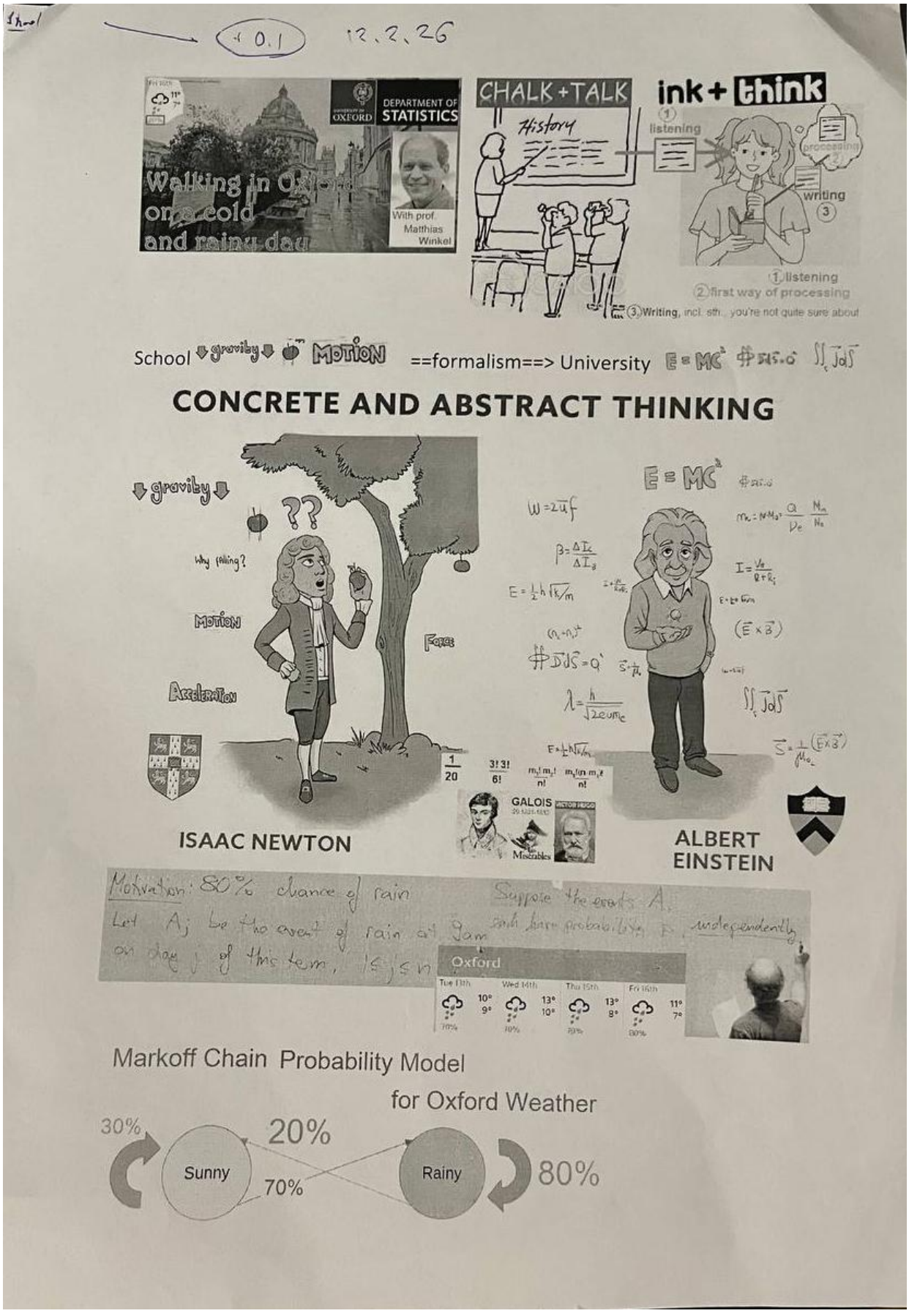
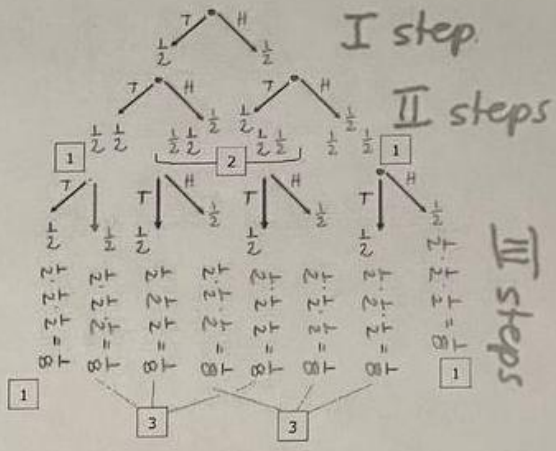
# 1:


