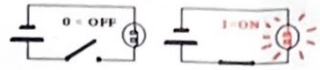
Massachusetts Institute of Technology (MIT)

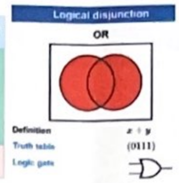
Lecture by Pr. Bob Gallagher
Boole (1815-1864) & **Shannon** (1916-2001)

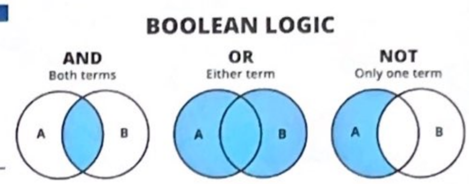


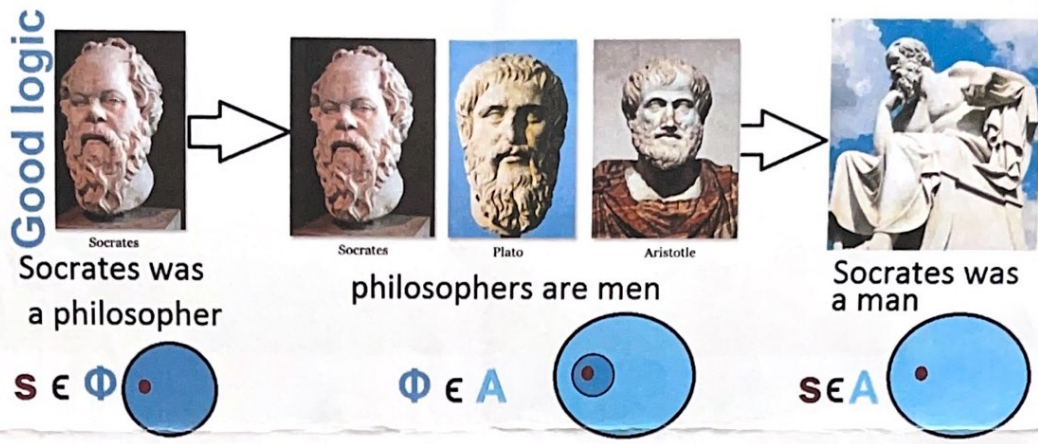
Logical addition (disjunction)

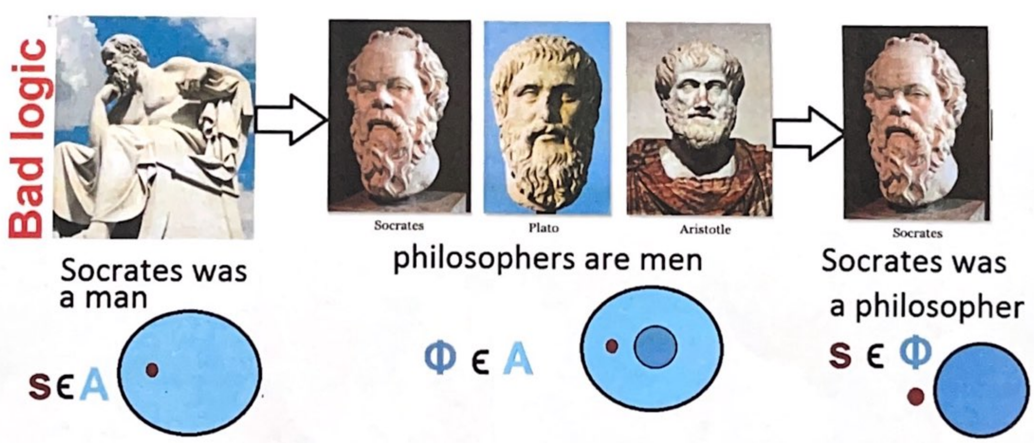
A	B	F=A∨B
0	0	0
0	1	1
1	0	1
1	1	1

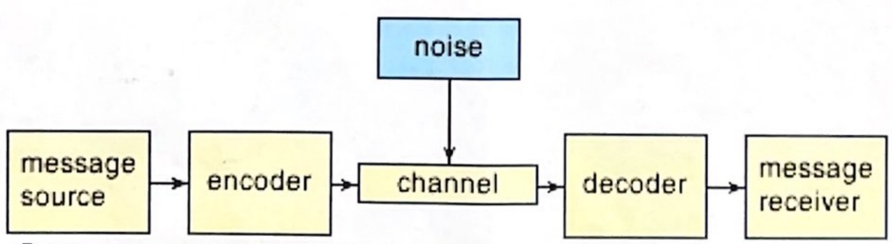
A	B	$A \vee B$
True	True	True
True	False	True
False	True	True
False	False	False











