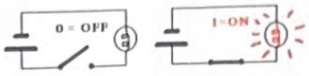
Massachusetts Institute of Technology (MIT)

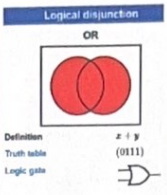
Lecture by Pr. Bob Gallagher
Boole (1815-1864) & Shannon (1916-2001)



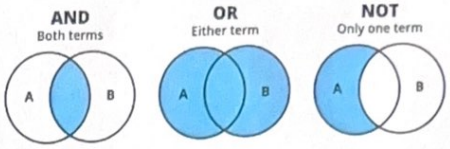
Logical addition (disjunction)

A	B	F=A∨B
0	0	0
0	1	1
1	0	1
1	1	1

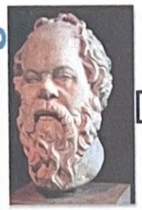
A	B	$A \vee B$
True	True	True
True	False	True
False	True	True
False	False	False



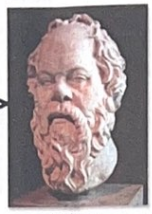
BOOLEAN LOGIC



Good logic


Socrates

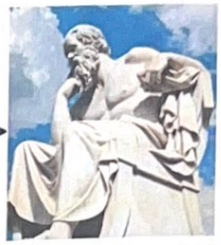
Socrates was a philosopher


Socrates

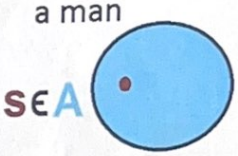

Plato


Aristotle

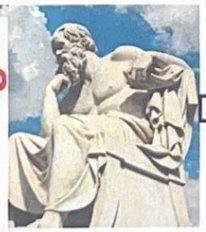
philosophers are men



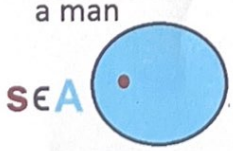
Socrates was a man

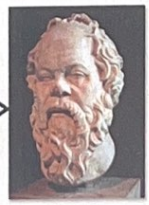


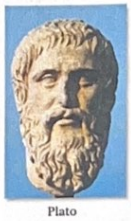
Bad logic

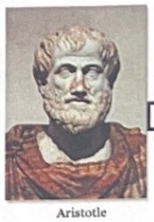


Socrates was a man

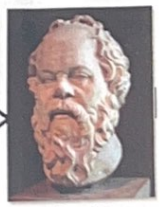



Socrates


Plato


Aristotle

philosophers are men


Socrates

Socrates was a philosopher

Oxford lecture

80% chance of rain at 9.am. on the day j

$0 \le j \le n$; 30,40 days

Suppose the event A have probability independently (P) 0,1...99

1. Event and probabilities

Consider an "experiment" which has a set of Ω of outcomes

$w \in \Omega$ - sample space

a. tossing a coin $\Omega = \{H, T\}$ (H: head, T: tail)

b. throwing a dice

$\Omega \{(i,j); i,j \in [1,2,3,4,5,6]\}$

let make them distinguishable

A subset of Ω is called an event

For example

a) a coin comes up tail $A = \{T\}$

b) We observe of total 9

$A = \{(3,6), (4,5), (5,4), (6,3)\}$

If we Ω is the outcome, we say that A occur if $w \in A$

Compliment of A:

A^c occurs if A does not occur

Union $A \cup B$ occur if A or B occurs (or both)

Intersection: $A \cap B$ occurs if both A and B occurs

Set difference: $A \setminus B = A \cap B^c$ occur if A occurs and B doesn't occurs

A and B disjoint $A \cap B = \emptyset$ i-e A and B cannot occur together

We assign the probability $P(A)$ of each A

Simpliest case:

Ω is finite and all outcomes are equally likely, then $P(A) = \frac{|A|}{|\Omega|}$

a) $|\Omega| = 2$, $|A| = 1$ $\Rightarrow P(A) = 1/2$

b) $|\Omega| = 36$, $|A| = 4$ $\Rightarrow P(A) = \frac{4}{36} = \frac{1}{9}$

Elementary combinatorics:

Arrangement of distinguishable object.

Suppose we have a distinguishable objects $n = 3$ [illegible]
ways are there to order them?

