Tahrir Square Math Club

Agenda

Welcoming word by prof. Wafik Lotfallah

Math clubs organizers

Vision

Goals

Challenges

Proposal

Welcoming Word

Prof. Wafik Lotfallah

Math Clubs Organizers

Mohamed Mohsen
Miniya University

Challenges

- Rote Memorization Over Understanding :

focus on solving problems mechanically without understanding the logic behind them nor the meaning .

- Out of touch with reality and Closed :

The lack of real-world application and Critical Thinking

Challenges

- Lack of Direction and Guidance :
  What i can do with math ? why did the prof us this formal ?
  how can i get a job ?

- Lack of community :
  You cant find people who share the passion , most of them are
  scatter across the place

Why Mathematics ?

Pure Intellectual Pursuit

math is beautiful in its own right. Abstract mathematics, is the study of the structure of math itself the like number theory , function analysis and topology , are studied for intellectual curiosity and lead to unexpected real-world applications.

Math is telling a story

Foundational for Science and Engineering

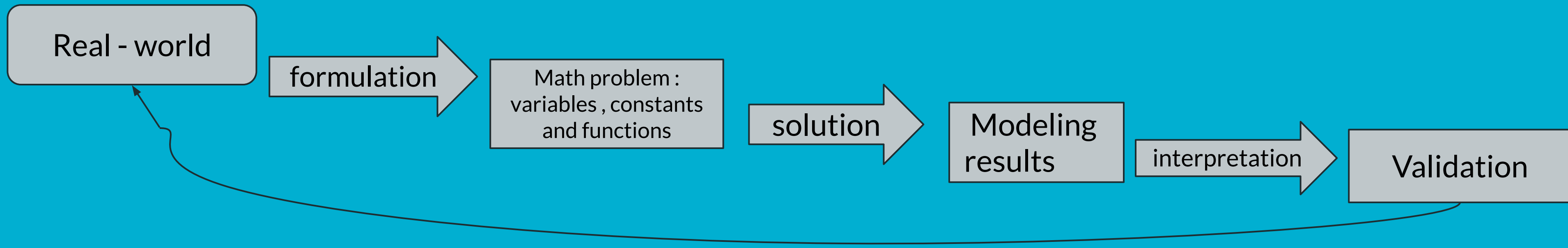
Mathematics is the language of physics, chemistry, engineering, and computer science. It provides the tools to model natural phenomena, analyze data, and develop new technologies.

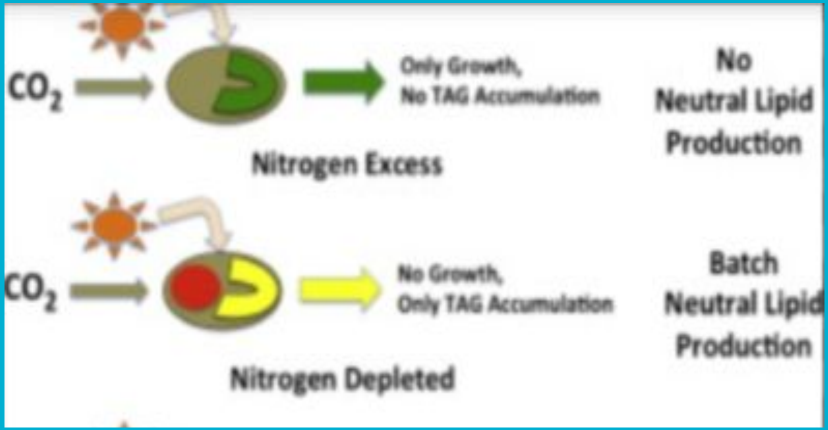
It is the core of scientific research

Math Superpower

The power of modeling , analysis and prediction

Mathematical model is : is a representation of a real-world system using mathematical concepts and equations to describe, analyze, and predict behaviors.



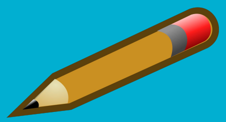


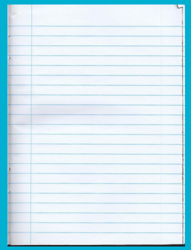
$$\frac{dX}{dt} = uX - hX \quad \rightarrow \textit{growth rate}$$

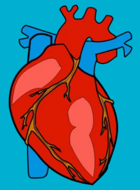
$$u = u\,max \frac{S}{Ks + S} \quad \rightarrow \textit{growth rate factor}$$

$$\frac{dL}{dt} = l\,max \frac{Kn}{Kn + N} \quad \rightarrow \textit{the lipids production}$$

All you need for math is :







But most importantly a community
And therefore we are here at the

MATH CLUB

Jannah Taha Darwish
Cairo University

Marwan Basem
Zewail City

Adham Gouda
The American University in Cairo

Vision

Towards an economic prosperity
through useless progress

Faculty of Arts Lecturer

Cairo Uni

Egyptian University History

Common Observation

CS Why Statistics? LLM

Eng Why Numerical Methods? PIM

Math Why..? Career Shift

Quick Success

Consumer not innovator

Use ChatGPT, NOT Compete with it

OpenAI Team

Dan Roberts

Email: drob@mit.edu
Twitter: @danintheory
GitHub: @danintheory
Website: danintheory.com
(just redirects back here)

I am a Research Scientist at OpenAI, working on *[redacted]*, and also a Visiting Scientist at the Center for Theoretical Physics at MIT. Previously, my research focused on the ways in which tools and perspectives from theoretical physics can be applied to AI.

I am a co-author of The Principles of Deep Learning Theory, co-authored with Sho Yaida, and based on research in collaboration with Boris Hanin. You can buy a copy in print from Amazon, directly from Cambridge University Press, or download a free draft from the arXiv!

If that sounds interesting, but perhaps also a bit much, you could instead check out my essays, Black Holes and the Intelligence Explosion and Why is AI hard and Physics simple?, or listen to to my podcast interview, What Physics Can Teach Us About AI.

