Foundations of *Artificial* Intelligence (FAI)

DA103DSAI

FAI *or* Φ

Lecture | 03

To Learn

We need to

intake **Signals**

Signal - what's that?

- Let's hear your thoughts - what is signal for you?

Signal - formally

- a signal, represented as ==a function of one or more variables==, may be defined as ==an observable change in a quantifiable entity== [1].
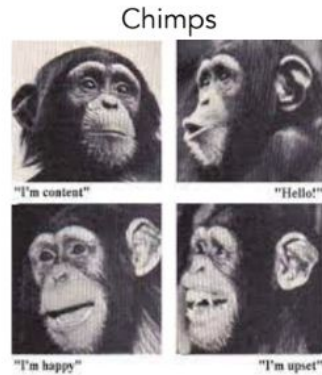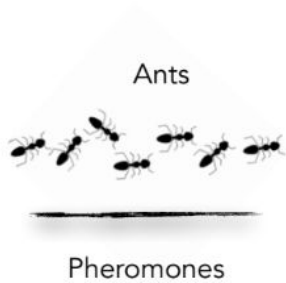
<div align="center">

(conveys information)

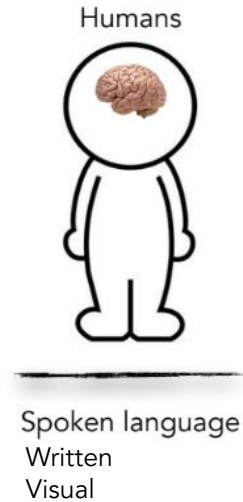</div>

Nice! we all are on same page now - let's proceed!

[1] Pragnan Chakravorty, "What is a signal?", Lecture Notes, IEEE Signal Proc. Magazine, 2018

- Signal, signal, everywhere
- Curious about communication signals

Ants

Pheromones

Chimps

"I'm content"   "Hello!"

"I'm happy"   "I'm upset"

Facial Expressions

Humans

Spoken language
Written
Visual
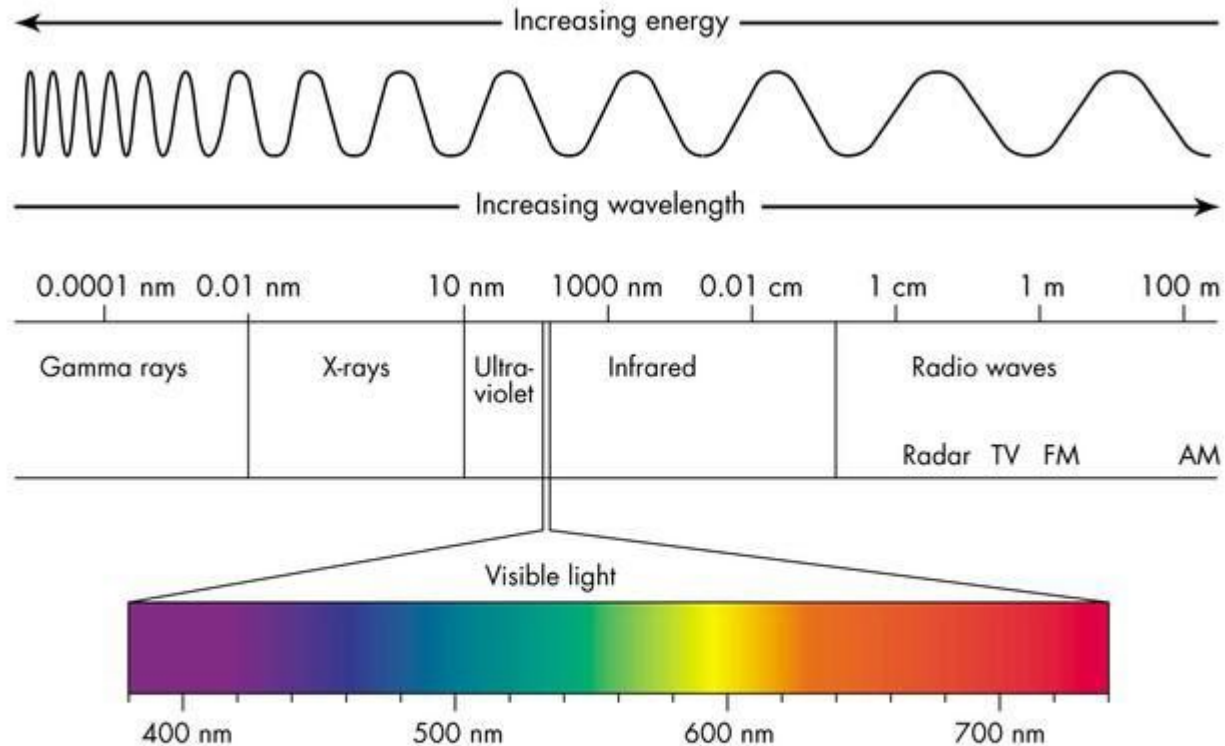
Visual Sensation