+0.1
12.2.26
DEPARTMENT OF STATISTICS
OXFORD
Walking in Oxford on a cold and rainy day
With prof. Matthias Winkel
CHALK + TALK
History
ink + think
listening
processing
writing
1 listening
2 first way of processing
3 Writing, incl. sth. you're not quite sure about
School gravity MOTION ==formalism==> University
CONCRETE AND ABSTRACT THINKING
gravity
Why falling?
MOTION
FORCE
ACCELERATION
ISAAC NEWTON
GALOIS
Les Misérables
ALBERT EINSTEIN
Motivation: 80% chance of rain
Oxford
Tue 13th
Wed 14th
Thu 15th
Fri 16th
Markoff Chain Probability Model
for Oxford Weather
30%
20%
Sunny
70%
Rainy
80%

## 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 |




$$(a+b)^0 = 1$$

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

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

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

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

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

Newton's Binomial

**2:**


Lecture by Pr. Bob Gallagher
Boole (1815-1864) & Shannon (1916-2001)
Massachusetts Institute of Technology (MIT)
MIT
BOOLEAN LOGIC
NOT
OR
AND
Logical addition (disjunction)
Socrates was a philosopher
philosophers are men
Socrates was a man
Socrates
Plato
Aristotle
Φ ε A
S ε Φ
S ε A
Socrates was a philosopher
philosophers are men
Socrates was a man
Socrates
Plato
Aristotle
Φ ε A
S ε Φ
S ε A
message source
encoder
channel
decoder
message receiver
noise
© 2000 Encyclopædia Britannica, Inc.

## Resume of Lecture by Pr. Bob Gallagher from MIT

Massachusetts Institute of Technology (MIT)

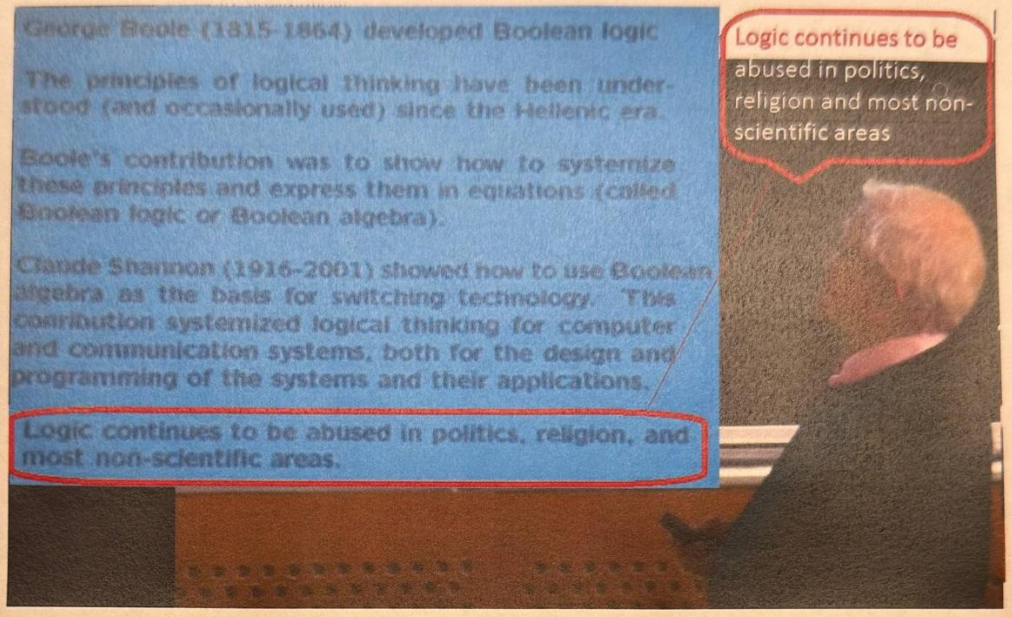
George Boole (1815-1864) developed Boolean logic