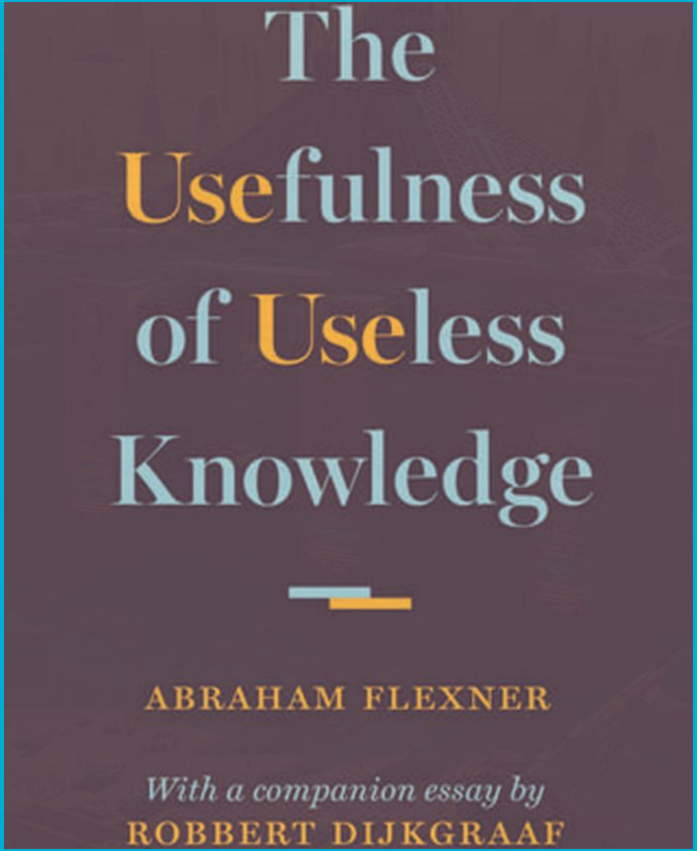
I'm also a member of the advisory committee for the AIMO Prize, and I'm very excited about the development of AI models that can reason, mathematically or otherwise.

Only a theoretical physicist can do it

Maryam Mirzakhani

The beauty of mathematics only shows itself to more patient followers

First women to be awarded Fields Medal



Institute of Advanced Study

World Economic Forum

International Monetary Fund

Quote

"We find that basic scientific research affects more sectors, in more countries and for a longer time than applied research (commercially oriented R&D by firms)"

EPFL

/ About / Facts / Data stories archive / Basic science research is also a source of new talents for society.

Basic science research is also a source of new talents for society.

Quote: Contrary to popular belief, not all scientists trained at EPFL follow an academic career .. source of highly skilled labour for Switzerland.

Conclusion

- Individual Skill
- Social talent attraction
- Nations Economy

Situation

- Individuals do not believe in Math -> Quick success
- Best talents travel abroad -> No community
- Economy degraded -> No innovation

Goals

- Assisting individuals
- Building a community, not dependent on a single entity
- Cooperation with the government

Yao's Class

- Students are awarded MIT, Stanford and other prestigious universities scholarships.
- China's endeavor to cultivate innovative talents.

Aspirations

- Abroad scholarships for individuals.
- Communication circle with Egyptians abroad.
- Internal fund by the government or external by others.

Activity

Regardless of the activity, like Competition, Workshop, Undergraduate Research, ..etc, What matters is the outcome not the approach.

Tools

Halls

Ewart Memorial Hall

Falaki Mainstage Theater

Oriental Hall

AUC Tahrir Square Venues

Tools

Dates

mm/dd/yyyy, --:-- --

mm/dd/yyyy, --:-- --

Add Date | Remove Date

Top Dates Submissions

Date	Count
6 February 2025 - 6:00 PM	187
2 February 2025 - 6:00 PM	22
4 February 2025 - 6:00 PM	16

Collectivae

Tools

Dr. Ahmed El-Refaie

Challenges

Transportation Outside Big Cairo

Government

Minority Respecting Mechanism

Adel Sobhy, MSA

Decide 4 workshops

User-base Preference

100 - Python

20 - Statistics

5 - Algebraic Geometry

2 - Homotopy Theory

Majority

100/127 = 0.8

3 workshops -> Python

Decide 4 workshops

Minority Respecting

1 workshop -> Python

1 workshop -> Statistics

1 workshop -> Algebraic Geometry

1 workshop -> Homotopy Theory

Voting Power

Jumana	Python	Time-series Analytics	1
Tameem	Python	Recommendation Engine	1
Rashid	Python	Recommendation Engine	1
Layla	Algebra	Representation Theory	3

2 Workshops: Rep Th. (3), Rec. Eng (1+1).

How?

Algebra power = Python power

$\sum_i$ power of vote i = $\sum_i$ power of vote i

System of Linear Equations

Instructor-student gap

Discussion

Undergraduate Research

Algebraic Combinatorics

Hamza Osman, Cairo Uni

Pigeonhole Principle: Solving Combinatoric Problems

This presentation explores the Pigeonhole Principle and its application in solving combinatoric problems. We'll delve into the principle itself and then examine how it can be used to prove various mathematical statements.

Introduction to Combinatorics

Combinatorics is a branch of mathematics that deals with the study of finite or countable discrete structures. It involves counting, arranging, and selecting objects from a set, and it's essential in various fields like computer science, probability, and statistics.

The Pigeonhole Principle is a fundamental concept in combinatorics that states that if you have more pigeons than pigeonholes, then at least one pigeonhole must contain more than one pigeon.

Problem 1: Product of Integers

The set M consists of nine positive integers, none of which has a prime divisor larger than six. Prove that M has two elements whose product is the square of an integer.

Step 1: Parity of Exponents

For each number m in M, define a function f(m) that maps m to the triple (a mod 2, b mod 2, c mod 2). This function records the parity (even or odd) of the exponents of 2, 3, and 5 in m.

Step 2: Pigeonhole Principle

The set M consists of 9 numbers. When we apply the function f to each number in M, we are mapping 9 numbers into 8 possible outcomes. By the Pigeonhole Principle, there must be at least two distinct numbers ($m_1, m_2 \in M$) such that $f(m_1) = f(m_2)$.

Problem 1: Product of Integers (cont.)

This means that m_1 and m_2 have the same parity for each of the exponents in their prime factorizations.

Step 3: Perfect Square

Let $m_1 = 2^{a_1} \cdot 3^{b_1} \cdot 5^{c_1}$ and $m_2 = 2^{a_2} \cdot 3^{b_2} \cdot 5^{c_2}$. Since $f(m_1) = f(m_2)$, we have $a_1 \equiv a_2 \pmod 2$, $b_1 \equiv b_2 \pmod 2$, $c_1 \equiv c_2 \pmod 2$.

Step 3: Perfect Square (cont.)

Now, consider the product $m_1 \cdot m_2$: $m_1 \cdot m_2 = 2^{(a_1+a_2)} \cdot 3^{(b_1+b_2)} \cdot 5^{(c1+c2)}$. Since a_1 and a_2 have the same parity, their sum (a_1+a_2) is even. The same is true for (b_1+b_2) and (c_1+c_2). Hence, each exponent in the product is even.

