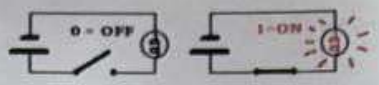
Massachusetts Institute of Technology (MIT)

Lecture by Pr. Bob Gallagher
Boole (1815-1864) & **Shannon** (1916-2001)

Sapere aude!



Logical addition (disjunction)

A	B	F=A∨B
0	0	0
0	1	1
1	0	1
1	1	1

Conjunction:

p	q	p∧q
T	T	T
T	F	F
F	T	F
F	F	F

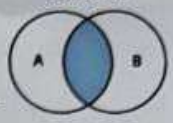
Definition
Truth table
Logic gate

Logical disjunction
OR

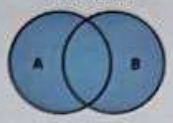
x + y
(0111)

BOOLEAN LOGIC

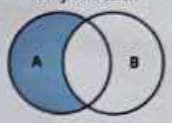
AND Both terms



OR Either term

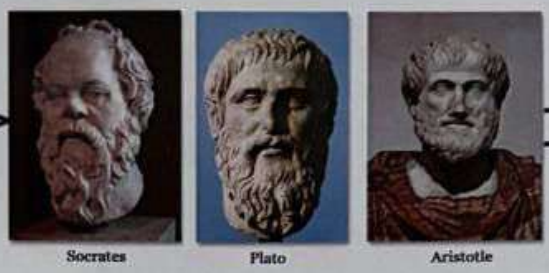


NOT Only one term



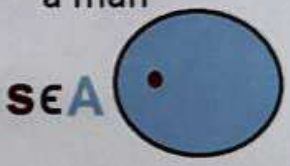
Good logic

Socrates was a philosopher



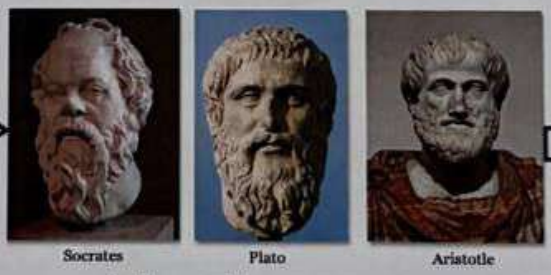
philosophers are men

Socrates was a man



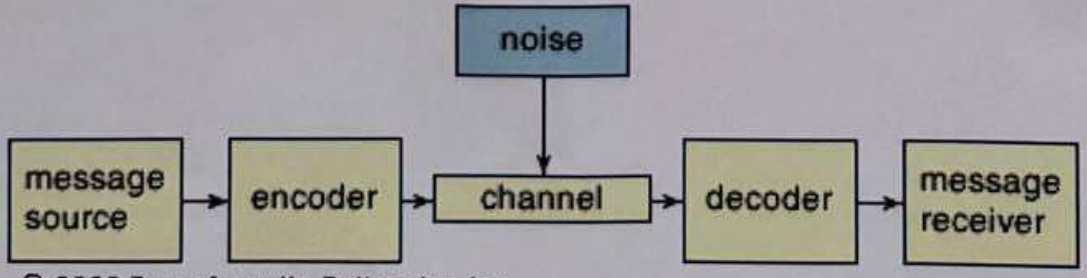
Bad logic

Socrates was a man



philosophers are men

Socrates was a philosopher



dot.net.by

+0.1

to Fin

(+0,2) for Fin

Gen $\frac{n!}{m_1! m_2! \dots m_k}$

1) $n! = (1 \cdot (n-1)(n-2)$

2) $P(A) = \frac{m_1! \cdot m_2!}{n!}$

3) $m_1 + m_2 = n$

4) $\frac{n!}{m_1! m_2! \dots m_k!}$

5) $\frac{n!}{m_1! \cdot (n-m_1)!}$

MTБанк
Банк свежих решений

Quantifying inf.

