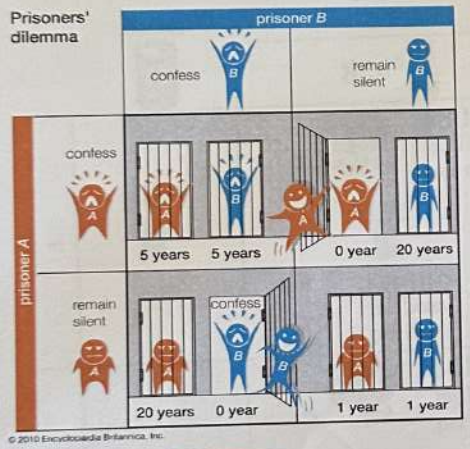
Barrel	1. $8 \cdot 10^6$ barrel/day	2. $10 \cdot 10^6$ barrel/day
1. $8 \cdot 10^6$ barrel/day	$800 millions per day $100 barrel $800 millions per day	$850 millions per day $85 barrel $680
2. $10 \cdot 10^6$ barrel/day	$680 millions per day $85 barrel $850 millions per day	$700 millions per day $70 barrel $700 millions per day



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

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

-1-1

Pareto Optimality