# Barn Owl* :
## The Silent Hunter

Akshay, Hitesh, Janani

Brain, Dynamics & Computation
IMSc, Chennai
04 June 2025

*Terms and conditions apply

# Built-in Satellite Dish!

https://gressenhallfw.wordpress.com/2014/05/28/gressenhalls-barn-owls-success-at-last/

# How does it locate the prey?

Sound?

Smell?

Body heat?

# How does it locate the prey?

Sound?

Smell?

Body heat?

*J. Exp. Biol.* (1971), **54**, 535–573
*With 5 plates and 5 text-figures*
*Printed in Great Britain*

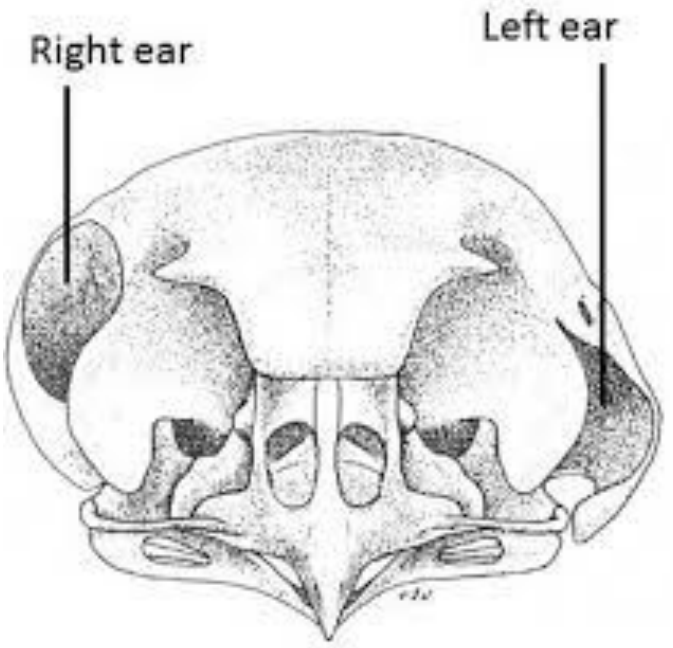
## ACOUSTIC LOCATION OF PREY BY BARN OWLS (*TYTO ALBA*)

By ROGER S. PAYNE
*Rockefeller University and New York Zoological Society*

(*Received* 20 *January* 1970)

# SOUND LOCALISATION IN BARN OWL

- Asymmetric ears (left lower, right higher) help determine elevation (up/down).
- ITD (Interaural Time Difference): Measures tiny differences in arrival time between ears → determines left/right direction.
- ILD (Interaural Level Difference): Compares intensity differences → determines up/down direction.



# Interaural Time Difference (ITD) Pathway

Sound Source

↓

Auditory Nerve

↓

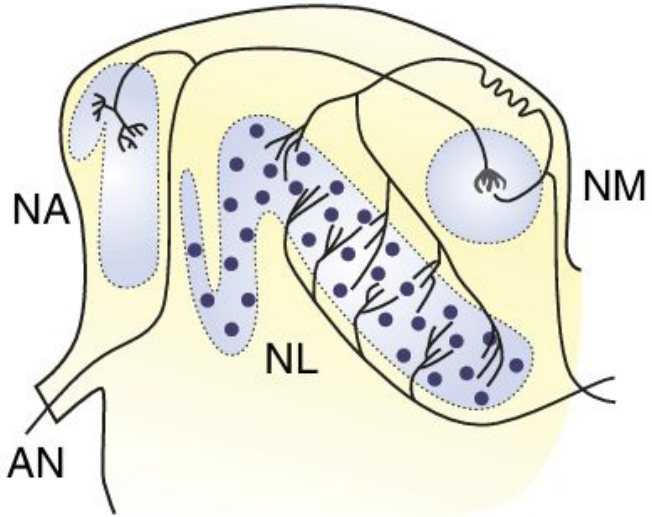
Nucleus Magnocellularis

↓

Nucleus Laminaris

↓

Midbrain




Sound localization: Jeffress and beyond Go Ashida and Catherine E Carr, Current Opinion in Neurobiology 2011, 21:745–751

