

+0.1 to final Grade
+0.1

+ 0.1 for
Handout
25. Feb 09

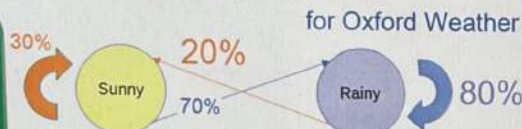
+0.1 for

Fri 16th 11° 7°
EX7%

pr. Matthias Winkel
DEPARTMENT OF STATISTICS

Walking in Oxford on a cold and rainy day

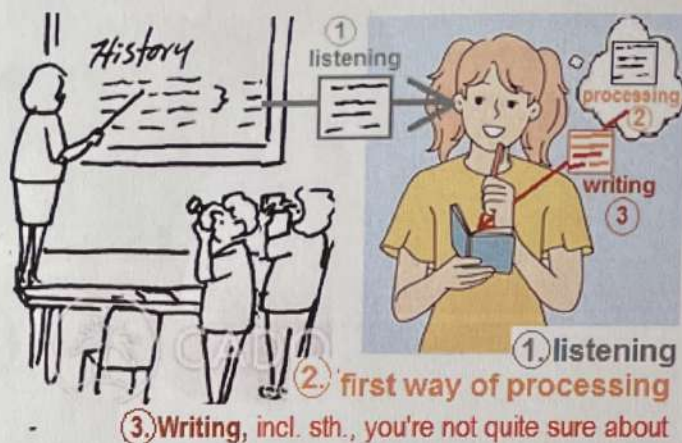
Markoff Chain Probability Model



Motivation: 80% chance of rain

Let A_j be the event of rain at Jam on day j of this term, $1 \leq j \leq n$

school = formalism $\Rightarrow$ Uni



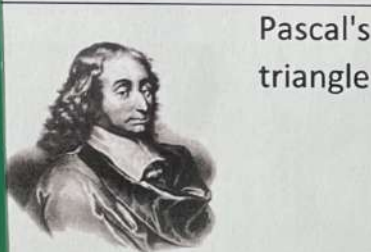
CHALK+TALK ink+think

take notes on the lecture yourself

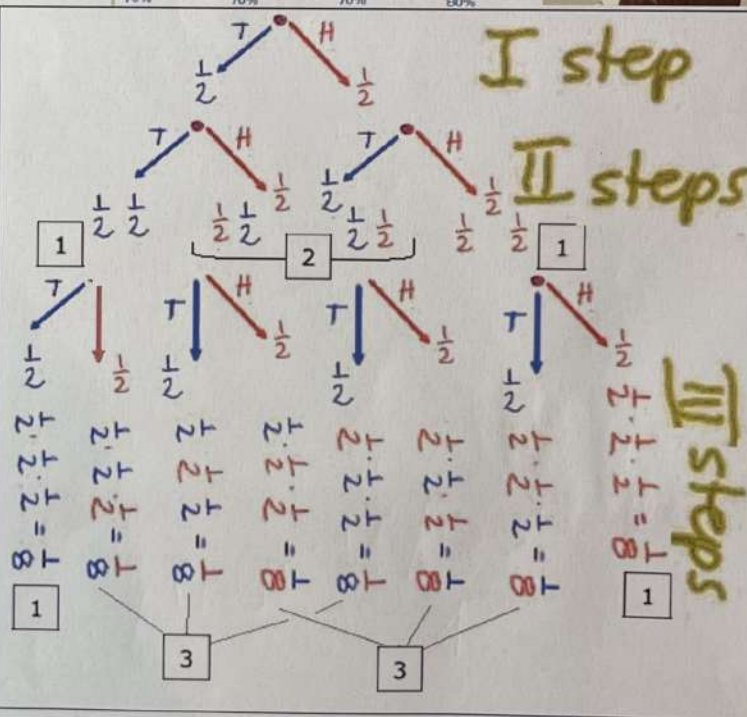
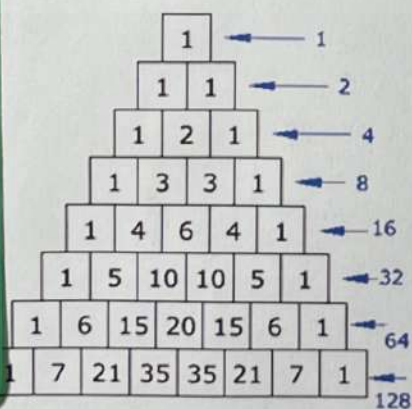
Suppose the events A_i each have probability p , independently