Problem 1: Product of Integers (cont.)

A number whose prime factorization has only even exponents is a perfect square. Therefore, the product $m_1 \cdot m_2$ is a perfect square.

1

Key Takeaway

By applying the Pigeonhole Principle, we can prove that within a set of nine integers with prime divisors no larger than six, there must exist two elements whose product is a perfect square.

Problem 2: Product of Integers (cont.)

The set L consists of 2023 integers, none of which has a prime divisor larger than 24. Prove that L has four elements, the product of which is equal to the fourth power of an integer.

Step 1: Parity of Exponents

Any number a in L can be written in the form $a = 2^{e_2}.3^{e_3}.5^{e_5}.7^{e_7}.11^{e_{11}}.13^{e_{13}}.17^{e_{17}}.19^{e_{19}}.23^{e_{23}}$, where each e_p is a nonnegative integer.

Step 1: Parity of Exponents (cont.)

We classify the numbers according to the parity of each of these nine exponents. For each prime p, we only care whether e_p is even or odd. Thus, each number is associated with a 9-tuple whose entries are 0 (for even) or 1 (for odd). The total number of possible such 9-tuples is $2^9 = 512$.

Problem 2: Product of Integers (cont.)

Now, by the Pigeonhole Principle, if we have more than 512 numbers, then at least two of them must fall into the same parity class. In our set L with 2023 elements, there must be at least one pair of numbers that belong to the same class. Let's call such a pair x and y.

Step 1: Parity of Exponents (cont.)

Since the parity of each exponent in x and y is the same, when we form the product xy, the exponent of any prime p in the prime factorization of xy is $e_{p(x)}+e_{p(y);}$ but since $e_{p(x)}$ and $e_{p(y)}$ have the same parity, their sum is even. Therefore, xy is a perfect square.

Step 2: Classifying the Squares

Now consider the set L', which consists of at least 756 squares. For any square s in L', write s = $2^{2f}{}_2.3^{2f}{}_3.5^{2f}{}_5.7^{2f}{}_7...23^{2f}{}_{23}$, where each f_p is a nonnegative integer.

Made with Gamma

Problem 2: Product of Integers (cont.)

In particular, the exponent of each prime in s is even. Now classify the numbers in L' according to the remainder when the exponents (which are even) are divided by 4. Since each exponent $2f_p$ is even, the possible remainders modulo 4 are only 0 and 2. For each prime, there are 2 possibilities. Therefore, the number of classes is at most $2^9 = 512$.

Step 2: Classifying the Squares (cont.)

But since there are at least 756 squares in L', the Pigeonhole Principle guarantees that there exist two distinct numbers in L', say u and v, that fall into the same class.

Step 2: Classifying the Squares (cont.)

Writing $u = 2^{2f_2} \cdot 3^{2f_3} \dots 23^{2f_{23}}$, $v = 2^{2g_2} \cdot 3^{2g_3} \dots 23^{2g_{23}}$, the fact that u and v are in the same class modulo 4 means that for each prime p, $2f_p \equiv 2g_p \pmod 4$.

Problem 2: Product of Integers (cont.)

Subtracting, we see that $2(f_p - g_p) \equiv 0 \pmod 4$, so $f_p - g_p \equiv 0 \pmod 2$. In other words, f_p and g_p have the same parity. Hence, for each prime p, the exponent in the product $uv = 2^{(2(f_2+g_2))}.3^{(2(f_3+g_3))}...23^{(2(f_{23}+g_{23}))}$ is divisible by 4, because $2(f_p+g_p)$ is even and, given that f_p and g_p are either both even or both odd, in either case f_p+g_p is even.

Step 2: Classifying the Squares (cont.)

Thus, we may write $uv = (2^{((f_2+g_2)/2)}.3^{((f_3+g_3)/2)}...23^{((f_{23}+g_{23})/2)})^4$.

That is, uv is a perfect fourth power.

Putting It All Together

Recall how we formed L'. Every element in L' came from pairing two elements of the original set L that were in the same parity class. Hence, each element $u \in L'$ is of the form $x \cdot y$ for some $x,y \in L$. Similarly, the element v in L' is the product of another pair $z \cdot w$ from L.

Problem 2: Product of Integers (cont.)

Thus, we have found four (not necessarily distinct) elements in L, x, y, z, w, such that (xy)(zw) = uv is a perfect fourth power.

1. **Key Takeaway**

   By applying the Pigeonhole Principle twice, we can prove that within a set of 2023 integers with prime divisors no larger than 24, there must exist four elements whose product is a perfect fourth power.