# Interaural Level Difference (ILD) Pathway

Sound Source

↓

Auditory Nerve

↓

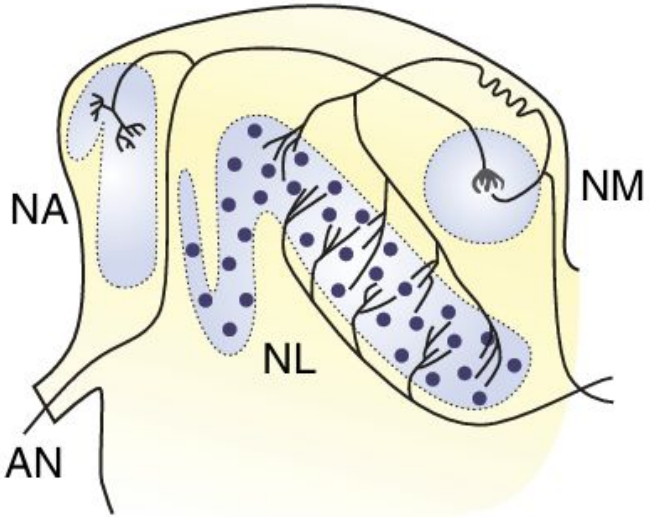
Nucleus Angularis

↓

Posterior lateral lemniscal nucleus (LLDp)

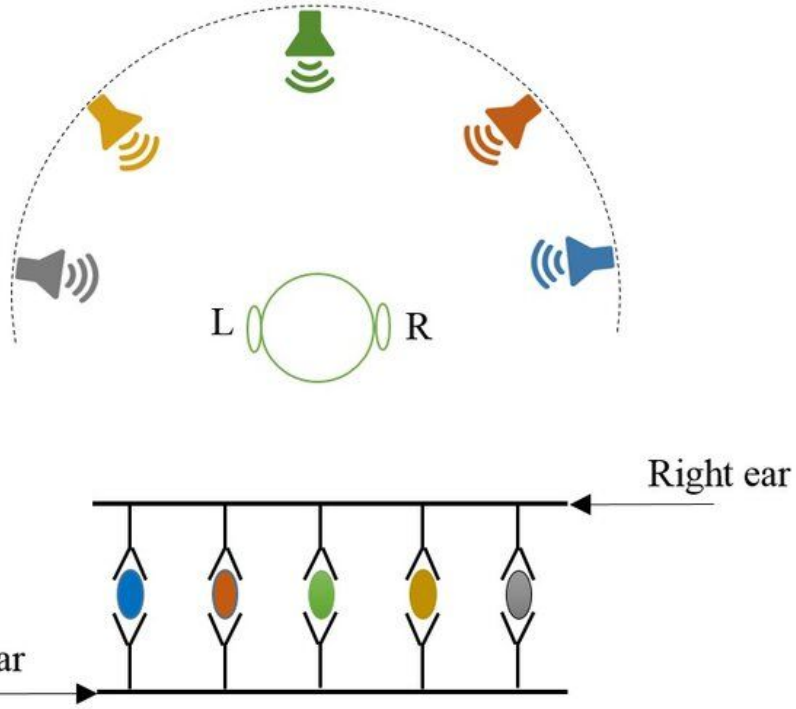
↓

Midbrain



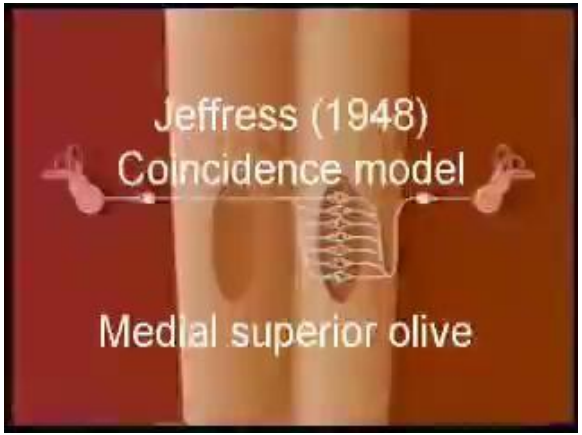

Sound localization: Jeffress and beyond Go Ashida and Catherine E Carr, Current Opinion in Neurobiology 2011, 21:745–751

# The Jeffress Model (1948)




Mosadeghzad, Mohamad & Rea, Francesco & Tata, Matthew & Brayda, Luca & Sandini, Giulio. (2015). Saliency Based Sensor Fusion of Broadband Sound Localizer for Humanoids. 10.1109/MFI.2015.7295835

# The Jeffress Model - A video




Sound localization: Jeffress and beyond Go Ashida and Catherine E Carr Current Opinion in Neurobiology 2011, 21:745–751

Animation by Prof. Tom Yin of the University of Wisconsin

# Our Owl and it’s world

Our owl is a five neuron owl which is functionally capable* of finding its prey by hearing to the feeble sounds they make.

It has evolved through the constraints of dimensions and by adding more degrees of freedom to its arsenal it is *still evolving* (future directions).

Initially it could just tell where the sound is coming from. If we assume our owl was on a plane with itself placed in the centre.