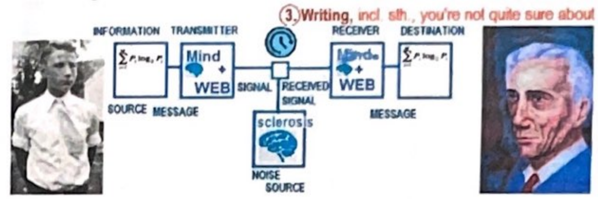
To save inf. we should keep it in 3 places:

-> HDD [1] 90% ok 10% of fail
-> site [2] 90% ..
-> www [3] 90% ..

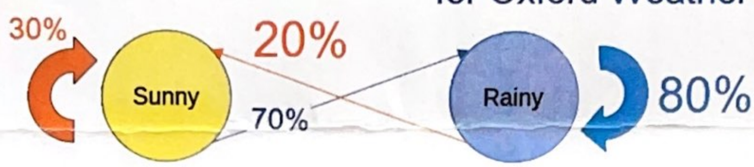
$1 - 0.1 \cdot 0.1 \cdot 0.1 = 0{,}999$ probability to save information 99.9%.

80% chance of rain

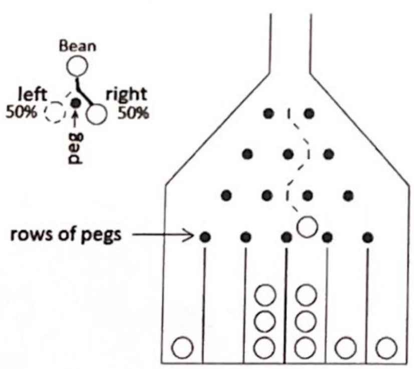
says the Met Office in its weather forecast for Oxford.

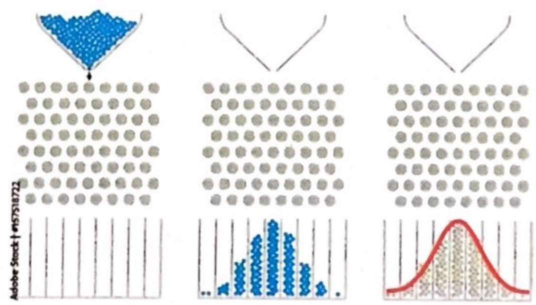


Markoff Chain Probability Model for Oxford Weather



If it is Rainy today => there is an 80% chance that it will be rainy tomorrow.