1. $\frac{6}{10} = 0{,}6$
2. $\frac{3}{10} = 0{,}3 \cdot 2 = 0{,}6$
3. $\frac{1}{10} = 0{,}1 \cdot 3 = 0{,}3$
4. $\frac{1}{10} = 0{,}1 \cdot 3 = 0{,}3$

$0.6 \cdot lb\left(\frac{1}{0.6}\right) + 0.3 \cdot lb\left(\frac{1}{0.3}\right) = 1{,}8$

0.289

$\left(\frac{10}{0.3}\right)$ $\frac{3}{0.1} \sim lb(3) \approx \boxed{1.8}$

$lb\left(\frac{10}{0.3}\right) = lb(3{,}333$

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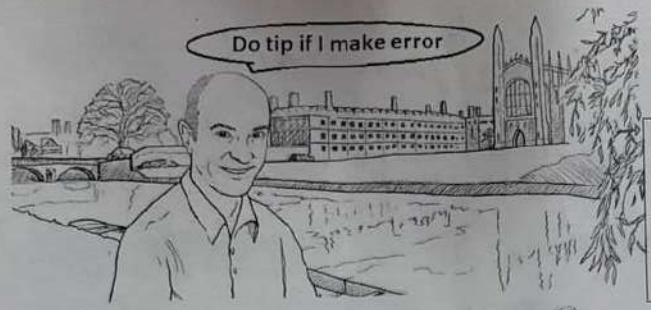
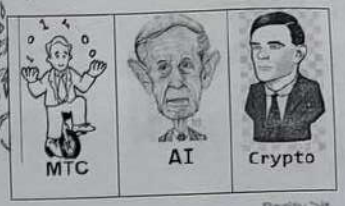
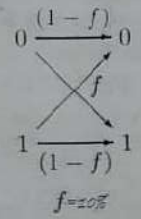
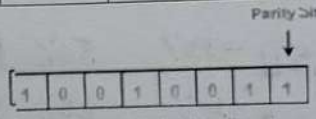


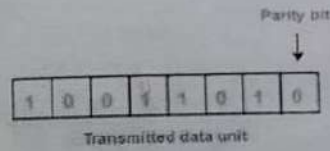
Sir **Dr. D. MacKay**,
University of Cambridge
(22 April 1967 – 14 April 2016)

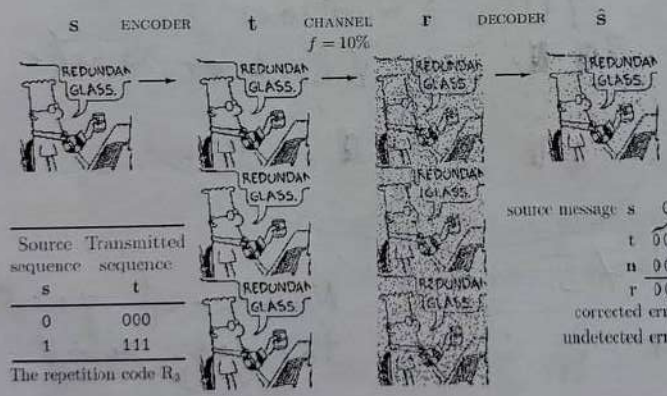


"I believe in clean energy,
but I also believe in mathematics"







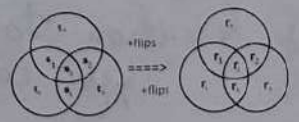


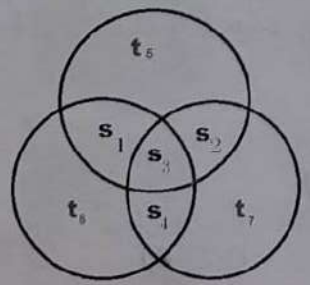
Source sequence s	Transmitted sequence t
0	000
1	111

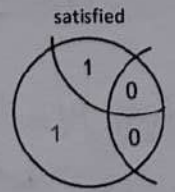
The repetition code R_3

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						*		

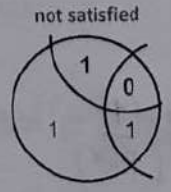
7.4. Hamming code. $\frac{4}{\Sigma} \rightarrow \frac{7}{t}$



