+0.1 11.2.26

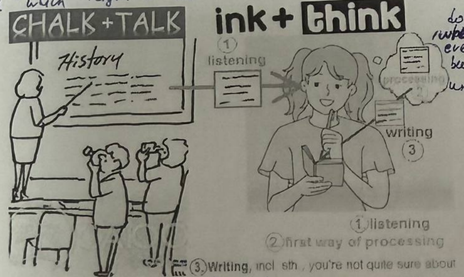
(+0.1) 16.2.26
ABBA

We dont start with formulas but with real observation.
① at first: it's raining
② then: 80% chance of rain
③ the Markov Weather model

It shows turning into a formal probabilistic model

traditional teaching methods which might be less effective

High uncentainty → high entropy



dont write everything, but first underst

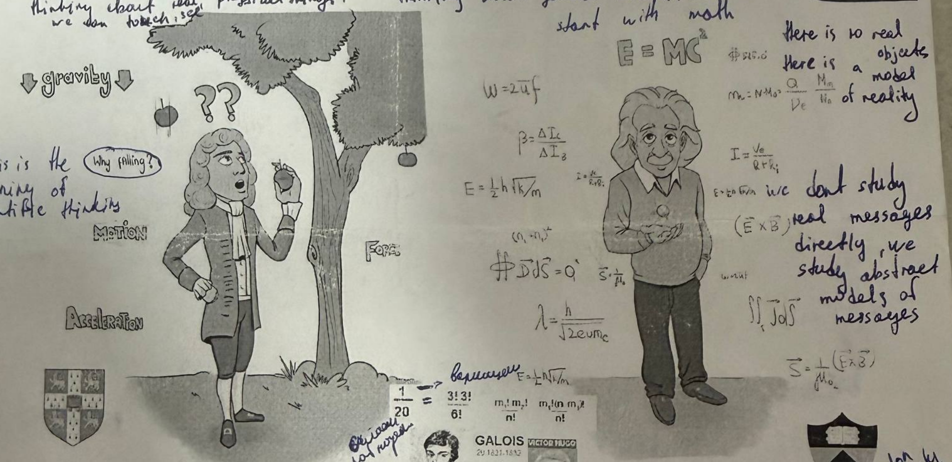
work with concrete things → School ⇩gravity⇩ MOTION translating an idea into the language of math ==formalism==> University work with models $E = MC^2$ $\oint \vec{D}\,d\vec{S} = Q$ $\iint \vec{J}\,d\vec{S}$

CONCRETE AND ABSTRACT THINKING

Consult

thinking about real, physical things. we can touch, see

thinking about general concept, formulas
start with math



this is the beginning of scientific thinking (Why falling?)

There is no real objects, there is a model of reality

we dont study real messages directly, we study abstract models of messages

Вероятность

ISAAC NEWTON

ALBERT EINSTEIN

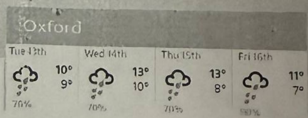
Princeton University

watching → ~~observing~~ the world → study structures abstract → describe the world through math theory

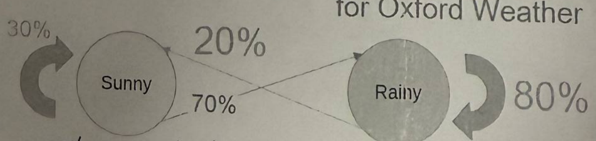
uncertainty → Motivation: 80% chance of rain

formalization of uncertainty → 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



the future depends only on the present and does not depend on the past

30% chance to stay sunny
70% chance to switch to Rainy

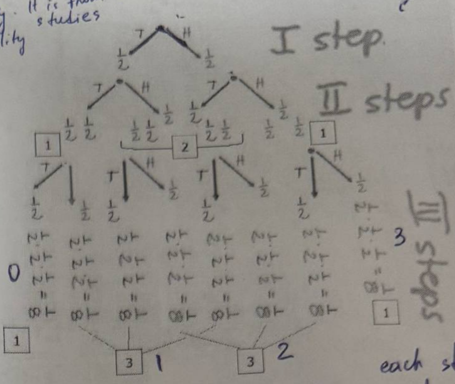
Pascal's triangle

studied gambling. It is from there that modern probability studies has grown

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
1 8 28 56 70 56 28 8 1	

T-tail
H-head

дерево с вероятностями



each step has two outcomes

Newton's Binomial

$(a+b)^0 = 1$

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

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

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

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

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

$(a+b)^7 = a^7 + 7a^6b + 21a^5b^2 + 35a^4b^3 + 35a^3b^4 + 21a^2b^5 + 7ab^6 + b^7$