Oxford

Tue 13th	Wed 14th	Thu 15th	Fri 16th
10° 9°	13° 10°	13° 8°	11° 7°
70%	70%	70%	80%



Pascal's triangle



+ 0.1
GALOIS
6!

+ 0.1
m.1 m.2
u/

+0.1 Pr ABBA

$$\begin{aligned}
 (a+b)^0 &= 1 \\
 (a+b)^1 &= a+b \\
 (a+b)^2 &= a^2 + 2ab + b^2 \\
 (a+b)^3 &= a^3 + 3a^2b + 3ab^2 + b^3 \\
 (a+b)^4 &= a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4 \\
 (a+b)^5 &= a^5 + 5a^4b + 10a^3b^2 + 10a^2b^3 + 5ab^4 + b^5
 \end{aligned}$$

+0.5 to final 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 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.

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

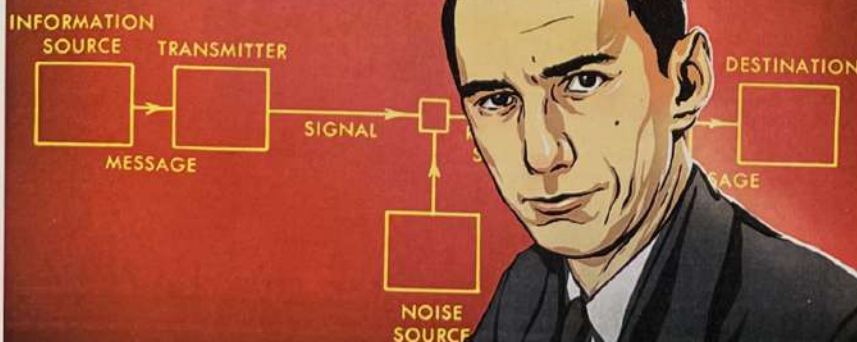
Kant, Gauss, Goethe - Germans

Germany Great



Bad logic (abuse of logic)

The Mathematical Theory of Communication



Creating a reliable connection over an unreliable (noisy) channel that's what IT is about

important

and that's what Shannon did

(+0.2) to final grade

9 10
4.5
10

Project



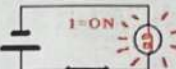
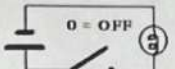
Massachusetts Institute of Technology (MIT)



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



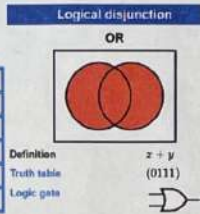
Sapere aude!



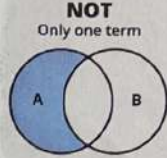
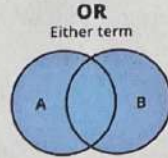
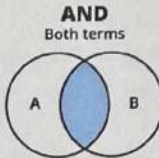
Logical addition
(disjunction)

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



BOOLEAN LOGIC



Good logic

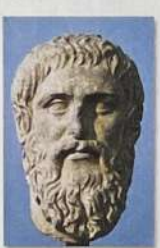


Socrates

Socrates was a philosopher



Socrates

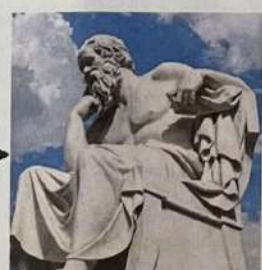
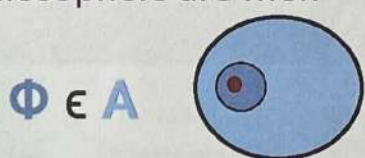