Popular Talks

Vienna & Russian Circles

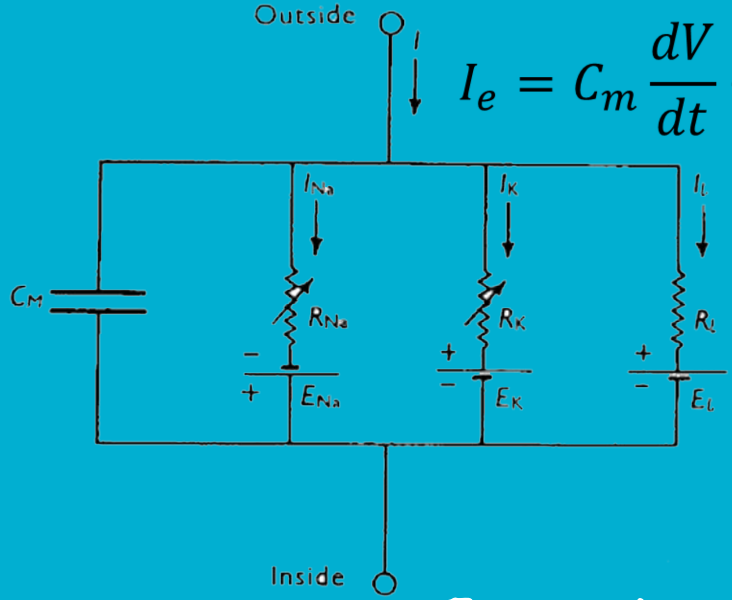
Usama Daoud

Computational Neuroscience

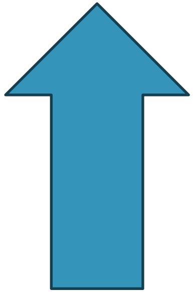
Hassan Al-Adawy

The Brain Equation

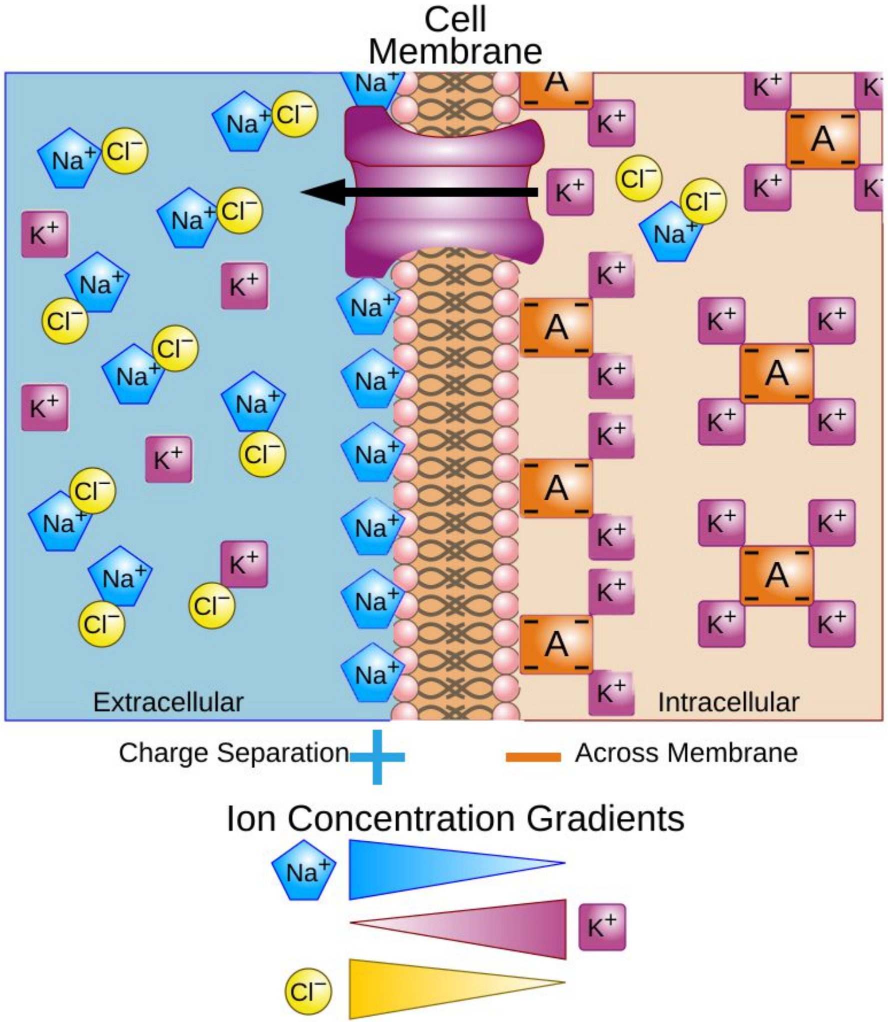
$$I_e = C_m \frac{dV}{dt} + G_l(V - E_l) + G_k(V)(V - E_k) + G_{Na}(V)(V - E_{Na})$$

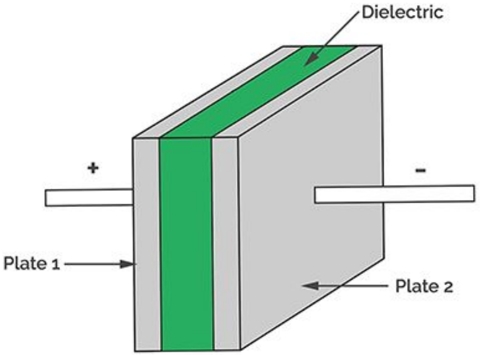


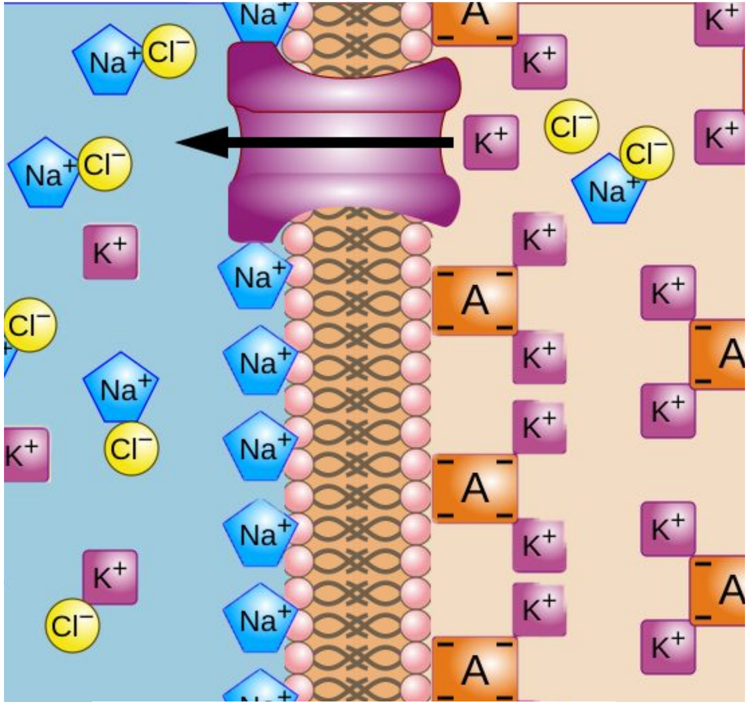
Introduction to Mathematical Neuroscience