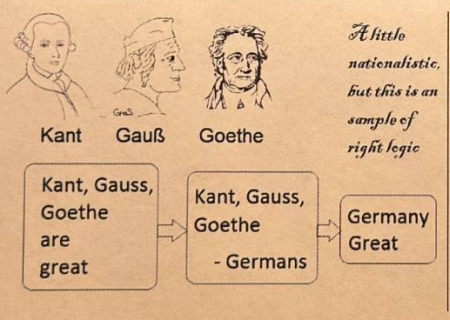
The principles of logical thinking have been understood (and occasionally used) since the Hellenic era.

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.

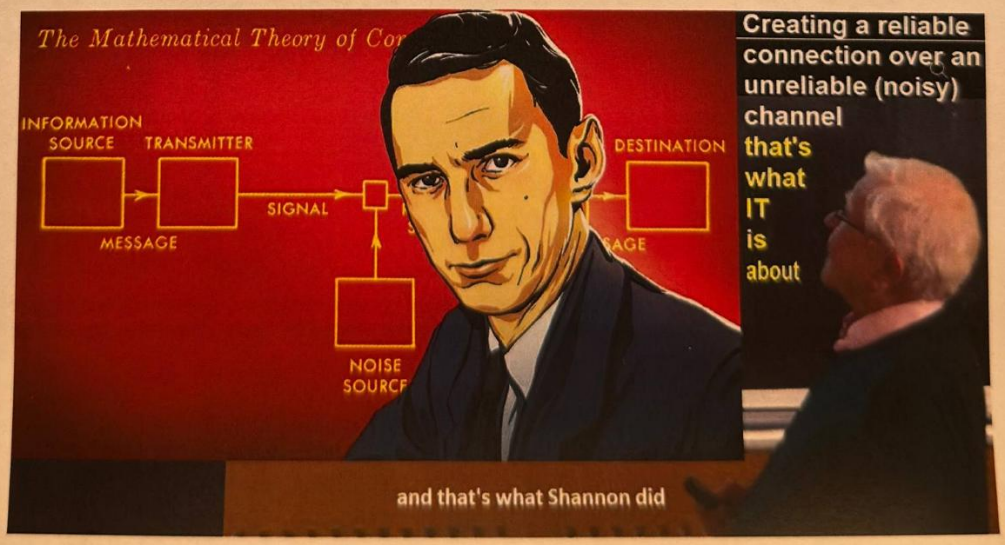
Logic continues to be abused in politics, religion, and most non-scientific areas.