$(a+b)^8 = a^8 + 8a^7b + 28a^6b^2 + 56a^5b^3 + 70a^4b^4 + 56a^3b^5 + 28a^2b^6 + 8ab^7 + b^8$

$a = 1$
$b = 1$

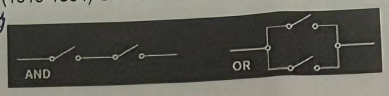
1) наблюдаем мир ← Исаак Ньютон
2) измеряем мир
3) считаем вероятность ← Галуа (комбинаторика)
4) изучаем структуры и симметрии ←
5) строим фундаментальные ← Эйнштейн
абстрактные теории

The binomial coeff.
Pascal's triangle is a way to record how many paths in the tree lead to the same outcomes

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

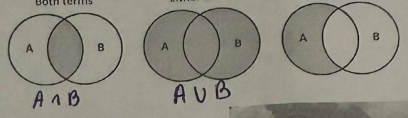
A	B	A ∨ B
True	True	True
True	False	True
False	True	True
False	False	False

Logical disjunction

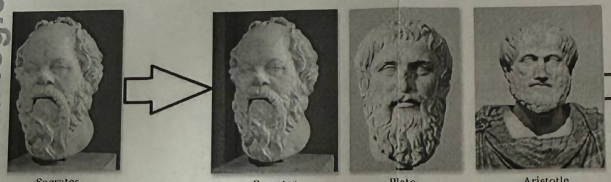
OR

Definition
Truth table
Logic gate

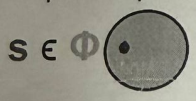
BOOLEAN LOGIC



Good logic



Socrates was a philosopher

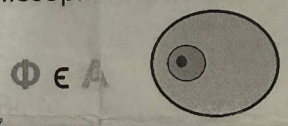


Socrates

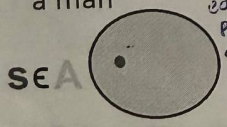
Plato

Aristotle

philosophers are men

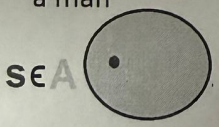


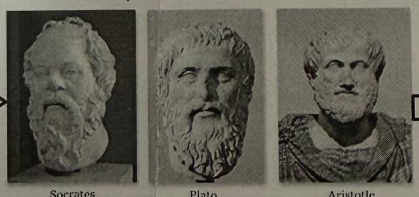
Socrates was a man



Bad logic

Socrates was a man



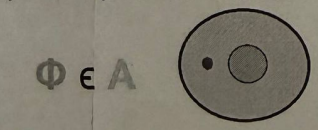


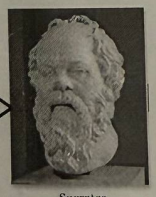
Socrates

Plato

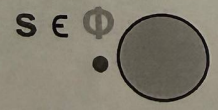
Aristotle

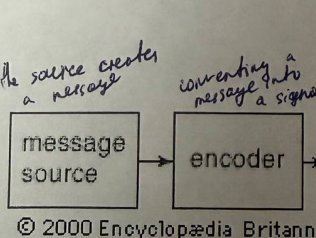
philosophers are men





Socrates was a philosopher





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+0.1 16.2 +0.1 12.2

Boole created the mathematical of logic and Shannon connected logic with electrical engineering

Resume of Lecture by Pr. Bob Gallagher from MIT

Massachusetts Institute of Technology (MIT)

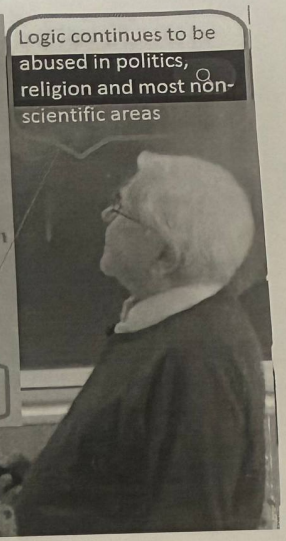
George Boole (1815-1864) developed Boolean logic

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 contribution 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.