Human vision

Cone cells help to see color

VISIBLE SPECTRUM

400 nm 500 nm 600 nm 700 nm

VIOLET BLUE CYAN GREEN YELLOW ORANGE RED
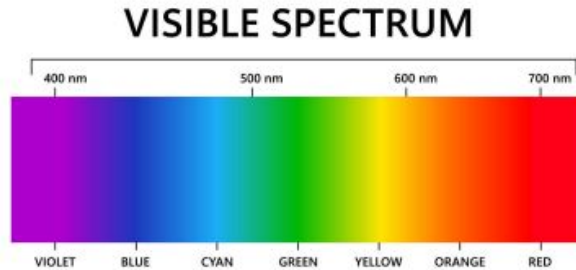
Human color vision has highest sensitivity to green

Eye color sensitivity

Hearing Sensation

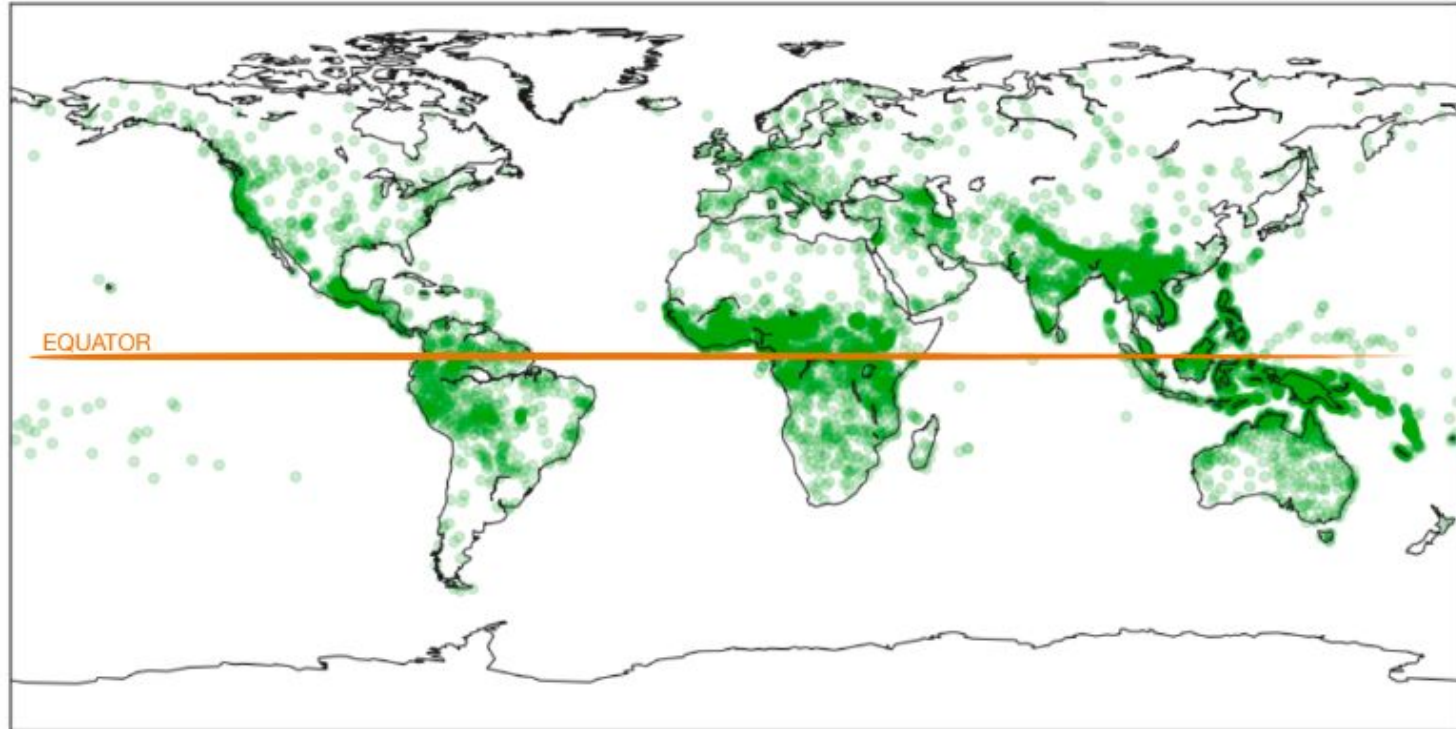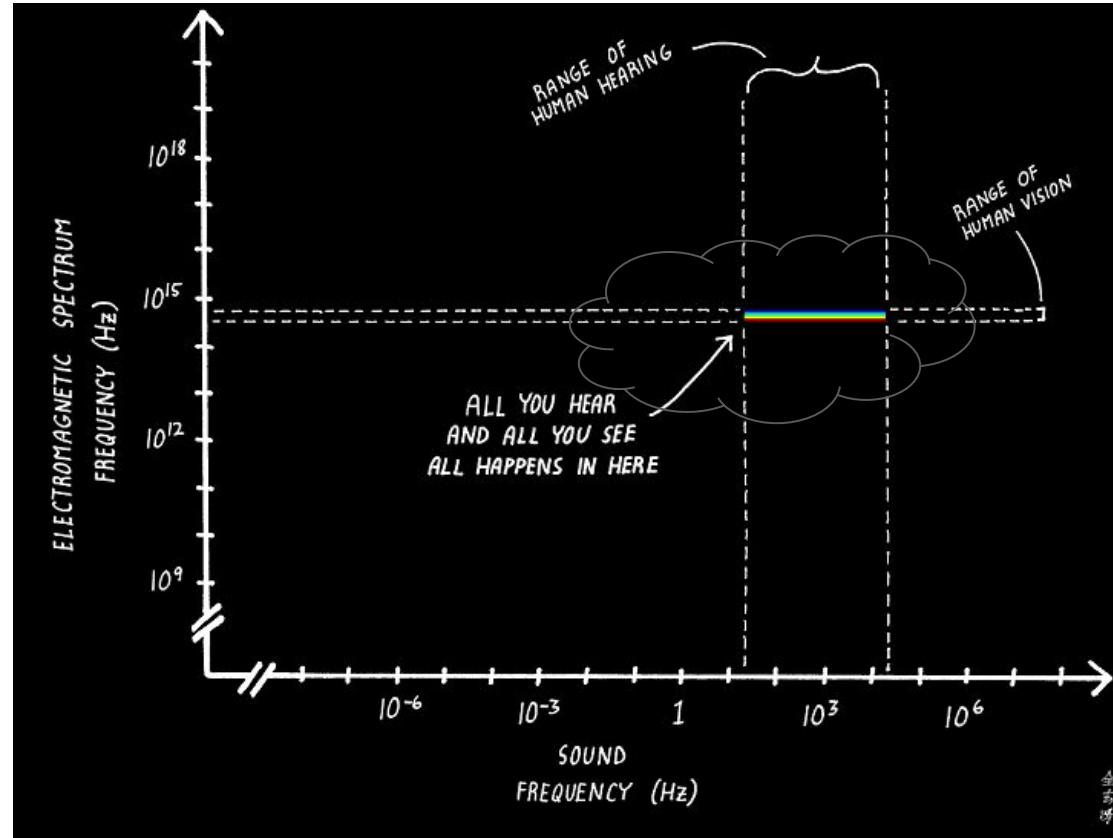| Animal	Range	(Octaves)	10 Hz	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
Tuna	50 Hz-1.1 kHz	(4.5 8va)						
Chicken	125 Hz-2 kHz	(4.0 8va)						
Goldfish	20 Hz-3 kHz	(7.2 8va)						
Bullfrog	100 Hz-3 kHz	(4.9 8va)						
Catfish	50 Hz-4 kHz	(6.3 8va)						
Tree frog	50 Hz-4 kHz	(6.3 8va)						
Canary	250 Hz-8 kHz	(5.0 8va)						
Cockatiel	250 Hz-8 kHz	(5.0 8va)						
Parakeet	200 Hz-8.5 kHz	(5.4 8va)						
Elephant	17 Hz-10.5 kHz	(9.3 8va)						
Owl	200 Hz-12 kHz	(5.9 8va)						
Human	31 Hz-19 kHz	(9.3 8va)						