$\Omega = 3! = 3 \cdot 2 \cdot 1 = 6$

Example:

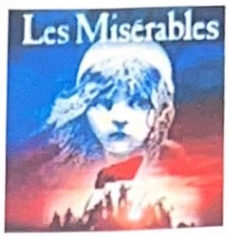
There are 6! ways to order the letters of GALOIS
If we randomly reorder the letters what is probability
that vowels are all before consonaints

$P(A) = \frac{3}{6} \cdot \frac{3}{5} \cdot \frac{2}{4} \cdot \frac{2}{3} \cdot \frac{1}{2} \cdot 1 = \frac{1}{20}$

$\frac{3!3!}{6!}$ GALOIS

Arrangements when not all object are indistinguishable
for may different arrangements of $\underbrace{AA}_{\text{are repeated}}BCD$ ← not repeated distinguishable

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

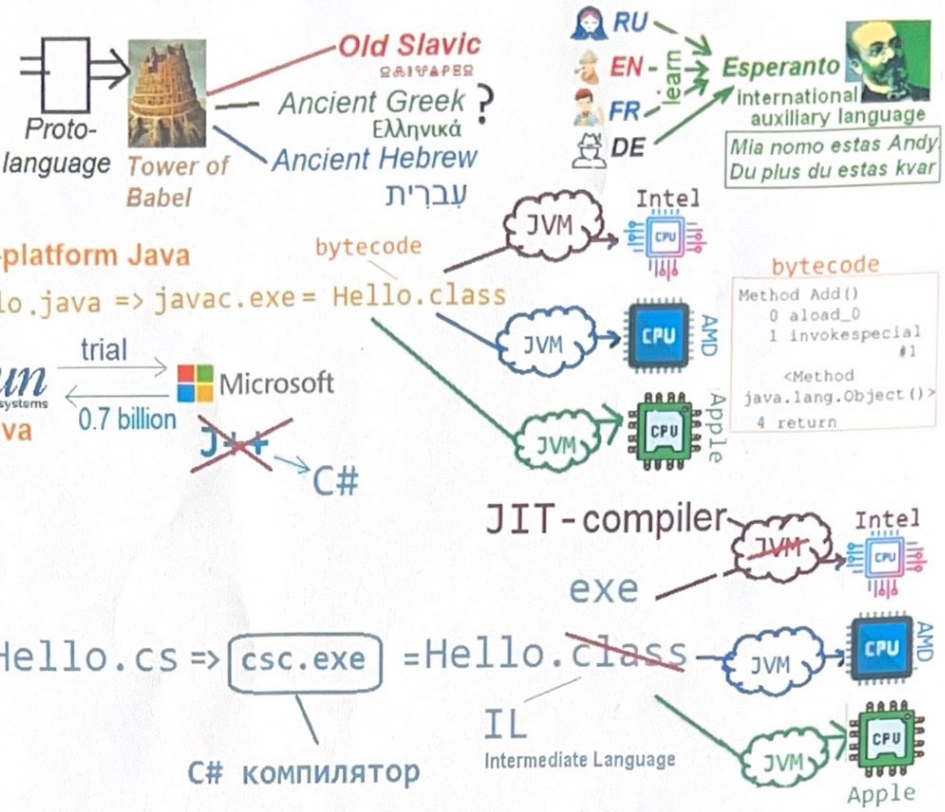


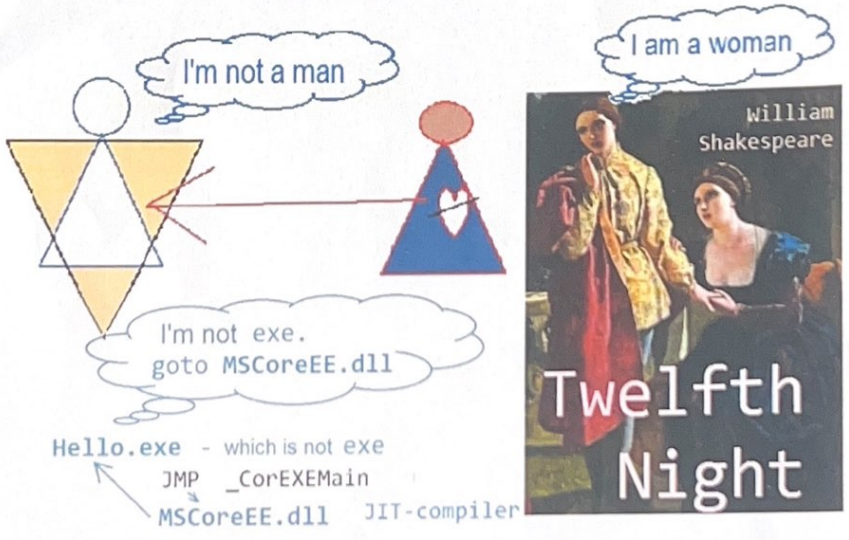
Example

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)?