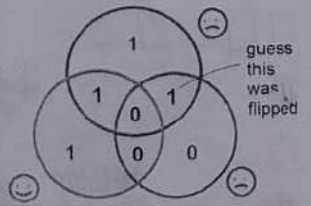




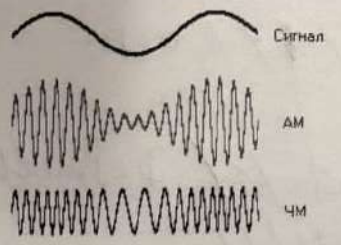
1+1+0+0=**0**



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



Reginald A. Fessenden
(October 6, 1866 – July 22, 1932)

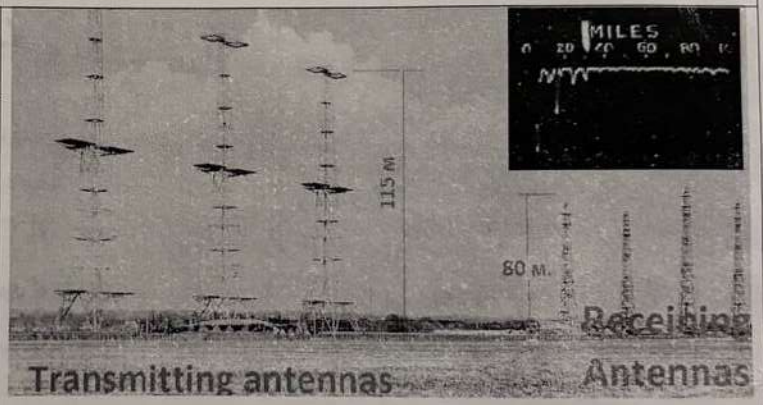


(October 6, 1866 – July 22, 1932)

first transmission of speech by radio (1900), and the first two-way radiotelegraphic communication across the Atlantic Ocean (1906)

"Ни одна организация, занимающаяся какой-либо конкретной областью деятельности, никогда не изобретает какие-либо важные разработки в этой области или не внедряет какие-либо важные разработки в этой области до тех пор, пока она не будет вынуждена сделать это из-за внешней конкуренции.." Oxford University Press. The Quarterly Journal of Economics , Feb., 1926, p. 262.

Battle of Britain
(3 month 3 weeks)
10.07-31.10.1940



Radar played a major role in the Battle of England

H. Nyquist

$$W = K \log m$$

Where W is the speed of transmission of intelligence,
m is the number of current values,
and, K is a constant.

Ralph **Hartley**
(81:1888-1970)

$$H = n \log s$$
$$= \log s^n.$$

~~1.aspx~~

Projects/1/1.aspx

index.html
↳ 1.aspx

<meta
HH

Projects/1/Default.aspx

Projects/1/

Goo

HTML Redirection

index.htm

url='1.aspx' -V

<html>
<head>
→ HTML Redirection
</head>
</html>

$$H = \sum_{x=1}^{n} p(x) \log_2 \left(\frac{1}{p(x)}\right)$$

$$H(x) = \log_2 \left(\frac{1}{p(x)}\right)$$

1st $\quad 0.6 \cdot \log_2 \left(\frac{1}{0.6}\right) = 0.6 \cdot \log_2 \left(\frac{10}{6}\right) =$

$0.2 \cdot \log_2 \left(\frac{1}{0.2}\right) = 0.2 \log_2 \left(\frac{10}{2}\right) =$

$0.1 \cdot \log_2$

$0.1 \cdot \log_2$

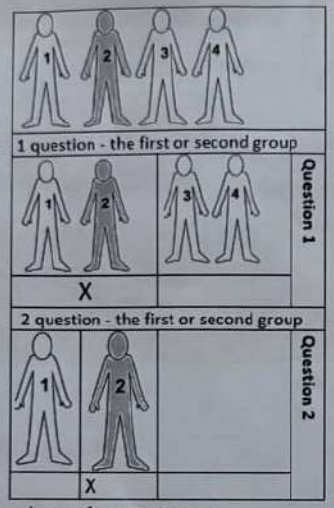
Σ

Shannon Ent. ↗

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

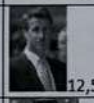


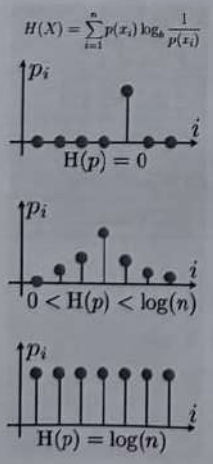
Average number of questions =

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		



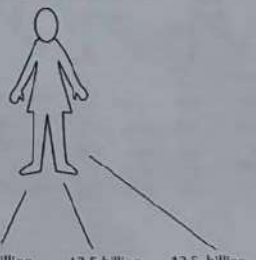
$$\sum_{i=1}^{n} p(i) \log_2 \frac{1}{p(i)}$$