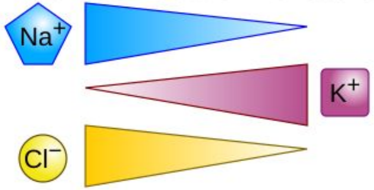
Positive charge

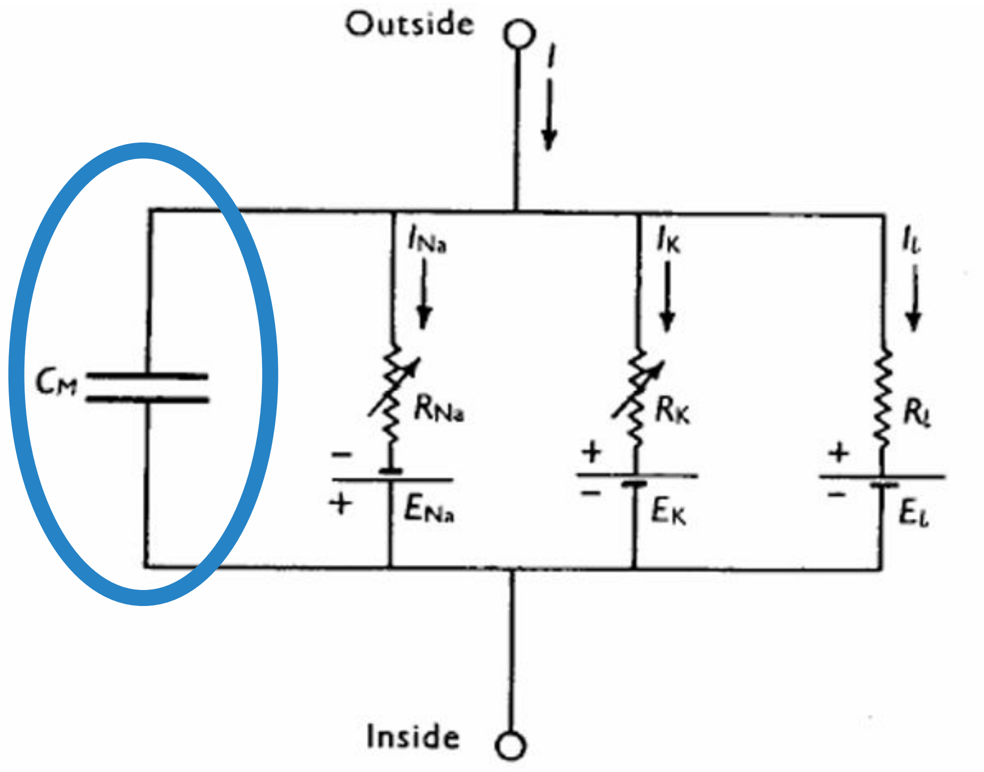


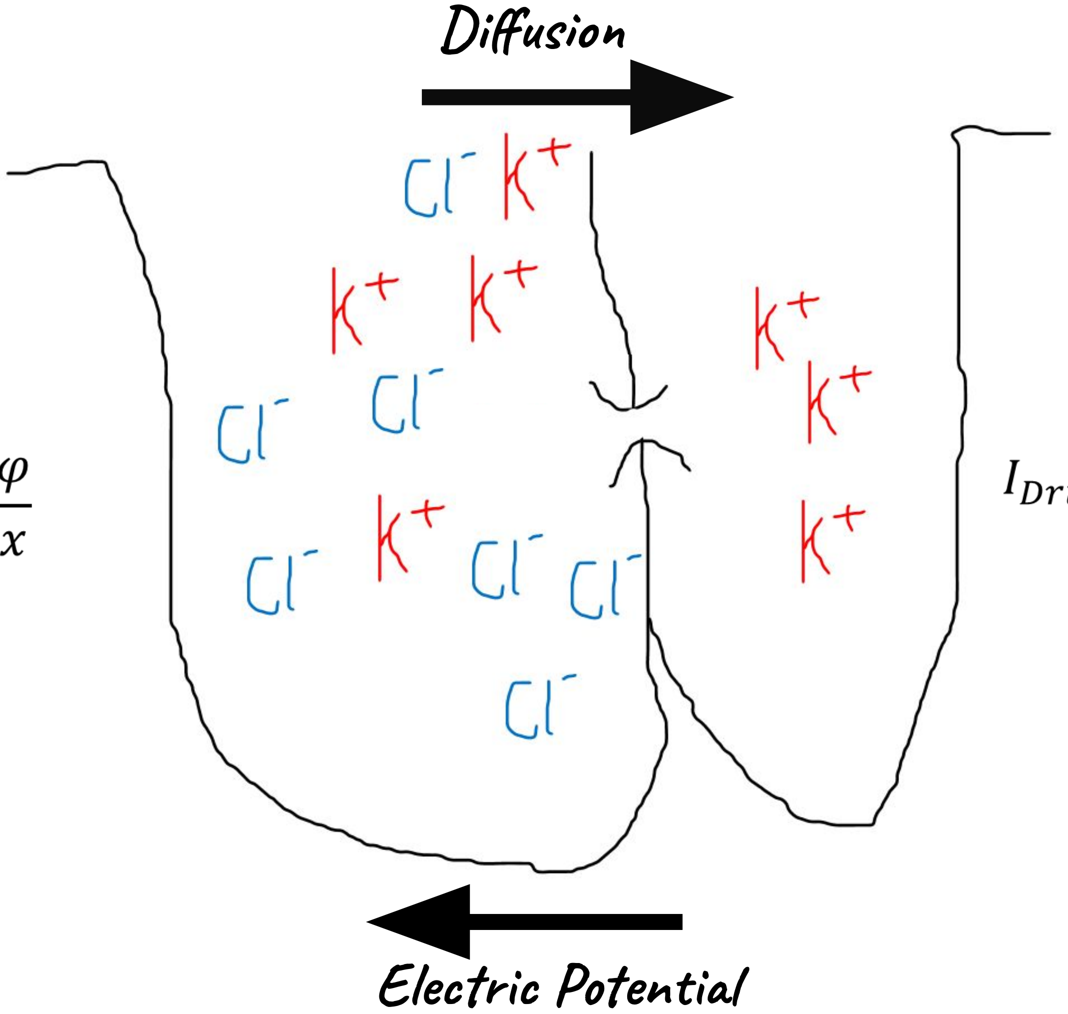




Ion Concentration Gradients







Fick's first law

$$I_{Diffusion} = qD\frac{\mathrm{d}\varphi}{\mathrm{d}x}$$

Ohm's law

$$I_{Drift} = \frac{q^2\varphi(x)D}{kT}\frac{dV}{dx}$$

D = diffusion constant
q = charge
φ = concentration at a point
x in space
k = Boltzmann constant
T = temperature
$\frac{dV}{dx}$ = electric field