Hi!


Proto-language
Tower of Babel
Old Slavic
Ancient Greek
Ελληνικά
Ancient Hebrew
עִבְרִית
RU
EN
FR
DE
learn
Esperanto
international auxiliary language
Mia nomo estas Andy
Du plus du estas kvar
Cross-platform Java
Hello.java => javac.exe = Hello.class
bytecode
JVM
Intel
CPU
AMD
Apple
bytecode
Method Add()
0 aload_0
1 invokespecial #1
<Method java.lang.Object()>
4 return
Sun microsystems
Java
trial
0.7 billion
Microsoft
J++
C#
JIT-compiler
exe
Hello.cs => csc.exe = Hello.class
C# компилятор
IL
Intermediate Language
Hello.vb => vbc.exe = Hello.class
.exe
VB компилятор
CIL - Common Intermediate Language
void .ctor() {
.maxstack 1
IL_0000: ldarg.0
IL_0001: call instance void System.Object::.ctor()
IL_0006: ret
} // end of method Add::.ctor
Hello.pl=> plc.exe = Hello.class
.exe


I'm not a man
I am a woman
I'm not exe.
goto MSCoreEE.dll
Hello.exe - which is not exe
JMP _CorEXEMain
MSCoreEE.dll
JIT-compiler
William Shakespeare
Twelfth Night

ABBA $\frac{4!}{2!2!}$

The number of arrangements of the N

$\underbrace{x_{11} \dots x_1}_{m_1}, \underbrace{x_2 \dots x_2}_{m_2}, \dots\dots, \underbrace{x_K \dots x_K}_{x_K}$

where $n = m_1 + m_2 + \dots + m_K$

$$\frac{n!}{m_1! m_2! \dots m_K}$$

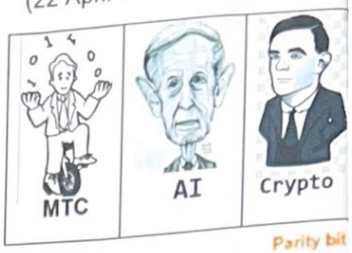
$$\boxed{\frac{n!}{m!(n-m)!}} \leftarrow \text{binomial coefficient}$$

$\binom{n}{m}$ Newton binomials

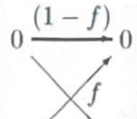
C_m

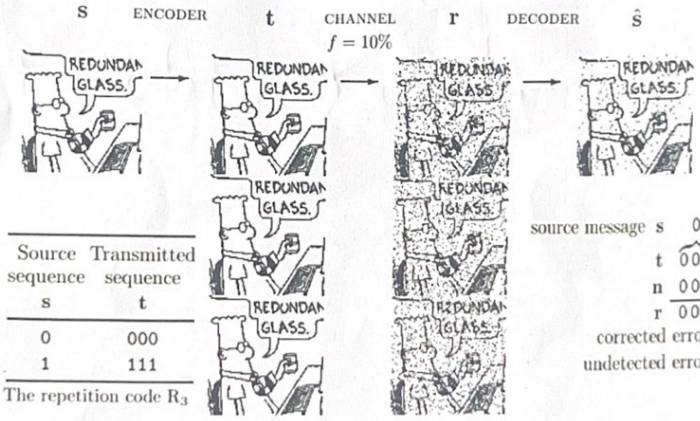
$$(1+x)^4 = 1 + 4x + 6x^2 + 4x^3 + x^4$$
$$\binom{4}{0}\ \binom{4}{1}\ \binom{4}{2}\ \binom{4}{3}\ \binom{4}{4}$$

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



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





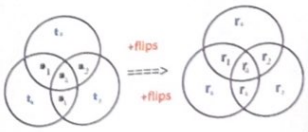
Source sequence s	Transmitted sequence t
0	000
1	111