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%**

Markoff Chain Probability Model for Oxford Weather

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

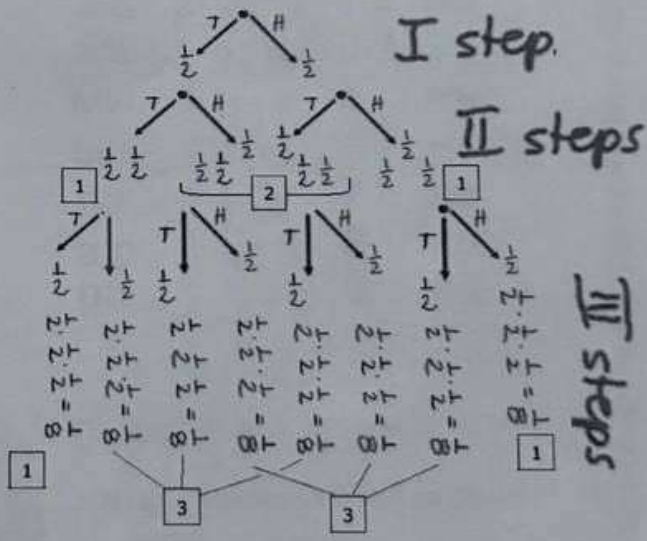
Motivation: 80% chance of rain

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

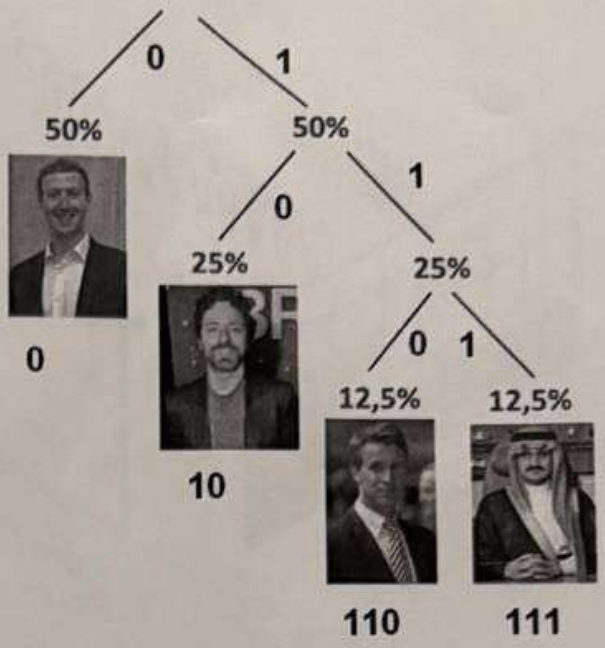
Pascal's triangle

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



Newton's Binomial

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



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