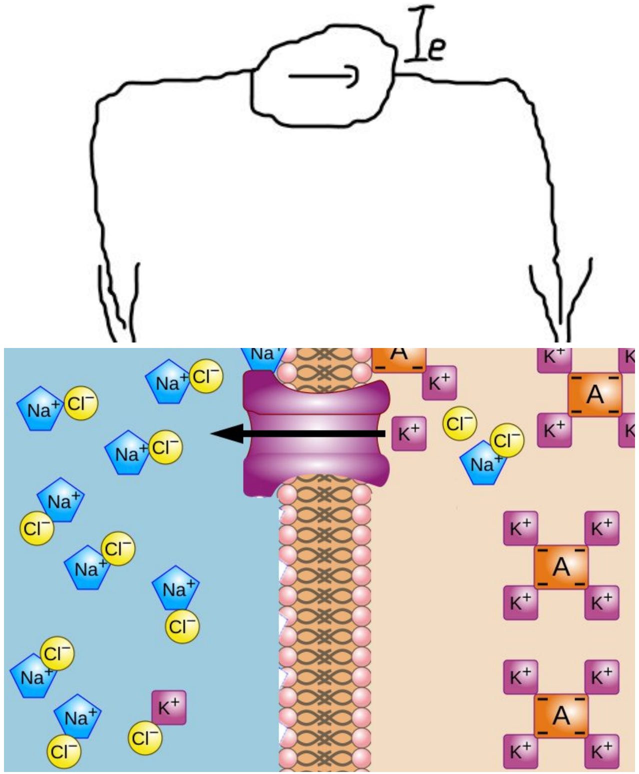
NERNST POTENTIAL

$$\Delta V = \frac{kT}{q} \ln \frac{\varphi_{out}}{\varphi_{in}}$$

The potential at which there is no current.