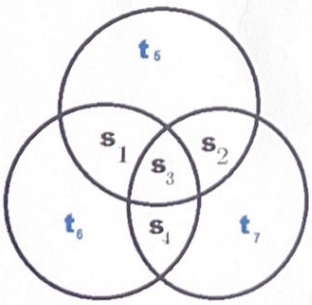
The repetition code R_3

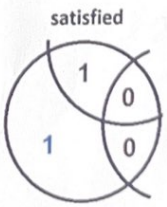
source message s	0	0	1	0	1	1	0
t	000	000	111	000	111	111	000
n	000	001	000	000	101	000	000
r	000	001	111	000	010	111	000
corrected errors		*					
undetected errors					*		

7.4. Hamming code.

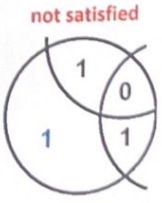
$$\frac{4}{\Sigma} \rightarrow \frac{7}{t}$$



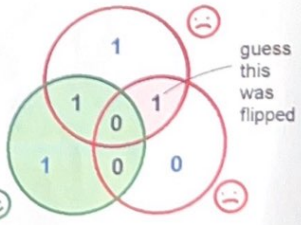




1+1+0+0=**0**



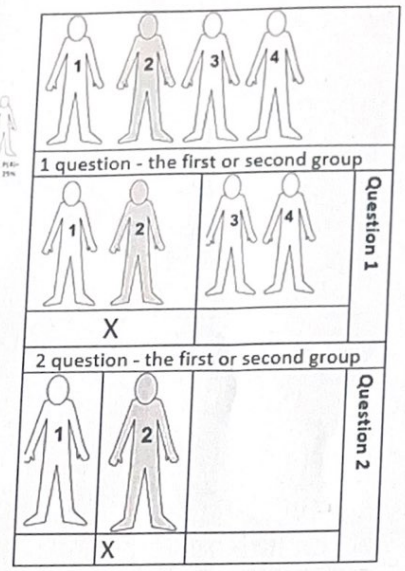
1+1+0+1=**1**



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**		

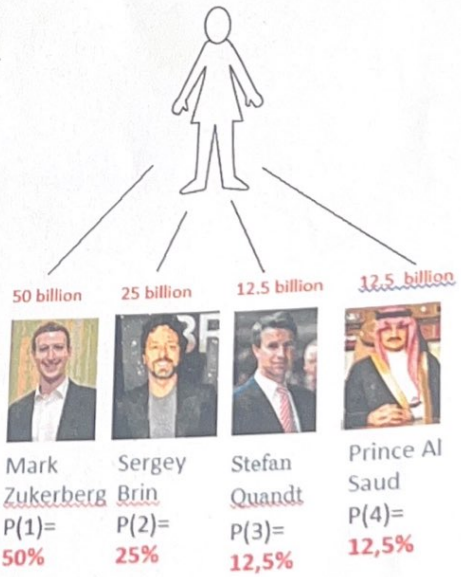
Quantifying information

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

Quantifying information

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

number of bits required to encode choice



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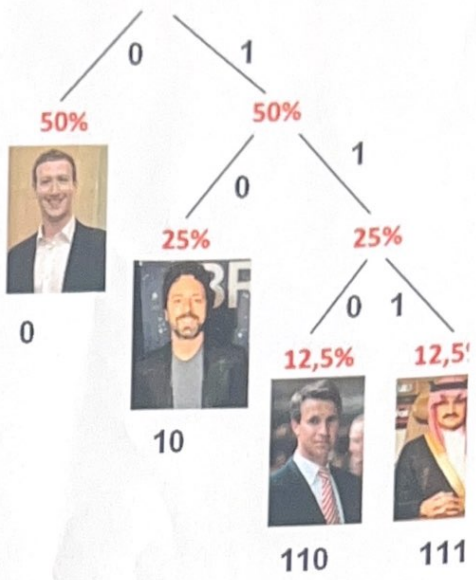


First-order approximation (symbols independent but with frequencies of Belarusian txt).