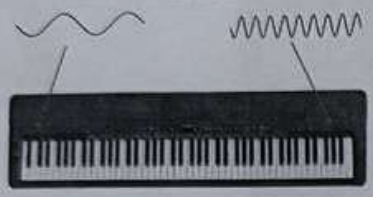
9

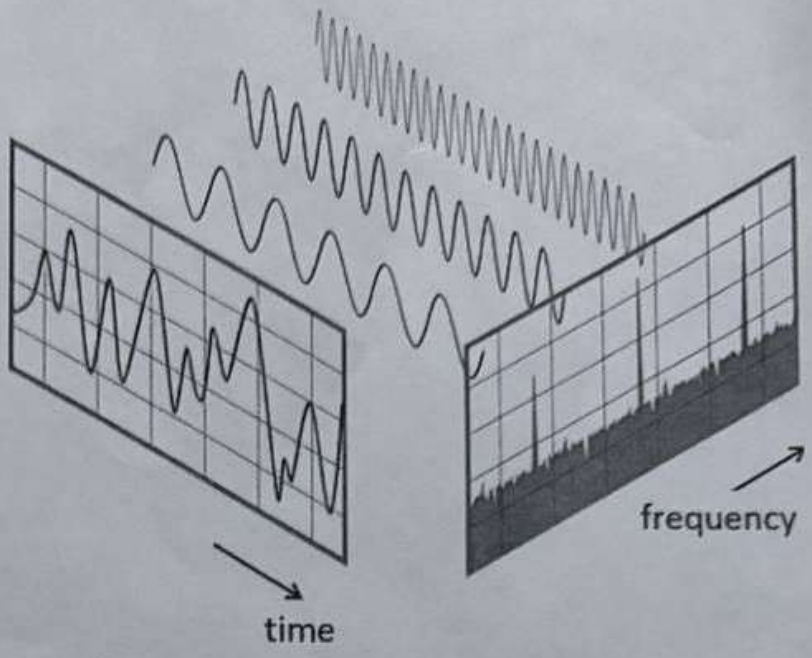
0. 4 6 7 3 1 9 1 6 7 3 5

ам ыл ла ам ма ра ма ыл ла ам мы

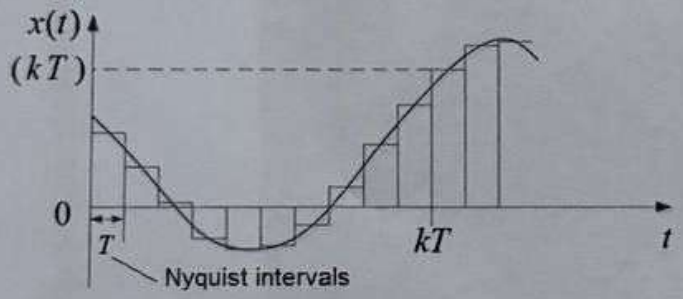
мылла рама

Fourier transform



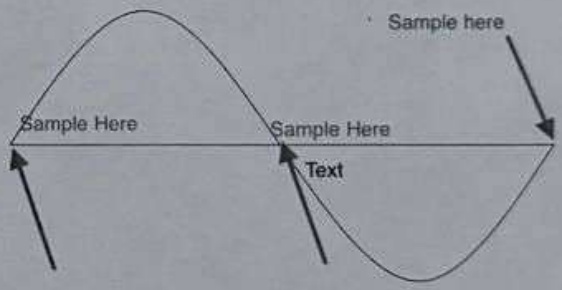


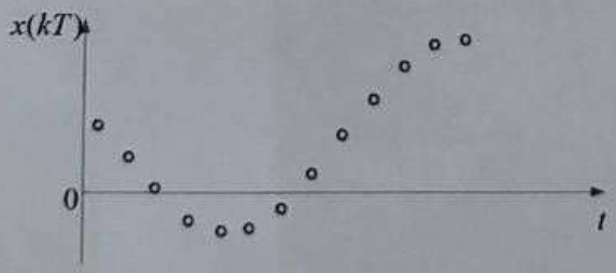
Sampling. Kotelnikov-Nyquist Theorem

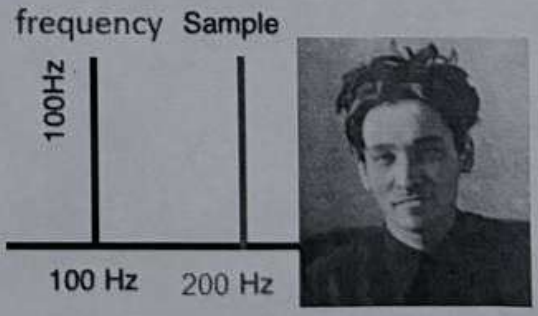


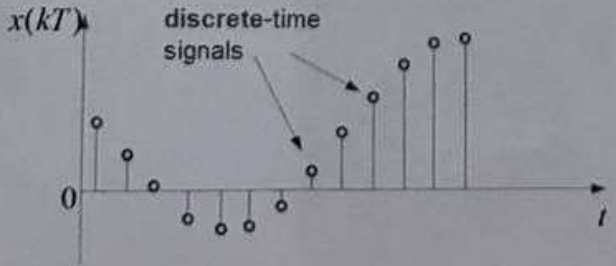
Time intervals T, through which readings s (kT) are taken, are called Nyquist intervals.