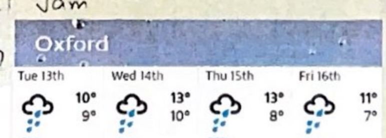


School gravity MOTION == formalism ==> University $E = MC^2$

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



then take notes on the lecture yourself

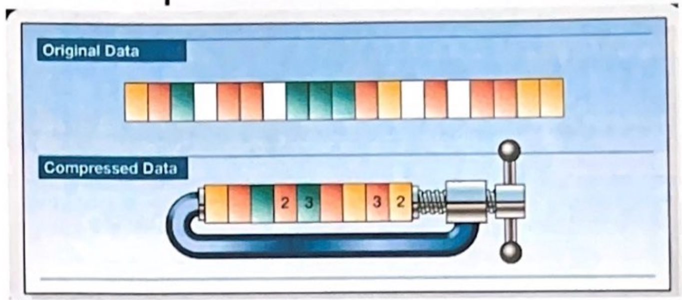
Motivation: 80% chance of rain

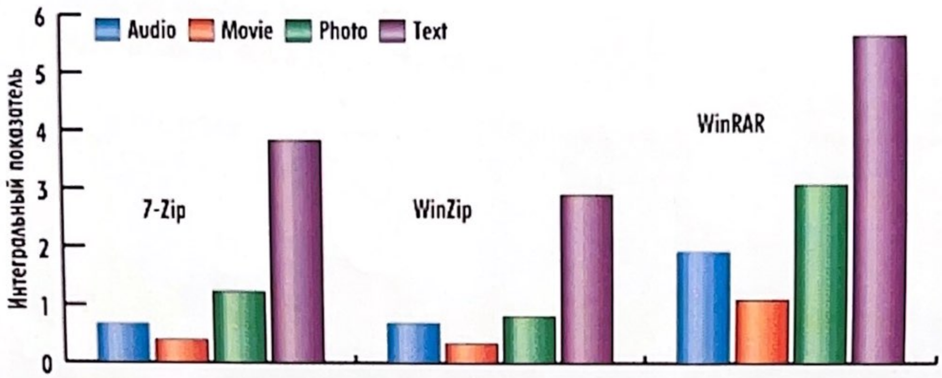
Let A_j be event of rain at 9am

40

on day j of this term, $1 \leq j \leq n - 39$

Comparison of the compression ratio of popular archivers





Before Compression

Data: AAAAAAABCCCCCCDDEEEEE →

Symbol	Frequency
A	7
B	1
C	6
D	2
E	5

After Compression

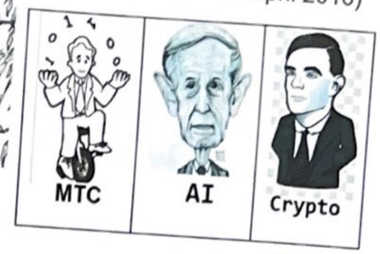
Symbol	Bit Code
A	00
B	111
C	01
D	110
E	10

Entropy compression ratio

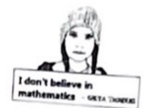
Before Compression = 21 x 8 bits =198 bits
After Compression = 7 x 2 bits + 1 x 3 bits + 6 x 2 bits + 2 x 3 bits + 5 x 2 bits = 45 bits

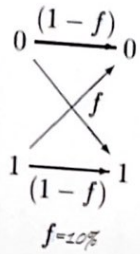
+0.4 to Exam
+0.2 to Exam
lb(32) = 5
36 = 5.2
+

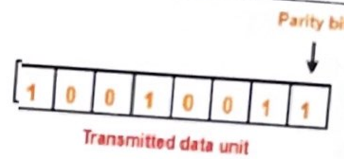
Sir **Dr. D. MacKay**,
University of Cambridge
(22 April 1967 – 14 April 2016)

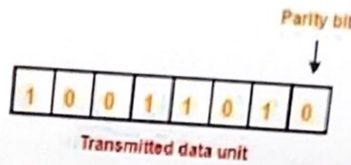


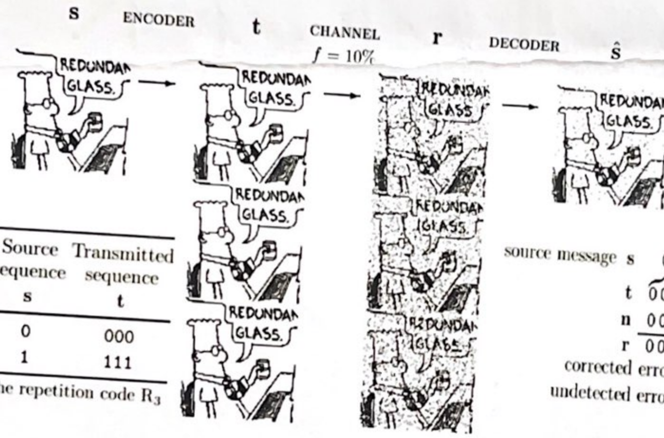
"I believe in clean energy,
but I also believe in mathematics"









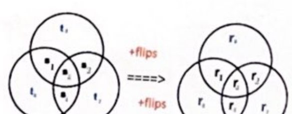


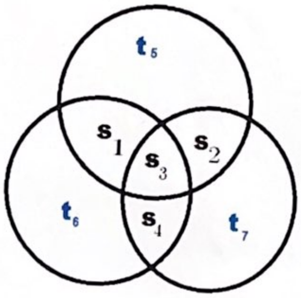
Source sequence **s**	Transmitted sequence **t**
0	000
1	111

The repetition code R_3

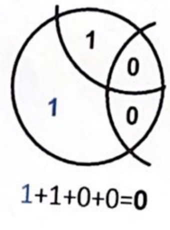
source message **s**	0	0	1	0	1	1	0
t	000	000	111	000	111	111	000
n	000	001	000	000	101	000	000
r	000	001	111	000	010	111	000
corrected errors		⋆					
undetected errors					⋆		