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			

лламаммар

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

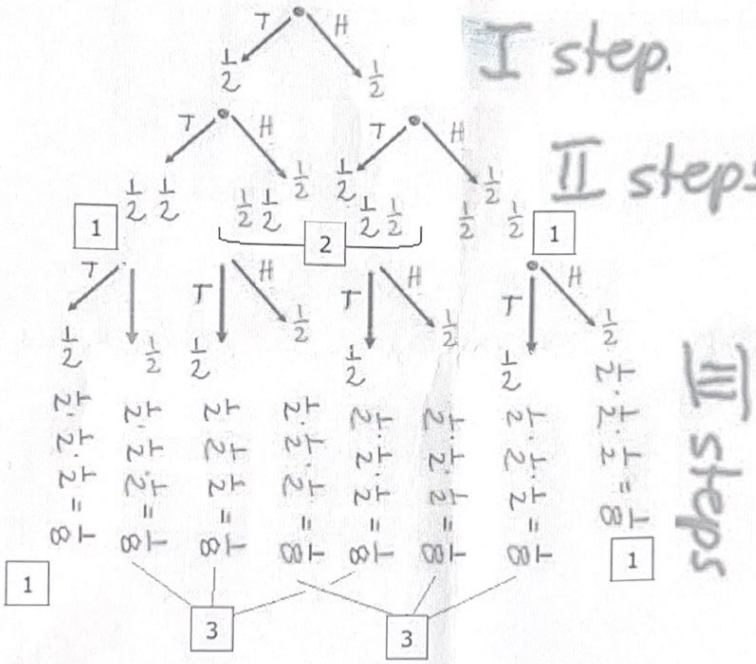
мылла рама

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

+0.1 $A_1 B_1 B_2 A_2$ — 4!

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

Pascal's triangle



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

						1								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

~~1 8 28 50 50 28 8 1~~

1 8 28 50 70 50 28 8 1

Shannon Hartley Theorem

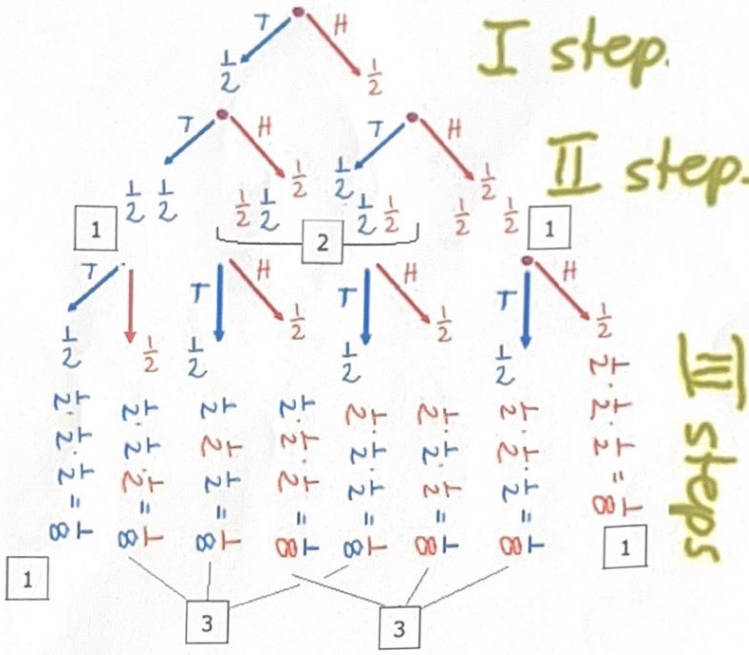
This is a measure of the *capacity* on a channel; it is impossible to transmit information at a faster rate without error.

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

- 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.

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



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

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

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

pow(2,4)=8

~~$(y+x)^8 = y^8 + 8y^7x + 28y^6x^2 + 50y$~~

$(y+x)^8 = y^8 + 8y^7x + 28y^6x^2 + 50y^5x^3 + 70y^4x^4 +$

$+ 50y^3x^5 + 28y^2x^6 + 8yx^7 + x^8$

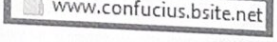
0.2 to Exam

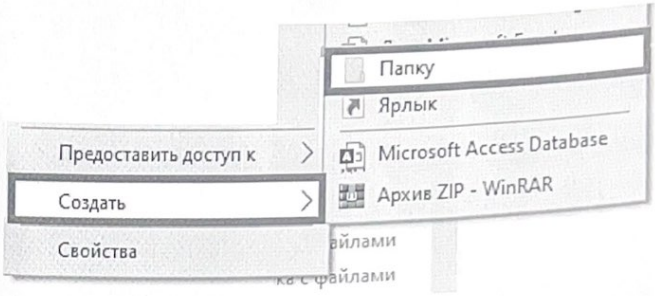
What should you do in class:

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



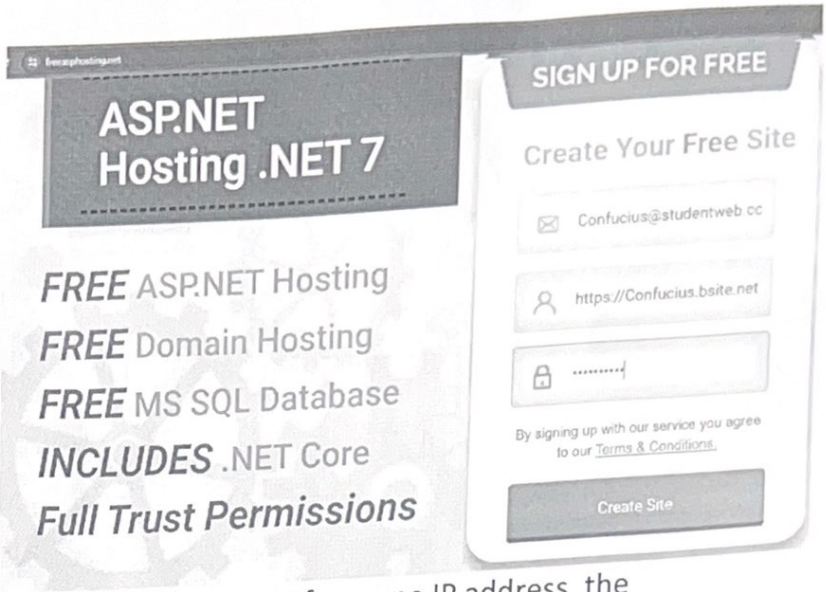


2. In a folder **D:\www.confucius.bsite.net** create a folder for Projects
D:\www.confucius.bsite.net\Projects

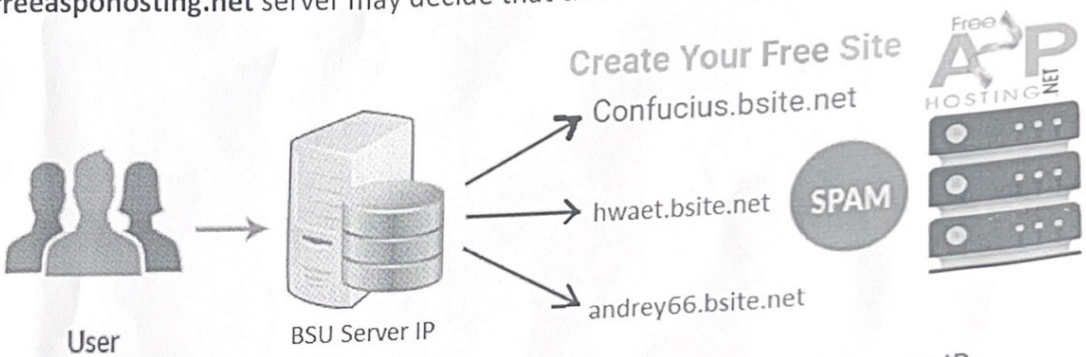
3. In a folder **D:\www.confucius.bsite.net\Projects** create a folder for Projects Number 0
D:\www.confucius.bsite.net\Projects\0

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

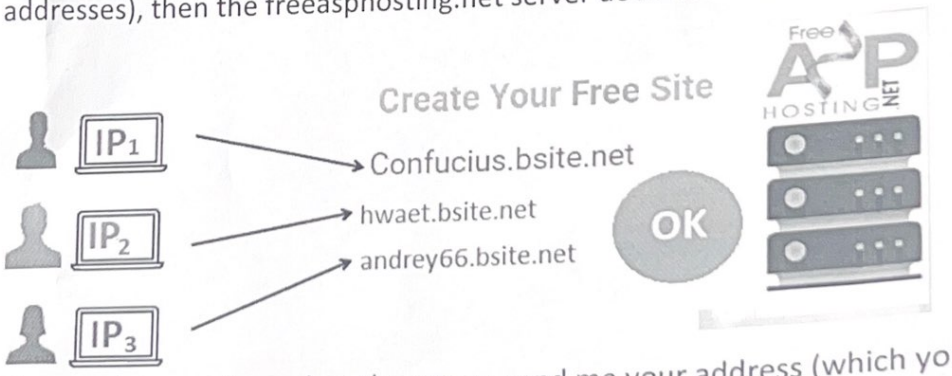
What should you do at home:
Register free hosting on **freeasphosting.net**
At home because many hosting services do not register from one IP address.