Sine with period T **Sampling at T/2**









$F_{sample} >= 2 * F_{max}$

$(T_{sample} <= T_{min}/2)$

+0.1 3 June +0.1 to fin Grade

Resume of Lecture by Pr. Bob Gallagher from MIT

Massachusetts Institute of Technology (MIT)

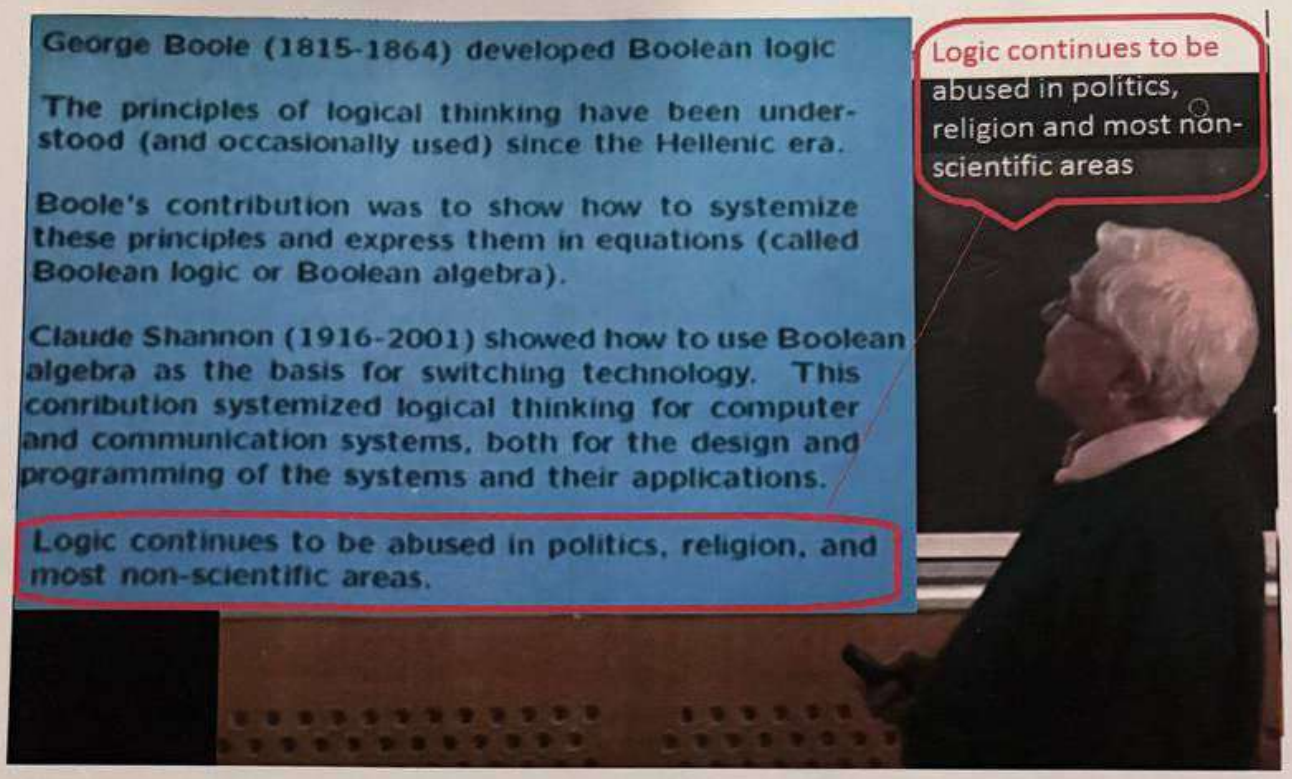
George Boole (1815-1864) developed Boolean logic

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.



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)