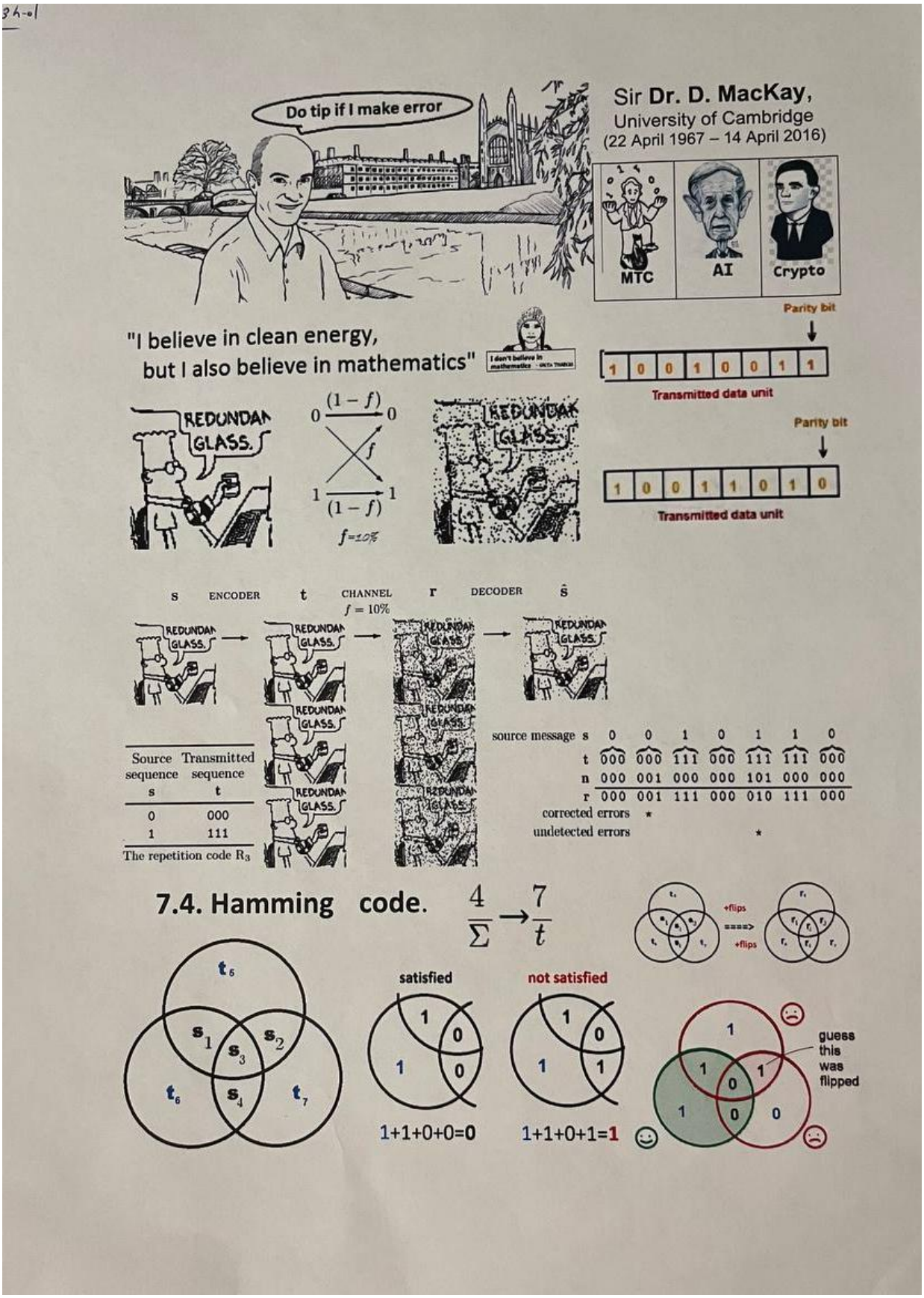





Bad logic (abuse of logic)



# 3:


Do tip if I make error
Sir Dr. D. MacKay,
University of Cambridge
(22 April 1967 – 14 April 2016)
MTC
AI
Crypto
"I believe in clean energy,
but I also believe in mathematics"
I don't believe in mathematics
Parity bit
1 0 0 1 0 0 1 1
Transmitted data unit
Parity bit
1 0 0 1 1 0 1 0
Transmitted data unit
REDUNDANT GLASS.
0 (1 − f) 0
f
1 (1 − f) 1
f=10%
s ENCODER t CHANNEL r DECODER ŝ
f = 10%
Source sequence s
Transmitted sequence t
0 000
1 111
The repetition code R3
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.
4/7 → t
+flips
====>
+flips
satisfied
not satisfied
1+1+0+0=0
1+1+0+1=1
guess this was flipped

# 4:

4-01

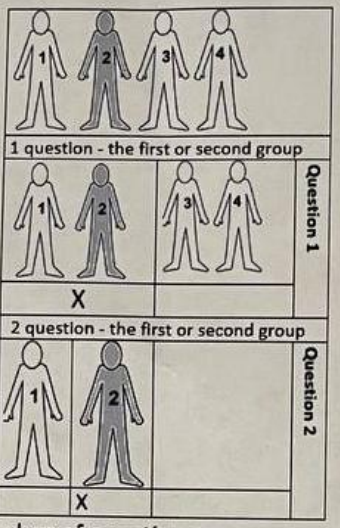
Picky Bride's problem $\log_2 N$ A||B, O||C.