Kant Gauß Goethe

A little nationalistic but this is an sample of right logic

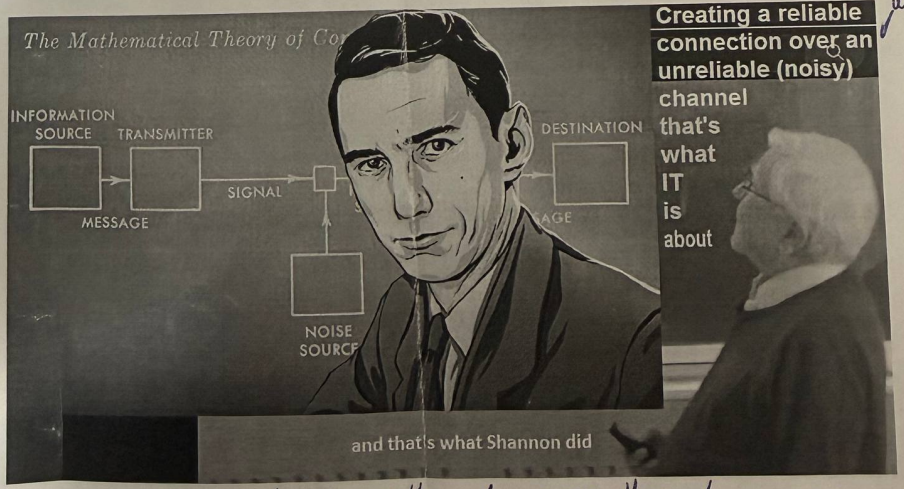
Kant, Gauss, Goethe are great

Kant, Gauss, Goethe - Germans

Germany Great

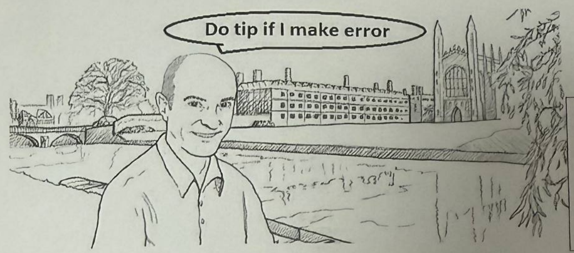
Bad logic (abuse of logic)

теорема шеннона.

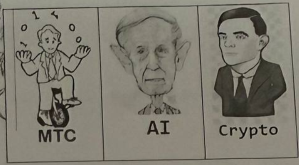


If you encode information correctly, then even through a noisy channel you can transmit data almost without errors

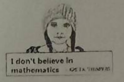
+0.1

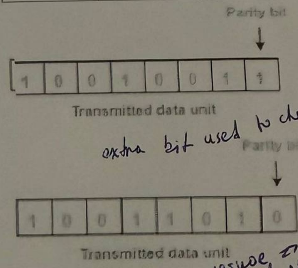


Sir **Dr. D. MacKay**,
University of Cambridge
(22 April 1967 – 14 April 2016)



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

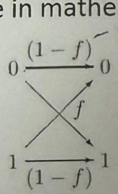




extra bit used to check

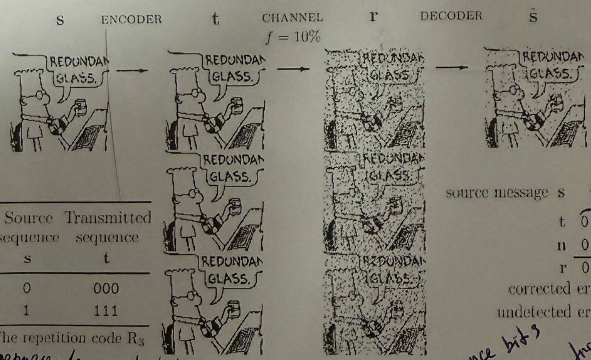
нечетное ≠ неправильно

if transmit data without a buffer any error destroys the information



— probability

$f = 10\% =$ error



Source sequence s	Transmitted sequence t
0	000
1	111

The repetition code R_3

represents each bit several times and uses majority voting

90%

$4(0{,}90)^7$

$(0{,}1)^2 \approx 1\%$

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					⋆		

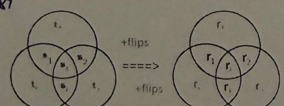
we count the majority

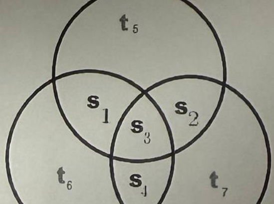
7.4. Hamming code.