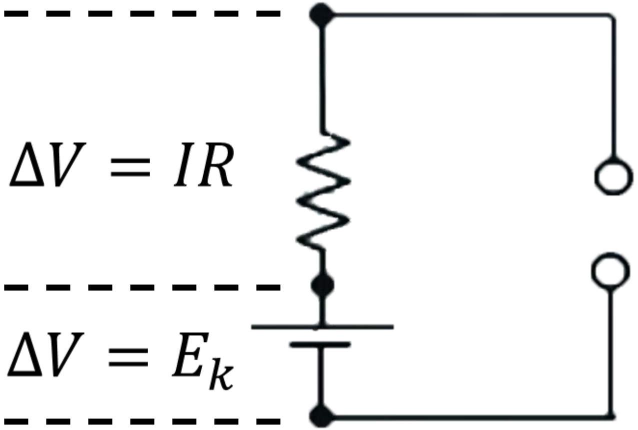
$$E_k = -75 \qquad E_{Na} = +55$$

At V = -75 there will be no current



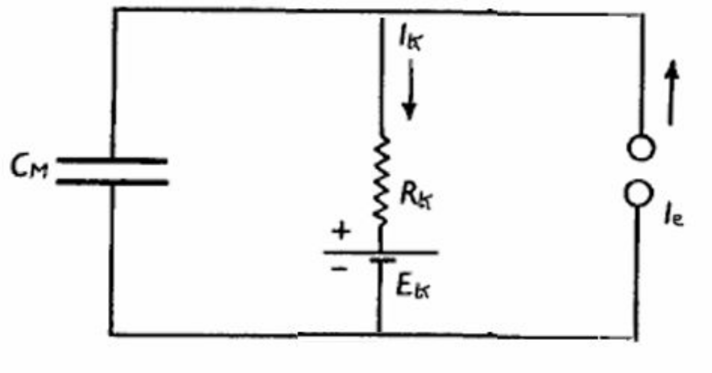
$$I = \frac{V - E_K}{R}$$

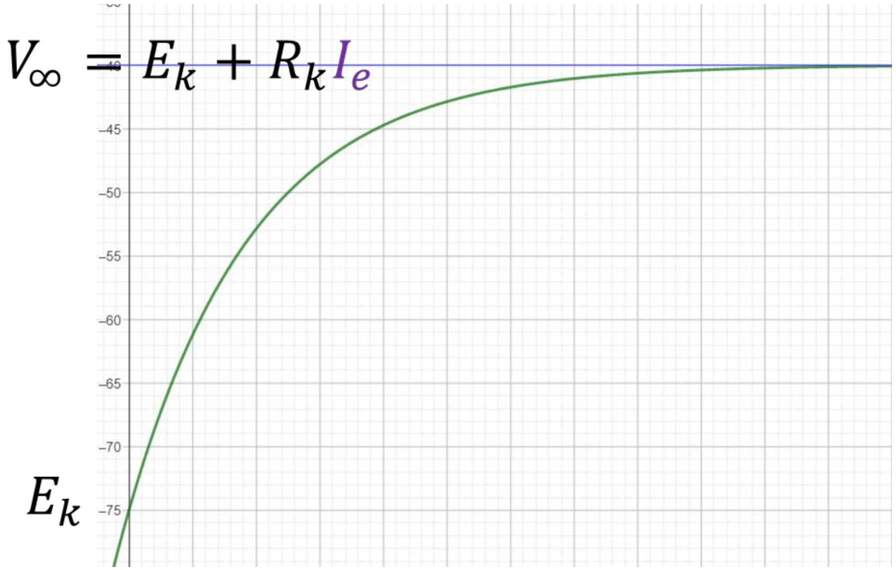
$$\Delta V = IR$$



$$\Delta V = E_k$$

$$V = IR + E_k$$





$$I_e = I_k + I_C$$

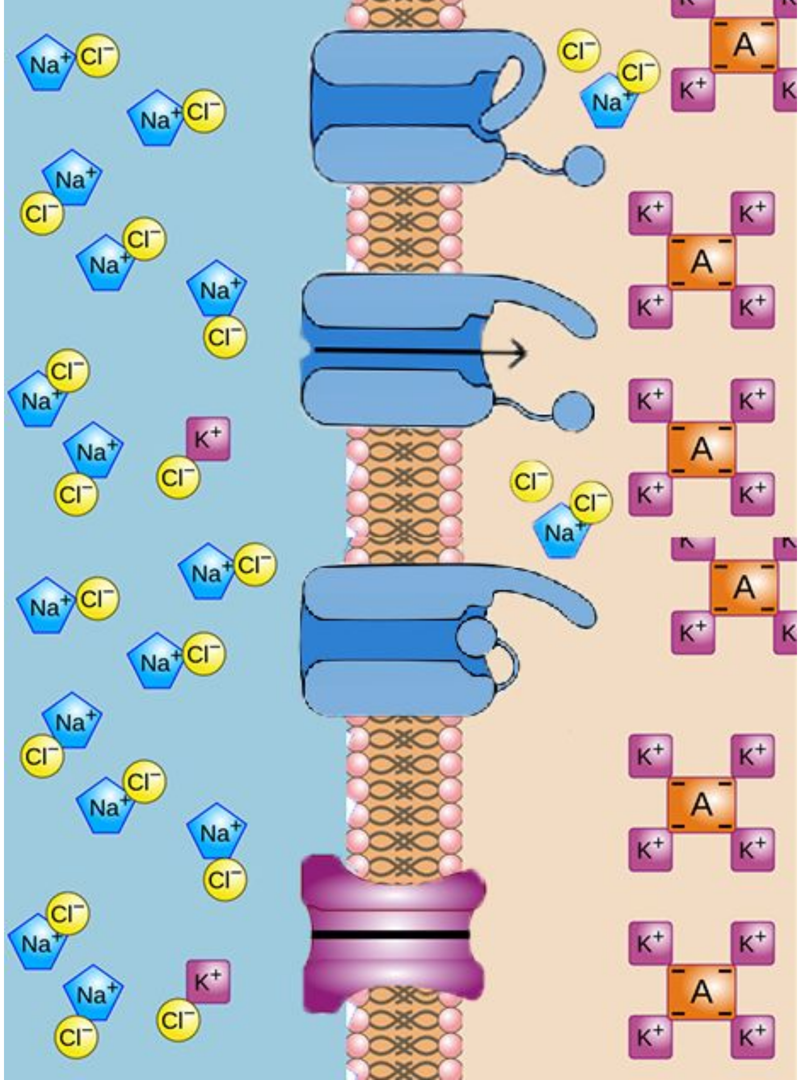
$$I_e = \frac{V - E_k}{R_k} + C_m \frac{dV}{dt}$$

$$R_k C_m \frac{dV}{dt} = -V(t) + (E_k + I_e R_k)$$

$$\tau \frac{dV}{dt} = -\mathrm{V(t)} + V_\infty$$

$$\tau = R_k C_m \qquad V_\infty = E_k + I_e R_k$$

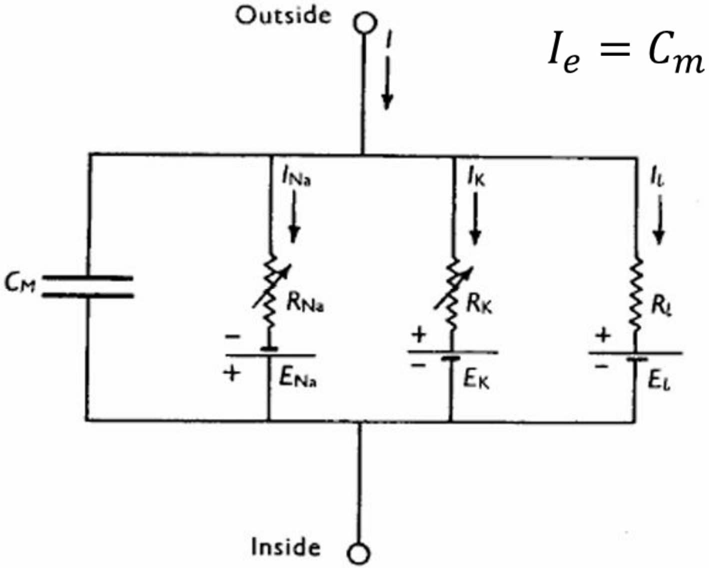
$$V(t) = V_\infty - I_e R_k e^{-\frac{t}{\tau}}$$



Na+
Cl−
K+
A

SIMPLIFIED HODGKIN-HUXLEY MODEL

$$I_e = C_m \frac{dV}{dt} + \frac{V - E_l}{R_l} + \frac{V - E_k}{R_k(V)} + \frac{V - E_{Na}}{R_{Na}(V)}$$



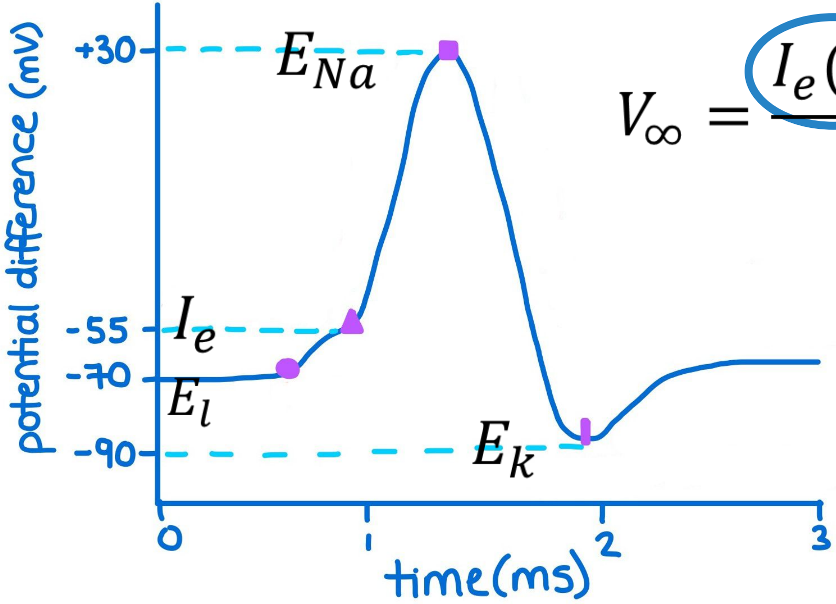
$$I_e = C_m \frac{dV}{dt} + G_l(V - E_l) + G_k(V)(V - E_k) + G_{Na}(V)(V - E_{Na})$$

$$G = \frac{1}{R}$$

$$\tau \frac{dV}{dt} = -V(t) + V_\infty$$

SIMPLIFIED HODGKIN-HUXLEY MODEL

$$\tau \frac{dV}{dt} = -V(t) + V_\infty$$



$$V_\infty = \frac{I_e(t) + E_l G_l + E_k G_k(V,t) + E_{Na} G_{Na}(V,t)}{G_l + G_k(V,t) + G_{Na}(V,t)}$$