Plato

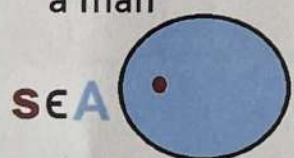


Aristotle

philosophers are men



Socrates was a man



Bad logic



Socrates was a man



Socrates



Plato



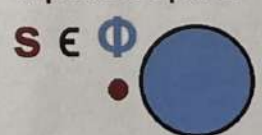
Aristotle

philosophers are men

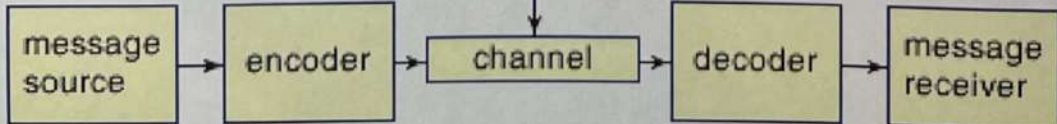


Socrates

Socrates was a philosopher



noise



XOR ✕

0	0	0
0	1	1
1	0	1
1	1	0

$$0101_2 \rightarrow 5_{10}$$

$$01111_2 \rightarrow 15$$

d: cd IT\Projects\0\
 ↑ Any text

```
class MBoole
```

```
{
```

```
    public static void Main()
```

```
    {
```

```
    }
```

```
}
```

```
    System.Console.WriteLine("Hi");
```

Save As

MBoole.cs

Prompt

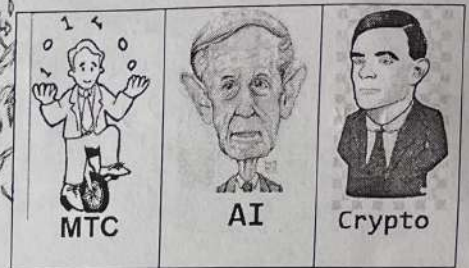
cmd

d:

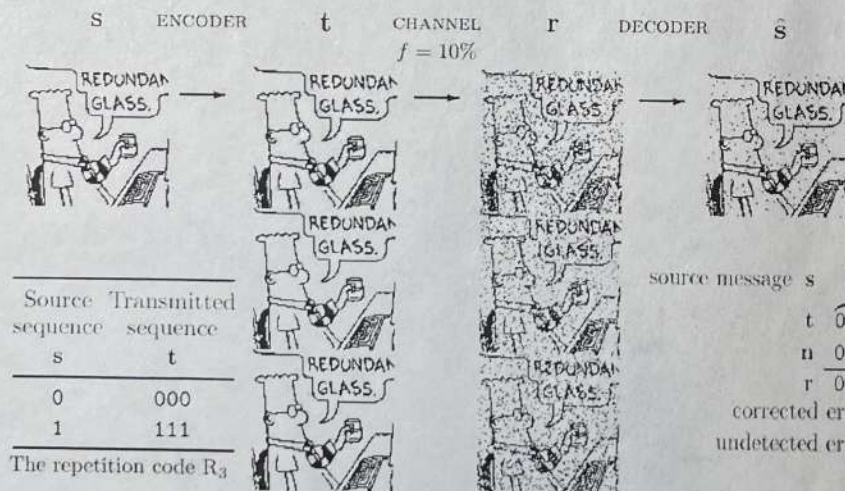
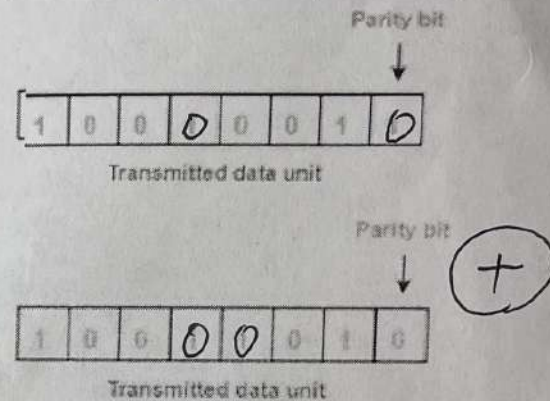
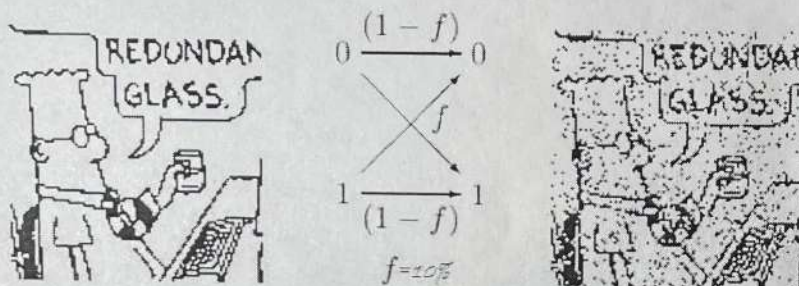
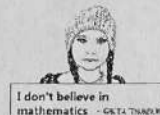
cd IT\Projects\0