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



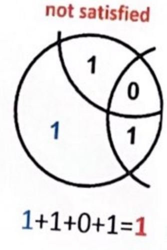


satisfied

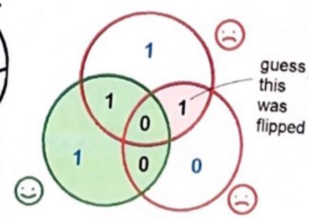


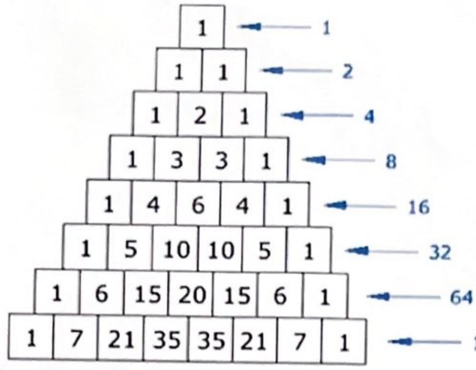
1+1+0+0=**0**

not satisfied



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





7
8 1 8 28
9 9 36

Shannon Hartley Theorem

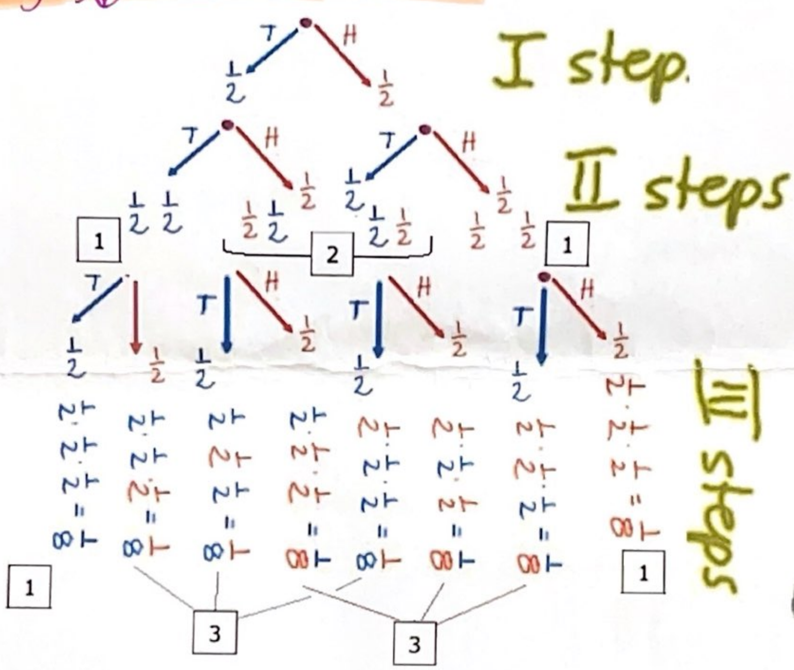
This is a measure of the *capacity* on a channel; it is impossible to transmit information at a faster rate without error.

$$C = B\log_2\left(1+S/N\right)$$

- C = capacity (in bit/s)
- B = bandwidth of channel
- S = signal power (in W)
- N = noise power (in W)

It is more usual to use SNR (in dB) instead of power ratio (as with terrestrial and commercial communications syste
S/N >> 1, then rewriting in terms of log10.

$$C = B\frac{\log_{10}(S/N)}{\log_{10}2} = B\frac{10\log_{10}(S/N)}{10.\log_{10}2} = B\frac{SNR}{3.01}$$



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

$(1+x)^5 = 1+5x+10x^2+10x^3+5x^4+x^5$

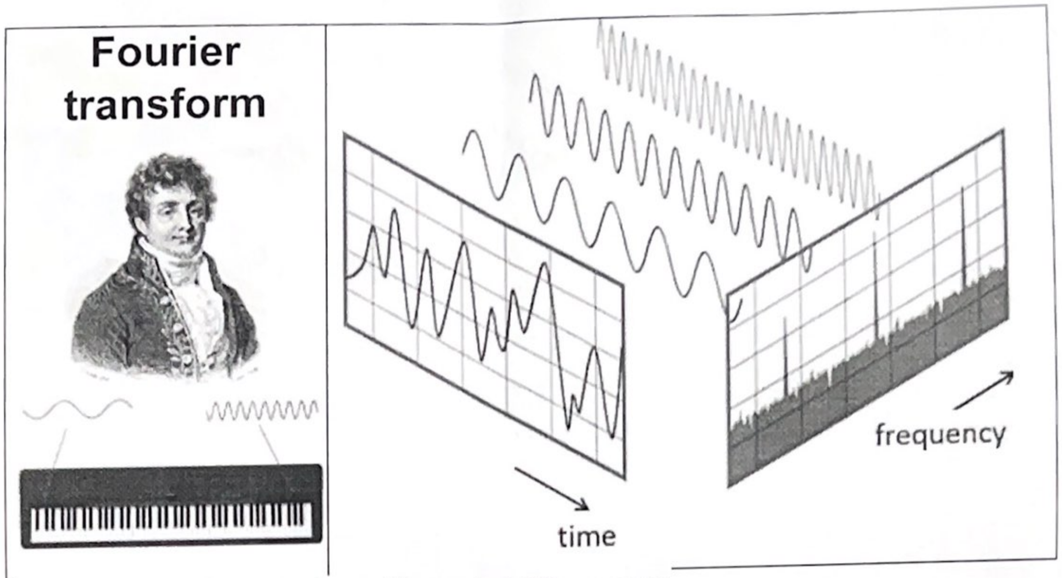
K=2 ordering of $\overset{m_1}{aaa}$ $\overset{m_2}{bbb}$ is $\frac{n!}{m_1!\cdot m_2!} = \frac{n!}{m_1!(n-m_1)!} =$