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.

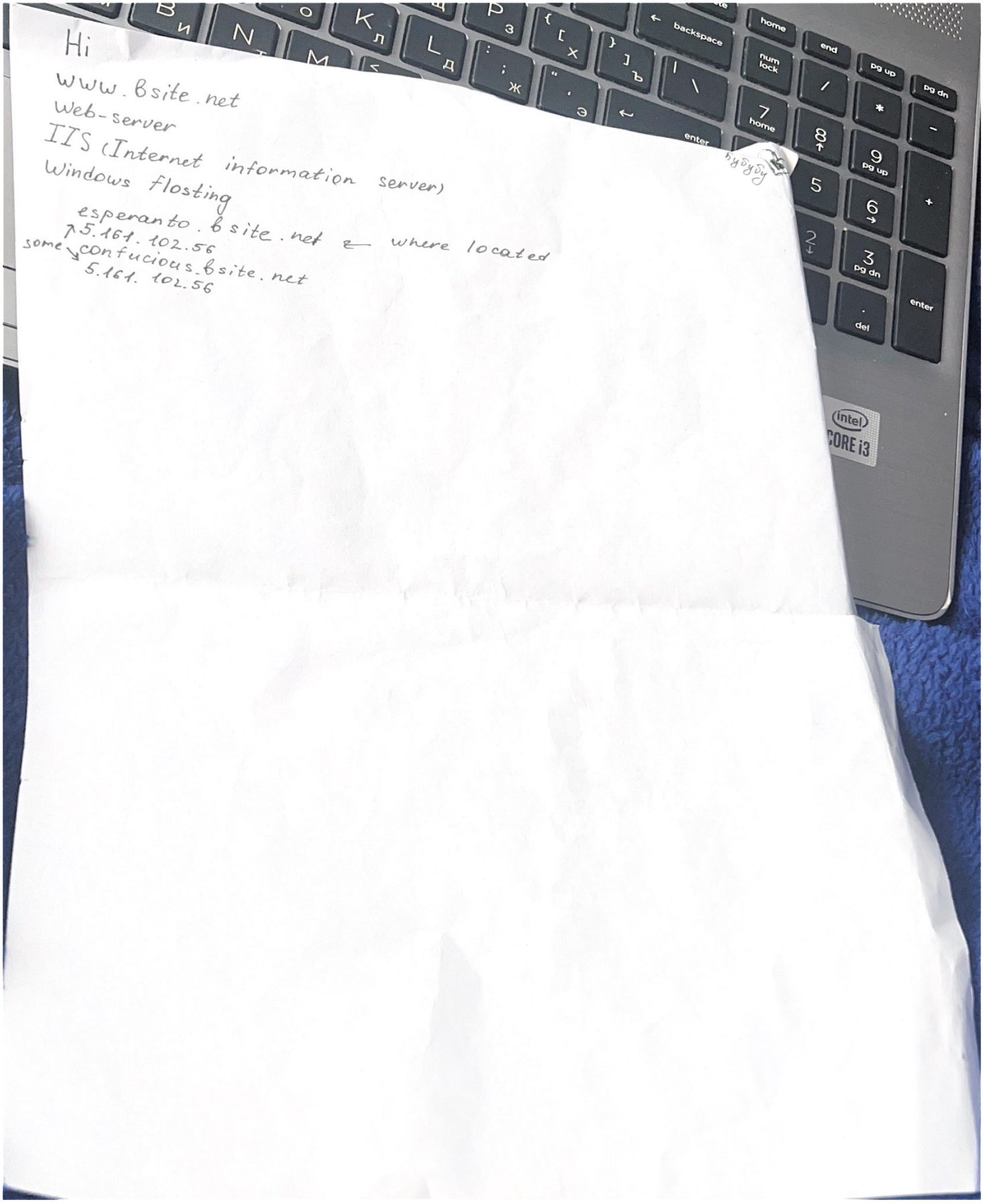


And if registration is carried out from different computers (with different IP addresses), then the freeasphosting.net server does not raise any suspicions.



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

3.0.2.



Hi

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Web-server
IIS (Internet information server)
Windows flosting

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