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



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



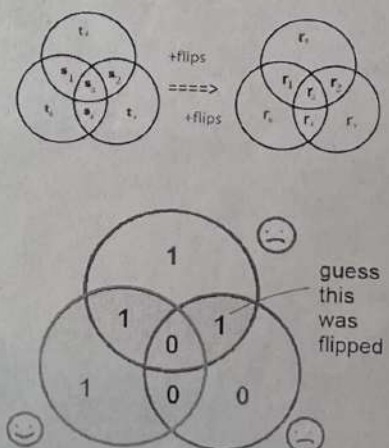
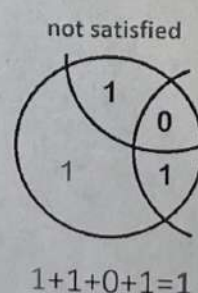
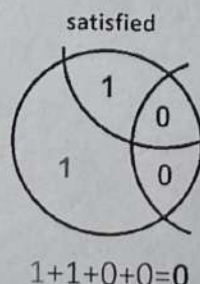
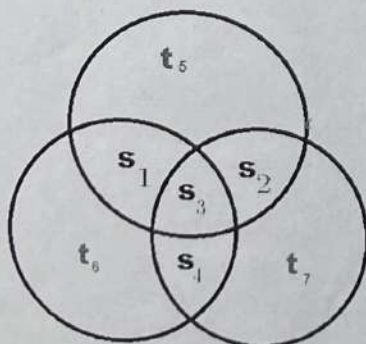
Source sequence	Transmitted sequence
s	t
0	000
1	111

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					*		

50%
ABC
DEF

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

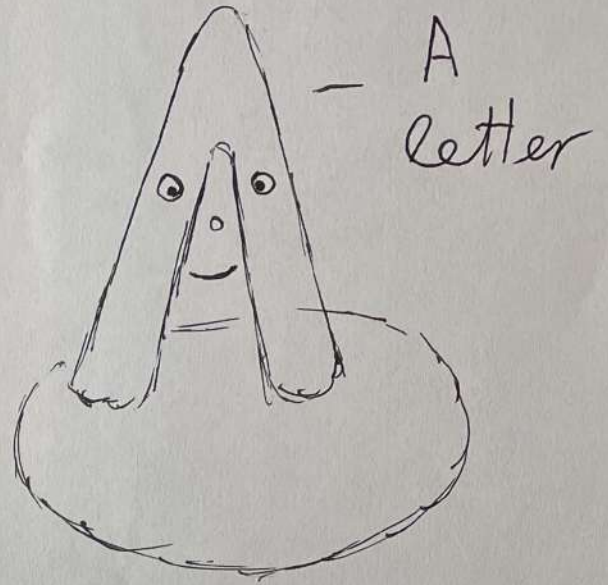


D!