$= \frac{n!}{m_2!\,(\underbrace{n-m_2}_{m_1})!}$

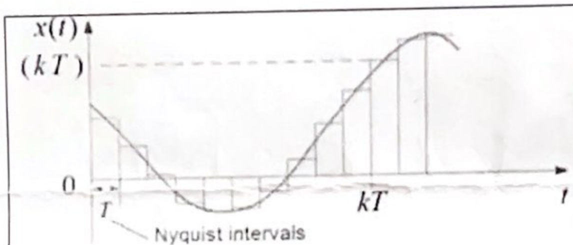
$(1+x)^4 = 1+4x+6x^2+4x^3+x^4$

$(y+x)^9 = y^9+9xy^8+36x^2y^7+84x^3y^6+126x^4y^5+$
$126x^4y^5+84x^6y^3+36x^7y^2+9x^8y+x^9$

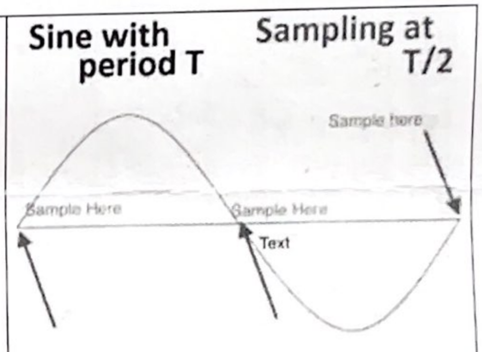
+0.2 to Exam

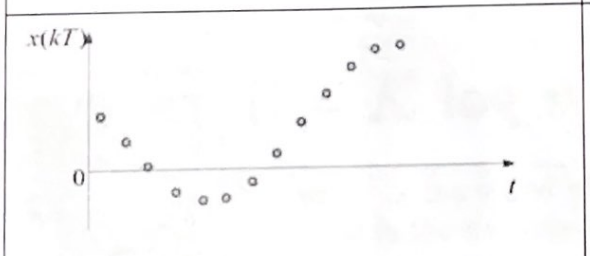


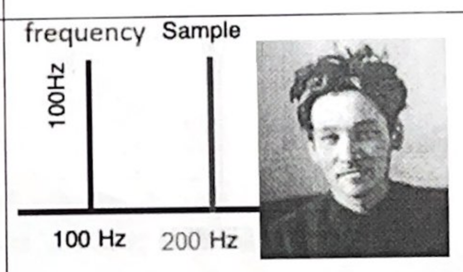
Sampling. Kotelnikov-Nyquist Theorem

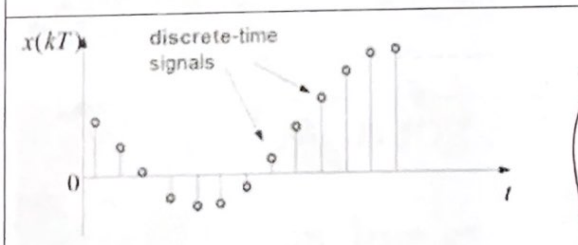


Time intervals T, through which readings s (kT) are taken, are called Nyquist intervals.