Харитон

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




$\log_2(4)=2$ бита

Average number of questions =

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

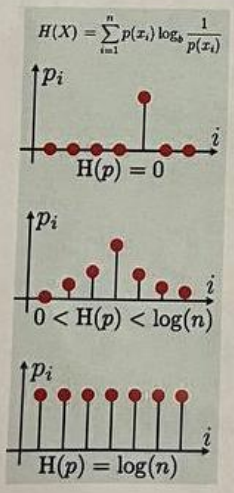
Average number of questions =

| 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 |

Шенон

$I = \log_2 \frac{1}{p_i}$




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

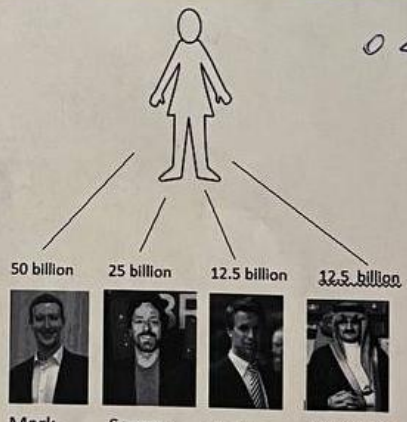
Quantifying information

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

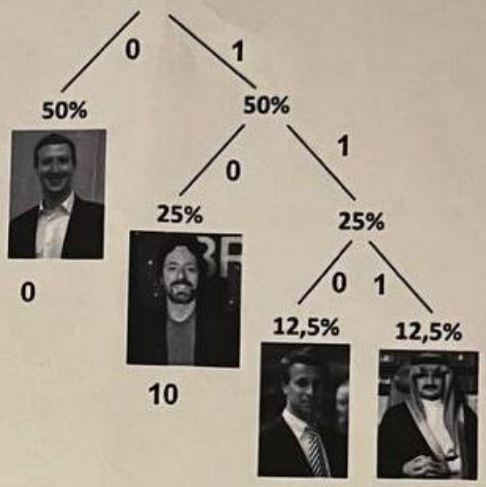
number of bits required to encode choice

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

$0 < H(p) < \log(n)$




$H = 0{,}5 \cdot \log_2\left(\frac{1}{0{,}5}\right) + \ldots = 1{,}75$ бита




Хаффмана:

чем 8-битные — X

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

Мама мыла ра

М - 3 — 30% — 10 — 2 — 1-3 М

а - 4 — 40% — 0 — 1 — 4-7 а

ы - 1 — 10% — 1100 — 4 — 8 -ы

л - 1 — 10% — 1101 — 4 — 9 -л

р - 1 — 10% — 111 — 3 — 10 -р

10

лла мамма р

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

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

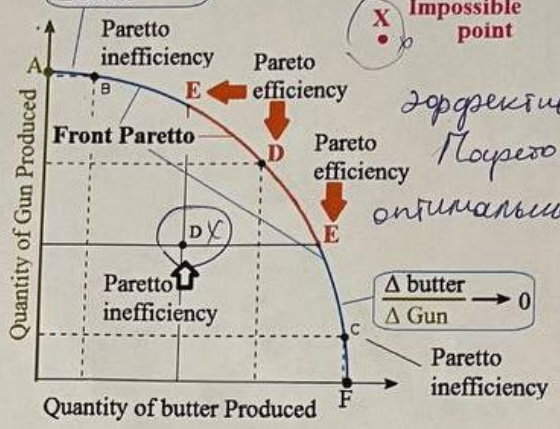


**Second-order approximation** (digram (2-symbols) structure as in Belarusian)

# 5:

5h-o1

Кривая производственных возможностей 1↑ 2↓

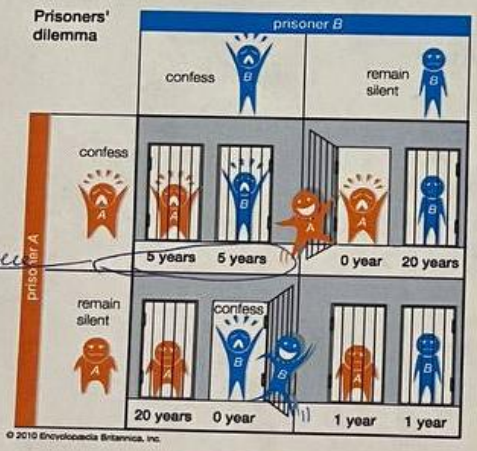



эффективность Парето оптимальны

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.