+0.1 to Fin Ex



Girls
invisible

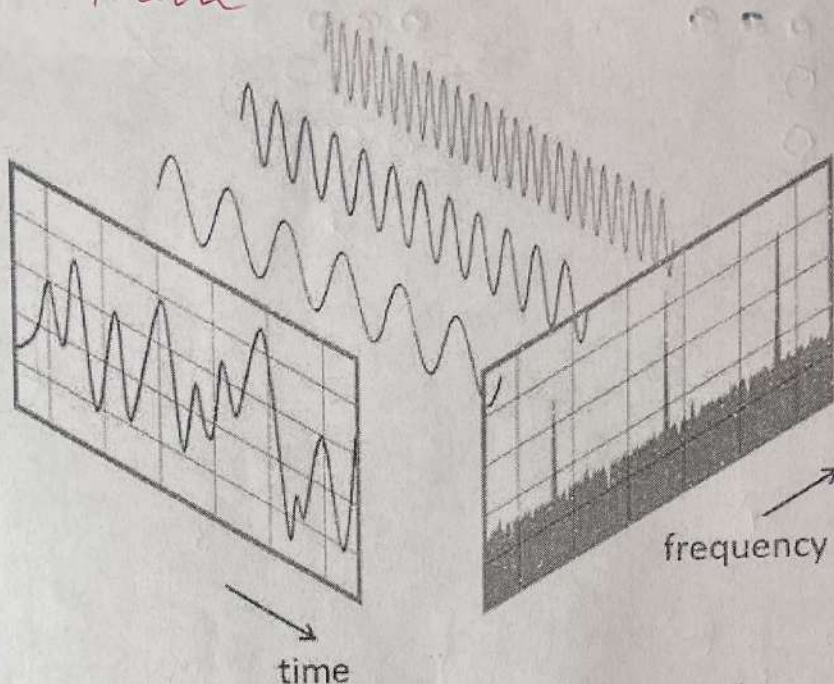


+0,7
to fin
Grade

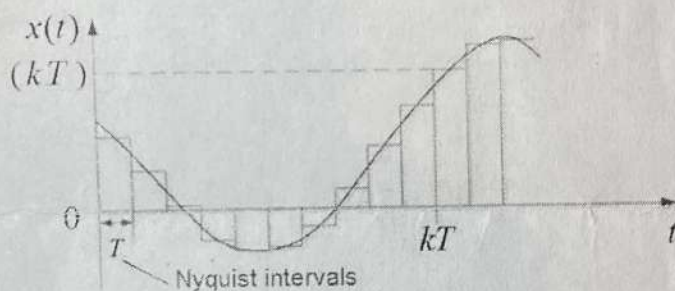
+0,1 to fin Grade 6.5.25
+0,3 to fin Grade 6.5.25

+0,1 for A
+0,1

Fourier transform



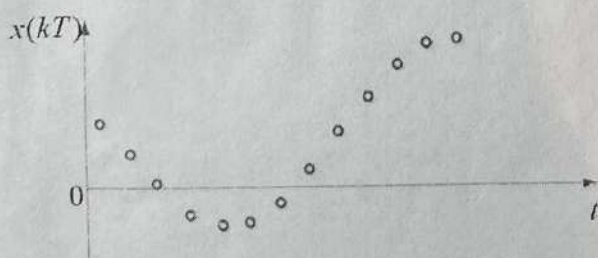
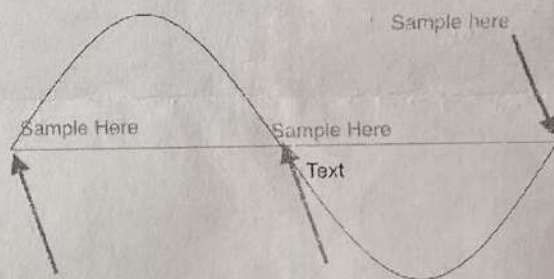
Sampling. Kotelnikov-Nyquist Theorem