$F_{sample}>=2*F_{max}$ $16*2+1$

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

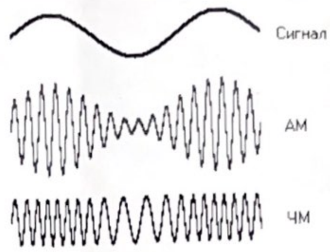
Fsample? 5 amlitude

$2\cdot 9$ 33 52

$s = 5\sin(2\pi\cdot 9t) + 3\sin(2\pi 8t)$ 16

the highest frequency component is 9Hz, thus

Fsample>= $2\cdot 9 = 18$ Hz -0.2 to Exam



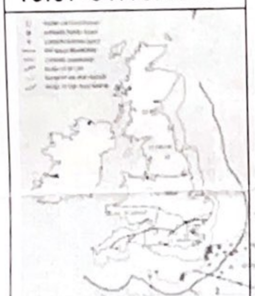
Reginald A. Fessenden

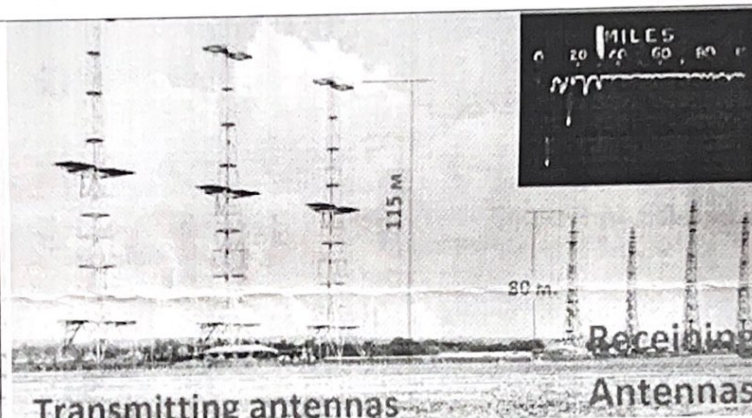
(October 6, 1866 – July 22, 1932)

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

"No organization engaged in any specific field of work, ever invents any important development in that field, or adopts any important development in that field, until forced to do so by outside competition." Oxford University Press. The Quarterly Journal of Economics , Feb., 1926, p. 262.

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



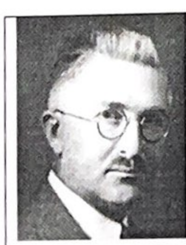


Radar played a major role in the Battle of England

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.



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

Proto-language

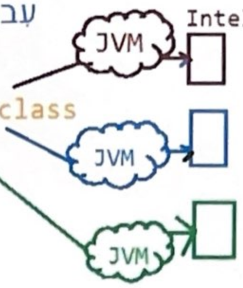
Tower of Babel

- Old Slavic ⰀⰁⰂⰃⰄⰅⰆ
- Ancient Greek ? Ελληνικά
- Ancient Hebrew עִבְרִית

RU, EN, FR, DE – learn → Esperanto

Cross-platform Java

Hello.java => javac.exe = Hello.class



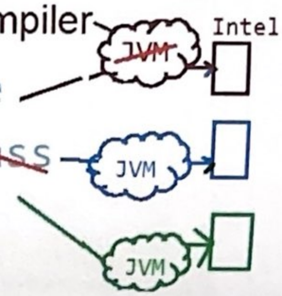
Sun Microsystems Java —trial→ Microsoft

←0.7 billion—

~~J++~~ → C#

CLR JIT-compiler

exe



Hello.cs => $\boxed{\text{csc.exe}}$ = Hello.~~class~~

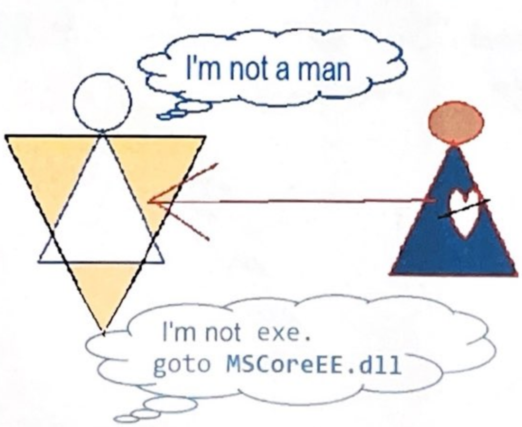
C# компилятор

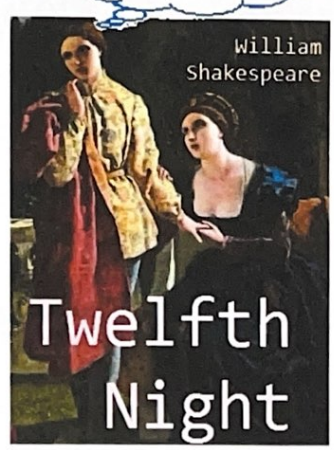
IL
intermedia
language

Hello.vb => $\boxed{\text{vbc.exe}}$ = Hello.~~class~~ .exe

VB компилятор

Hello.pl => $\boxed{\text{plc.exe}}$ = Hello.~~class~~ .exe

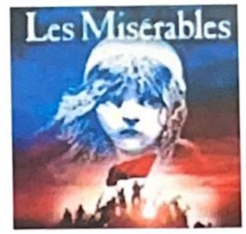




Hello.exe - which is not exe

MSCoreEE.dll JIT-compiler

É. Galois (1811-1832) [Les Misérables | Do You Hear the People Sing]?