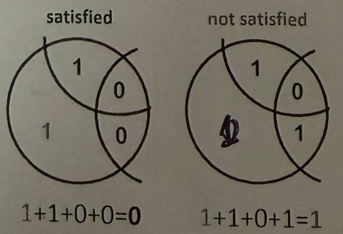
$$\frac{4}{\Sigma} \rightarrow \frac{7}{t}$$

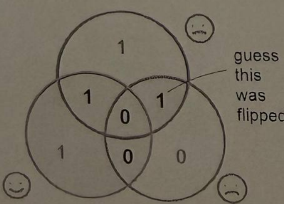
source bits

3- transm. bits





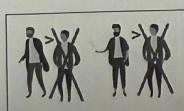




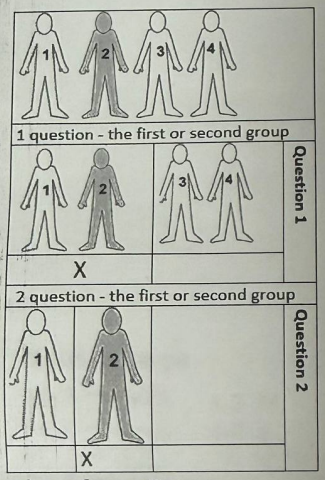
0 = test passed
1 = test failed

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 =

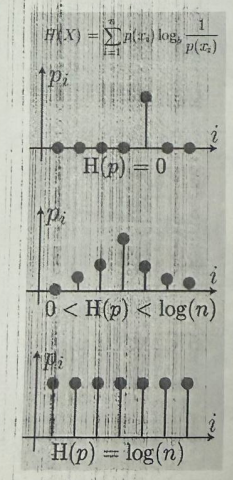
2*0.25+ 2*0.25+ 2*0,25+ 2*0,25 =2

Average number of questions =

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

if one option occures more often than others, it is better to ask about it first

Question 1. Is this Zuckerberg?	 50%	1*0.5 $-\log_2 2$
Question 2. Is this Sergey Brin?	 25%	2*0.25 $\log_4 4$
Question 3. Is this Stefan from BMW?	 12,5%	3*0,125 $\log_2 8$
So Prince Saud	 12,5%	3*0,125
Average number of questions = **1,75**		



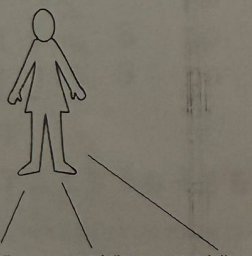
$$\sum_{i=1}^{n} p(i) \log_2 \frac{1}{p(i)}$$

Quantifying information

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

number of bits required to encode choice

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





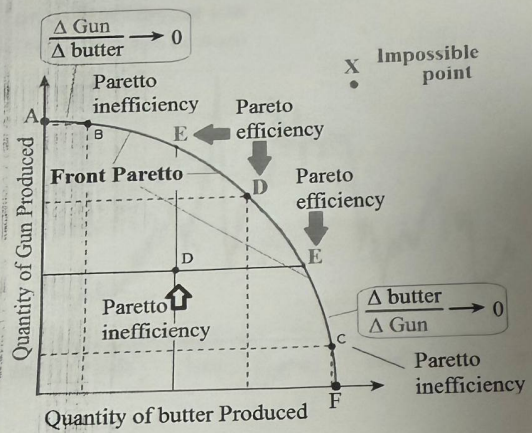

Mark Zukerberg P(1)= **50%**

Sergey Brin P(2)= **25%**

Stefan Quandt P(3)= **12,5%**

Prince Al Saud P(4)= **12,5%**

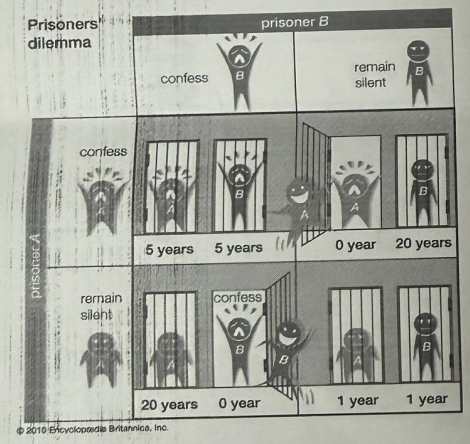
information is related to uncertainty. The more uncertain an event is, the more information we gain when it occurs.

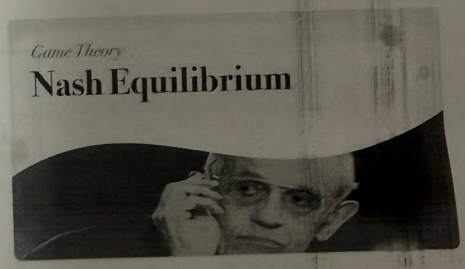


by Vilfredo Pareto

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.





** => 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	0 / -20	-1 / -1

-1-1

Pareto Optimality