Chinchilla	52 Hz-33 kHz	(9.3 8va)						
Horse	55 Hz-33.5 kHz	(9.3 8va)						
Cow	23 Hz-35 kHz	(10.6 8va)						
Raccoon	100 Hz-40 kHz	(8.6 8va)						
Sheep	125 Hz-42.5 kHz	(8.4 8va)						
Dog	64 Hz-44 kHz	(9.4 8va)						
Ferret	16 Hz-44 kHz	(11.4 8va)						
Hedgehog	250 Hz-45 kHz	(7.5 8va)						
Guinea pig	47 Hz-49 kHz	(10.0 8va)						
Rabbit	96 Hz-49 kHz	(9.0 8va)						
Sea lion	200 Hz-50 kHz	(8.0 8va)						
Gerbil	56 Hz-60 kHz	(10.1 8va)						
Opossum	500 Hz-64 kHz	(7.0 8va)						
Albino rat	390 Hz-72 kHz	(7.5 8va)						
Hooded rat	530 Hz-75 kHz	(7.1 8va)						
Cat	55 Hz-77 kHz	(10.5 8va)						
Mouse	900 Hz-79 kHz	(6.4 8va)						
Little brown bat	10.3 kHz-115 kHz	(3.5 8va)						
Beluga whale	1 kHz-123 kHz	(6.9 8va)						
Bottlenose dolphin	150 Hz-150 kHz	(10.0 8va)						
Porpoise	75 Hz-150 kHz	(11.0 8va)						

Humankind boasts of **7000 plus** spoken languages!