Example

There are 6! ways to order the letters of GALOIS

If randomly reorder the letters what is probability that the Vowels (A, O, I) are all before consonants (G, L, S)?

aoi gls $3! = 6$

aoi gls
aoi gsl
aoi sgl
aoi slg
aoi lgs
aoi lsg

$\}$ 6 $\quad i \quad 1 \cdot 3! = 6$

A revolution may well put end to despotism, but it never produce true reform in way of thinking.

I. Kant

aoi gls
iao gsl
.... g...

3 letters $3!$
i gls
i lsg $\quad 3!$
1st position
io gls $\quad 2 \cdot 3!$
aio gls $\quad 3! \cdot 3!$

i	$1 \cdot 3!$	$1 \cdot 6$
oi	$2 \cdot 3!$	$2 \cdot 6$
aoi	$\boxed{3! \cdot 3!}$	$3 \cdot 6$

$$P_{rc} = \frac{3! \cdot 2!}{5!}$$

ABBA $\quad \frac{4!}{2! \cdot 2!}$ The number of arrangements of the N objects.

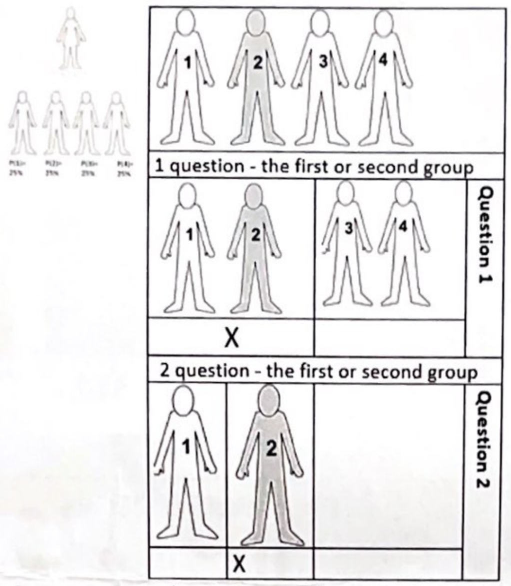
$\underbrace{x_1, \dots, x_1}_{m_1}$, $\underbrace{x_2 \dots x_2}_{m_2}$, $\dots$, $\underbrace{x_k \dots x_k}_{m_k}$ where $n = m_1 + m_2 + \dots + m_k$