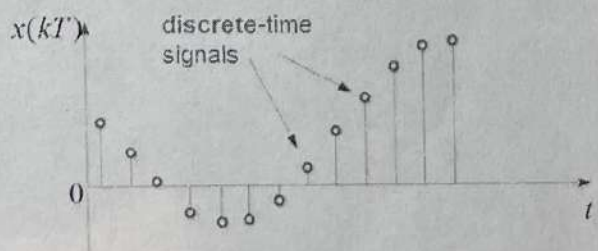
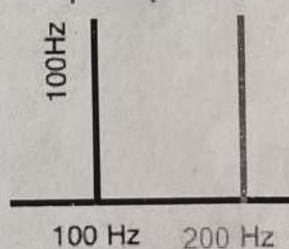
Time intervals T , through which readings $s(kT)$ are taken, are called Nyquist intervals.

Sine with period T

Sampling at $T/2$



frequency Sample



$$F_{\text{sample}} \geq 2 * F_{\text{max}} \\ (T_{\text{sample}} \leq T_{\text{min}} / 2)$$

$$\left. \begin{array}{l} f=1 \quad T=1 \\ f=2 \quad T=\frac{1}{2} \\ f=3 \quad T=\frac{1}{3} \end{array} \right\} \Rightarrow T = \frac{1}{f} = f^{-1}$$

quantity of int. = $\log_2 x$

T - period, f - frequency (Hz)

Как переписать все константы в нисеке,
чтобы это не замесило

Events and probabilities

- consider our "experiment", which has a set of Ω of outcomes $\omega \in \Omega$.

Ex. 1) tossing a coin $\Omega = \{H, T\}$

2) throwing a dice  

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

set of possible outcomes

A - subset of Ω - event

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

b) $A = \{(3, 6)\}$ - event

If $\omega \in \Omega$ is the outcome, we say that A occurs if $\omega \in A$

complement of A : $\bar{A}$ - occurs when A doesn't occur
 A^c

set difference: $A \setminus B = A \cap B^c$

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

Union: $A \cup B$ occurs if any A or B occurs

Boolean

$\&$	00	0
	01	0
	10	0
	11	1

Union	00	0
	01	1
	10	1
	11	1

• A and B are disjoint if $A \cap B = \emptyset$

$\Downarrow$

A and B can't occur together

• $p(A)$ - probability of each event A : $A = \{T\}$, $A = \{(i, j) - \}$

Case 1



Ω is finite and all outcomes are equally likely

$$p(A) = \frac{|A|}{|\Omega|}$$

Example 1 a) coin $|\Omega| = 2$ b) dice $|\Omega| = 6$

$$|A| = 1$$

$$|A| = 1$$

$$p(A) = \frac{1}{2}$$

$$p(A) = \frac{1}{6}$$

Elementary combinatorics

• Arrangement of distinguishable objects

• Suppose we have n distinguishable objects

1st 2nd 3rd



How many ways to order them



$$n = 3! = 6$$

For n there are n options for 1st &
then $n-1$ for 2nd object &
inductively $n - (n-1) - n$ th

In all there are $n(n-1)(n-2)\dots 2 \cdot 1 = n!$ permutations

$$P(A) = \frac{m_1! \cdot m_2!}{n!}, \quad m_1 + m_2 = n \quad \begin{matrix} 2 \cdot 3 = 6 \\ 6 \cdot 4 = 24 \end{matrix}$$

$$P(A) = \frac{(n-m)! \cdot m!}{n!}$$

Arrangements when not all objects are indistinguishable

AAA BCD } 6!

indistinguishable

distinguishable

(AAA)

(A₁A₂A₃)

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

(number of combinations when the order doesn't matter)

$$ABBAA = \frac{5!}{2! \cdot 2! \cdot 1!}$$

$$\frac{4!}{2!} \rightarrow \frac{4!}{2! \cdot 2!}$$

$$TALLINN = \frac{7!}{1! \cdot 1! \cdot 1! \cdot 2! \cdot 2!}$$

$$\frac{3!}{2! \cdot 2!}$$

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

$$\frac{n!}{m! \cdot (n-m)!}$$

$$k=2$$

$$\frac{n!}{m! \cdot (n-m)!} \quad \text{— Final Formula}$$