$$\tau = \frac{C_m}{G_l + G_k(V) + G_{Na}(V)}$$

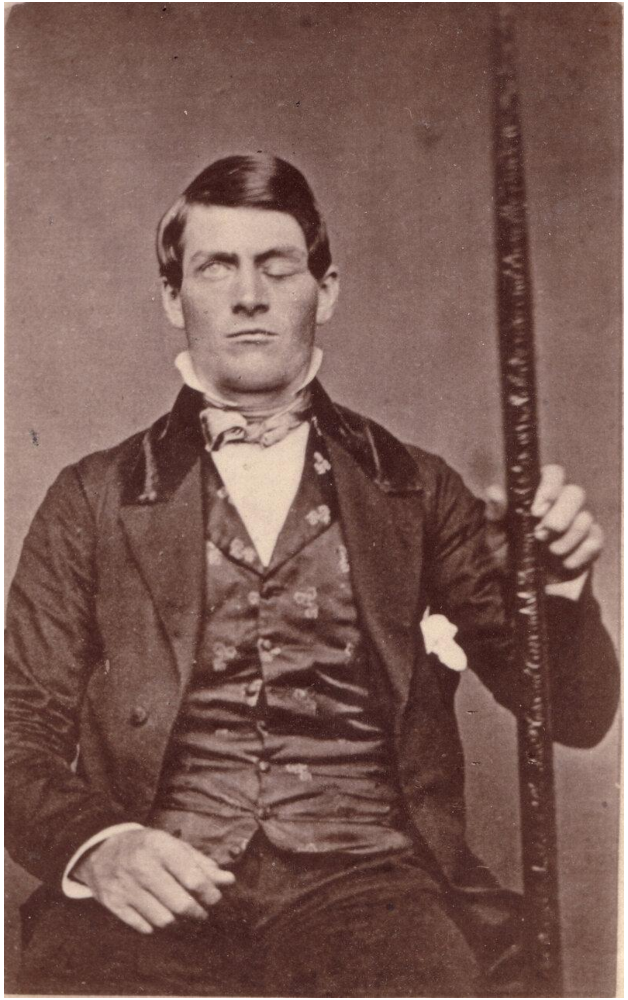
the Nobel Prize

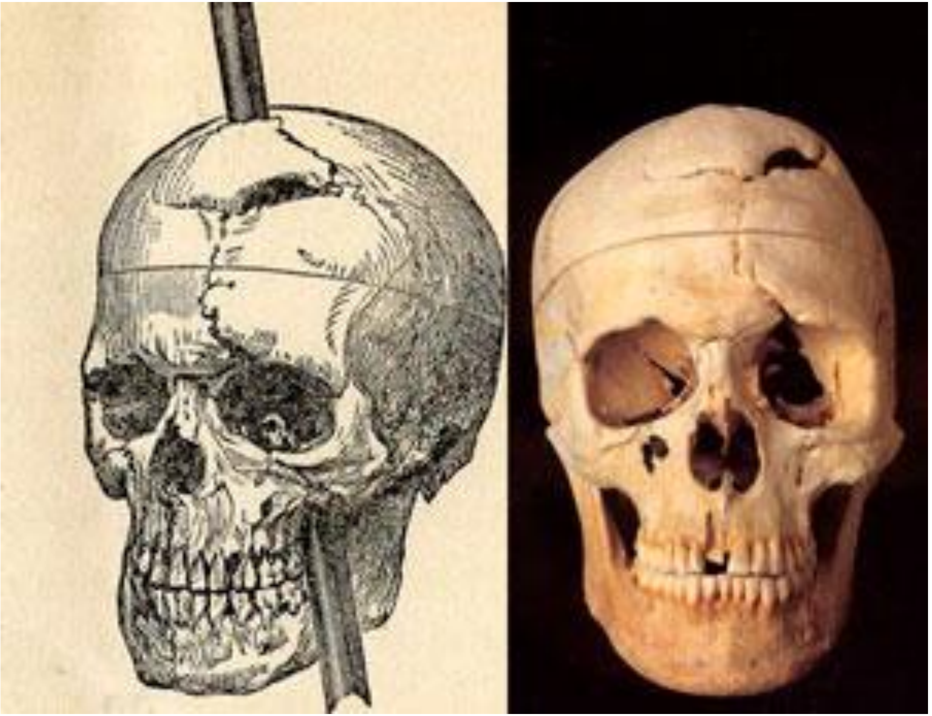
To Alan
from
Richard.

International annual **1963** English edition

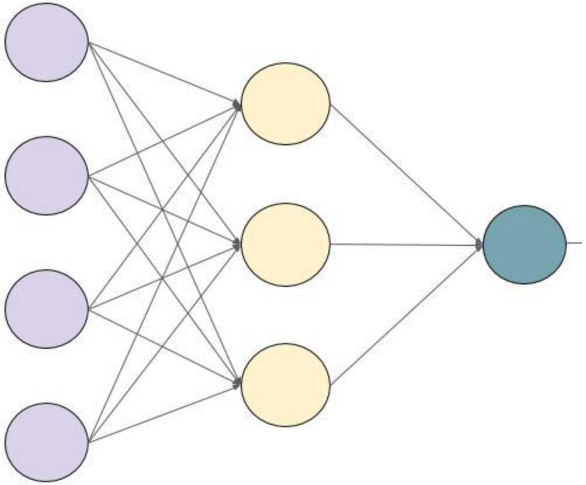
NERVE-CELL ENIGMA SOLVED

The British scientists, A. L. Hodgkin and A. F. Huxley, experimenting with the nerve fibers of squids and lobsters.

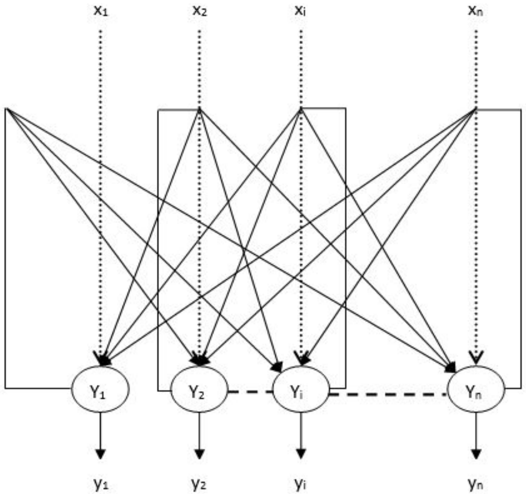




Feedforward Networks: Model Vision



Recurrent Networks: Model Memory




gettyimages
Credit: Pascal Le Segretain
2189210871


THE
NOBEL
PRIZE

THANK YOU!

IF YOU WANT TO GET STARTED..

Lectures:
https://www.youtube.com/watch?v=PnJEj6TokDA&list=PLUl4u3cNGP61I4aI5T6OaFfRK2gihjiMm

Book:
https://www.ictp-saifr.org/wp-content/uploads/2015/05/MathNsci.pdf

A recent article that I like:
https://link.springer.com/article/10.1007/s10827-024-00878-y