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

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**		

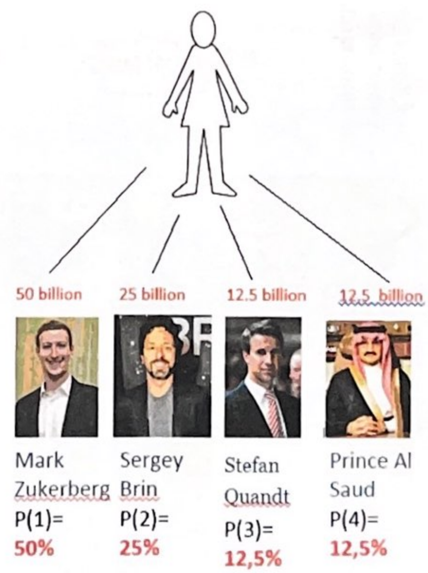
Quantifying information

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

Quantifying information

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

number of bits required to encode choice



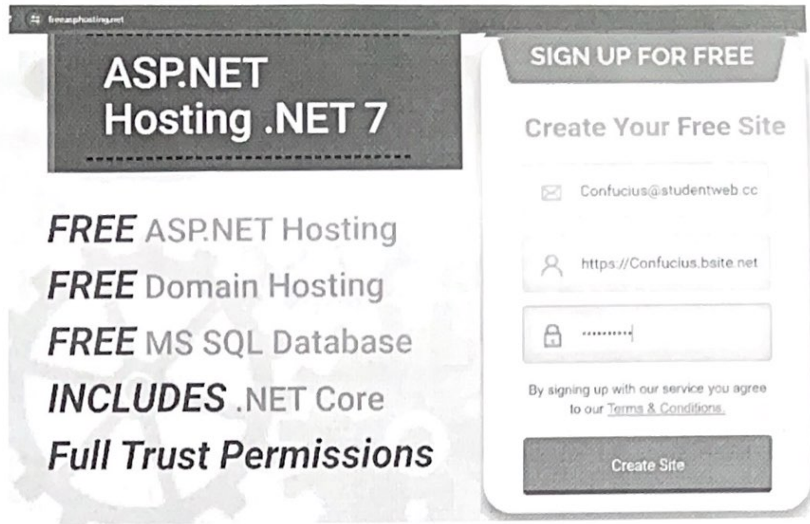
ce

$\log_2(26) = 4.8$

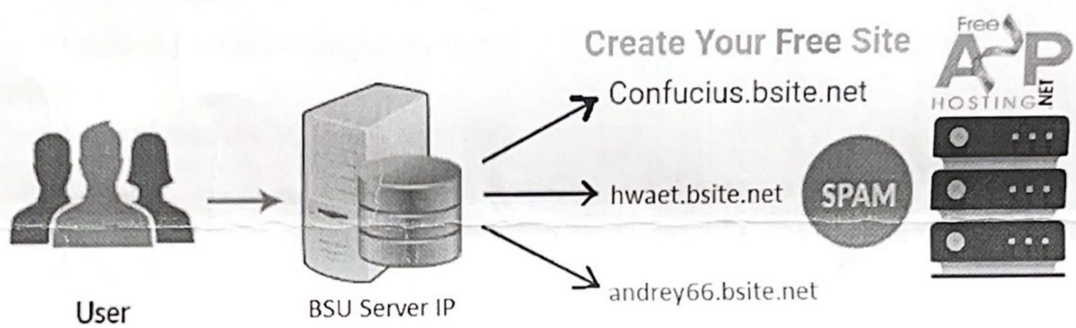
or 4.7

+ 0,25 to Exam

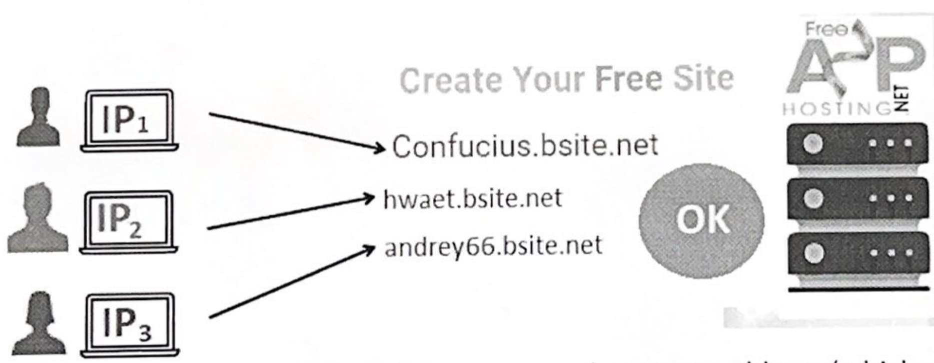
What should you do at home: Register free hosting on **freeasphosting.net** At home because many hosting services do not register from one IP address.



If several dozen hosting attempts to register from one IP address, the **freeaspohosting.net** server may decide that this is a SPAMer and block it.



And if registration is carried out from different computers (with different IP addresses), then the freeasphosting.net server does not raise any suspicions.



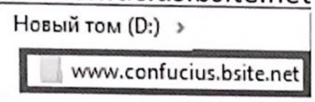
After you have registered on the server, send me your address (which you received during registration) by email.

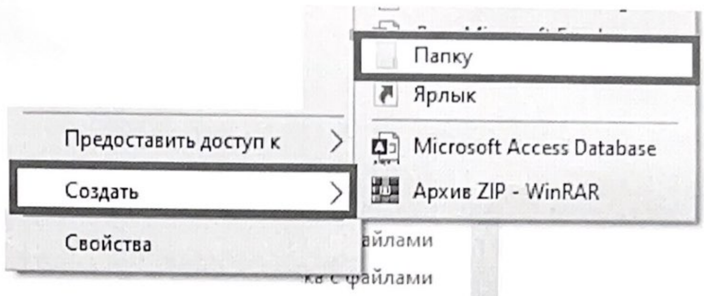
What should you do in class:

0. Come up with a good name for your site.

I came up with a name for my site - Confucius (in my opinion, this is a good name) www.**confucius**.bsite.net

1.On a disk or on a flash drive, make a folder that matches the name of the site www.**confucius**.bsite.net





2. In a folder **D:\www.confucius.bsite.net** create a folder for Projects **D:\www.confucius.bsite.net\Projects**

3. In a folder **D:\www.confucius.bsite.net\Projects** create a folder for Projects Number 0
D:\www.confucius.bsite.net\Projects\0

4. In a folder **D:\www.confucius.bsite.net\Projects\0** create file ***index.htm***

10.179.32.238 index.html

гора нора гроб

3. 1. 1

+0.2 to Exam