From Project PHOIBLE 2.0.

EQUATOR

Our Visual-Sonic world

Humans

https://abstrusegoose.com/421
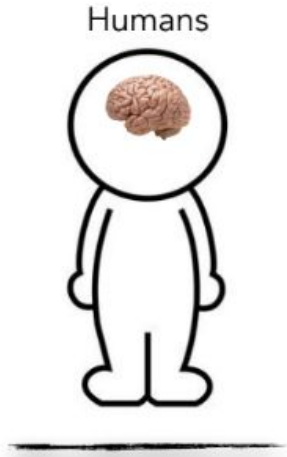
Senses Beyond Our Own

How Other Species Experience the World

🦇 **Echolocation** – Bats and dolphins use high-frequency sound to "see" in total darkness.

🐝 **Ultraviolet Vision** – Bees detect patterns on flowers invisible to humans.

🐘 **Infrasound Communication** – Elephants send messages over kilometers through low-frequency rumbles.

🐍 **Infrared Sensing** – Pit vipers detect heat signatures of prey, even in complete darkness.

🦈 **Electroreception** – Sharks sense weak electric fields from muscle activity of prey.

🦋 **Polarized Light Detection** – Butterflies navigate using subtle changes in light polarization.

Neeraj Sharma (Neeks), IIT Guwahati, *India | M2025*

Switching to the Computation World

Distinction between Signals and Data

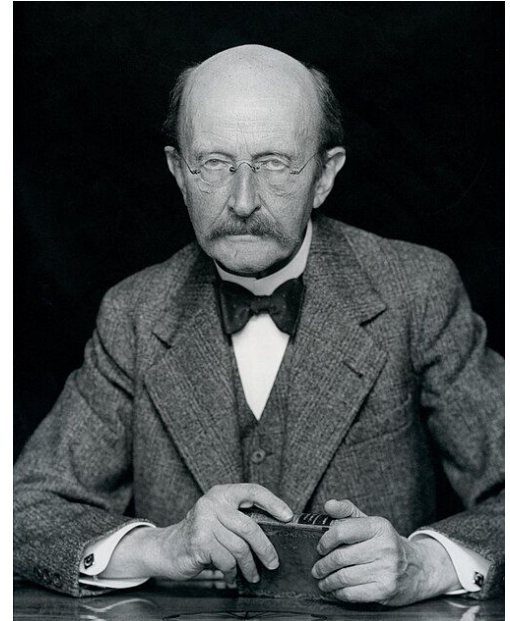Signals exist in nature. $\longrightarrow$ Data is what we measure.

"An experiment is a question which science poses to nature,

a measurement is the recording of nature's answer."

Max Planck
(German Theoretical Physicist)

Max Karl Ernst Ludwig Planck
(1858 - 1947)

Data

Etymology

From Latin datum = "that which is given"

Plural of datum → data = things that are given

Data

Etymology

From Latin datum = "that which is given"

Plural of datum → data = things that are given

In modern terms

Data means raw facts handed over for processing.

A representation of facts, measurements, observations, or symbols that can be recorded, stored, and analyzed.

Data Collection … *briefly*

A representation of facts, measurements, observations, or symbols that can be recorded, stored, and analyzed.

Era	Data Type	Purpose
Ancient civilizations	Census, crop records	Taxation, military planning
17th–18th century	Vital stats, trade logs	State administration, population studies
19th century	Scientific experiments	Standardized measurements
Early 20th century	Industrial logs, surveys	Optimization, policy decisions
Digital age (post-1960)	Electronic signals, databases	Automation, analytics, computing
Big Data era (2000s–)	Social media, sensors, IoT	Predictive modeling, AI, personalization

Data

It can take different forms depending on the source it is coming from.

Modality	Example	Data Type	Format
Text	News article, tweet	Character or token sequence	Plain text, token list
Image	Photograph, X-ray	2D matrix (pixels)	JPEG, PNG, tensors
Audio	Speech, music	1D time series or 2D spectrogram	WAV, MP3, array
Sensor	Accelerometer, EEG	1D or multi-channel time series	CSV, JSON, array
Tabular	Survey, health records	Fixed-length vectors	CSV, Excel, SQL

Thank you

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