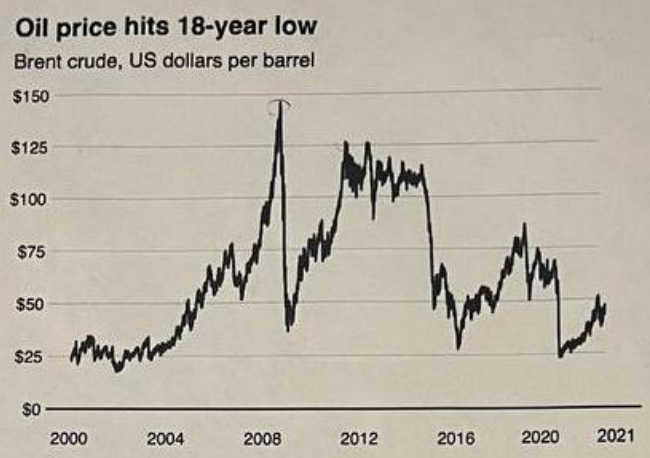


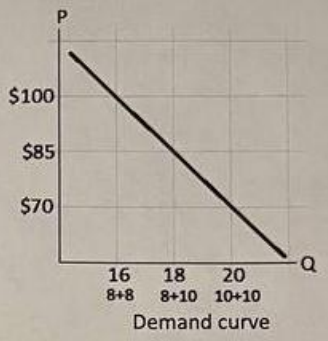

равновесие Нэша

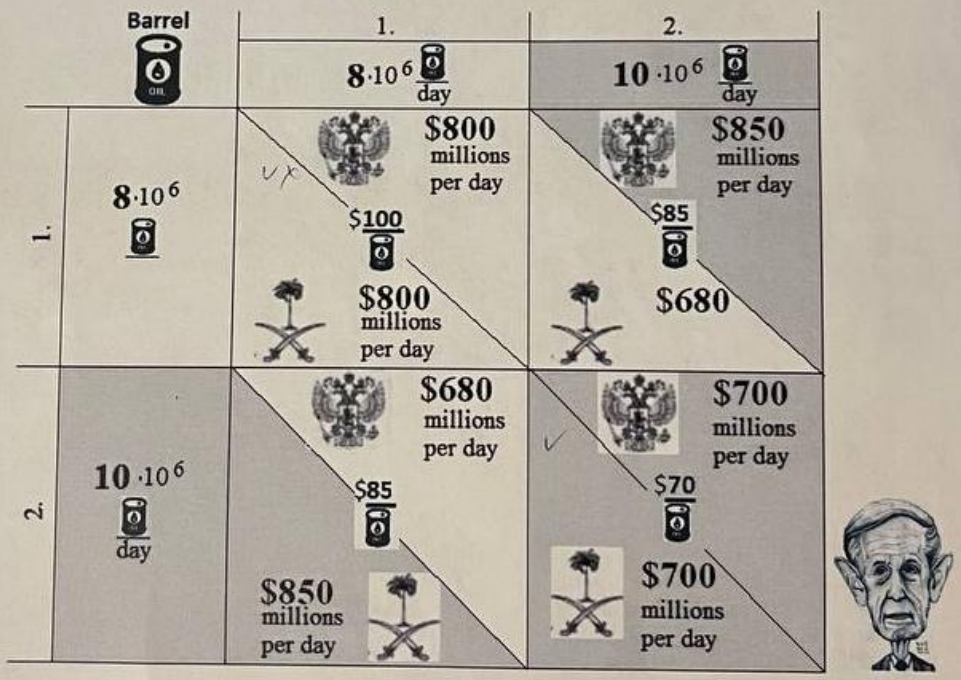

** => Nash equilibrium

| $H_2(x)$ / $H_1(x)$ | 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


Oil price hits 18-year low
Brent crude, US dollars per barrel
$150
$125
$100
$75
$50
$25
$0
2000
2004
2008
2012
2016
2020
2021


P
$100
$85
$70
Q
16
8+8
18
8+10
20
10+10
Demand curve


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