It could tell from which region of this plane the sound is coming from. Either from the left half or from the right half.

* t & c applied

# The story of our owl continued

Slowly it evolved and developed the capabilities to determine the angle of the source and hence also estimate the distance.

Now it’s in the process of evolving to another dimension, from a plane to a sphere of perception.

# Terms and Conditions

- Lives in a line or a plane
- Only has limited (computational) resources
- If you insist, it is a spherical owl.

Illustration: Jane Tattersfield

# The Model

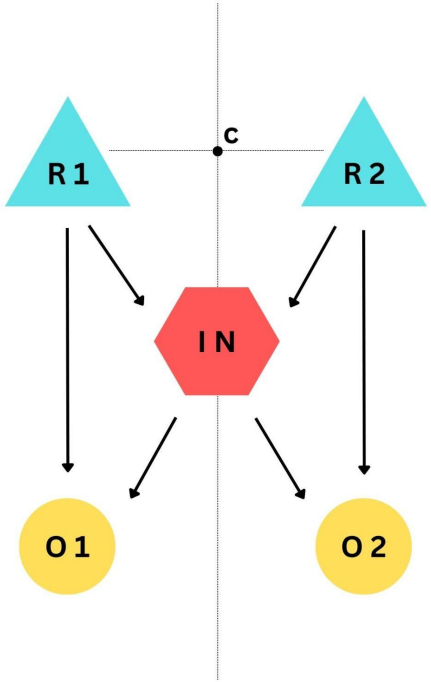
**Owl on a plane with zero degrees of freedom - just left/right :**

The system responsible for this decision making comprises of a network of 5 neurons.

It comprises of two receptor neurons which convert acoustic stimulus to current pulses (square waves of a fixed amplitude and duration), an interneuron and two output neurons.

The interneuron and the output neurons are modelled as leaky integrate and fire neurons

# The network architecture




**R 1 -** Receptor 1

**R 2 -** Receptor 2

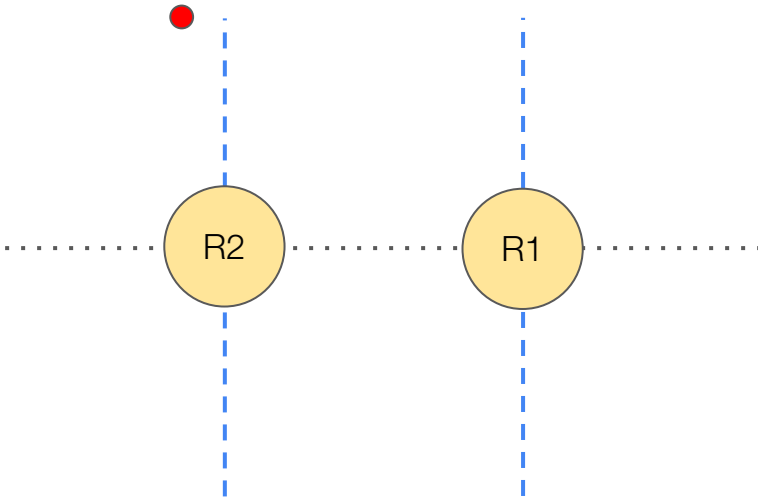
**I N -** Interneuron

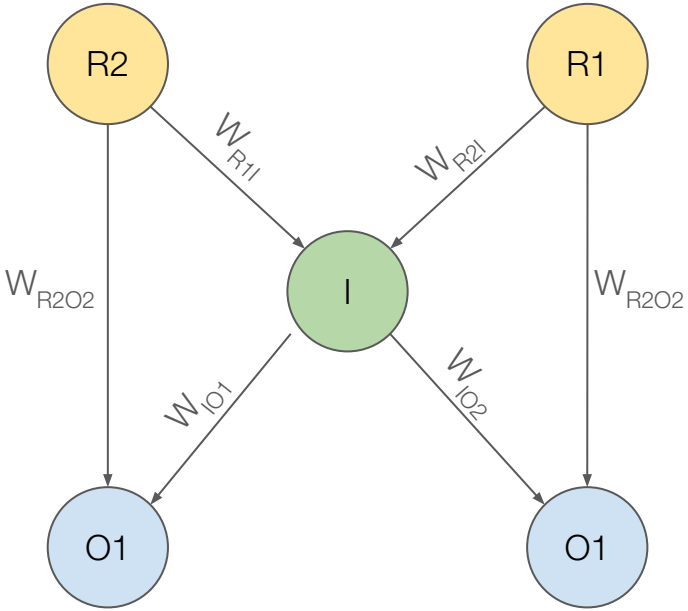
**O 1 -** Output neuron 1

**O 2 -** Output neuron 2

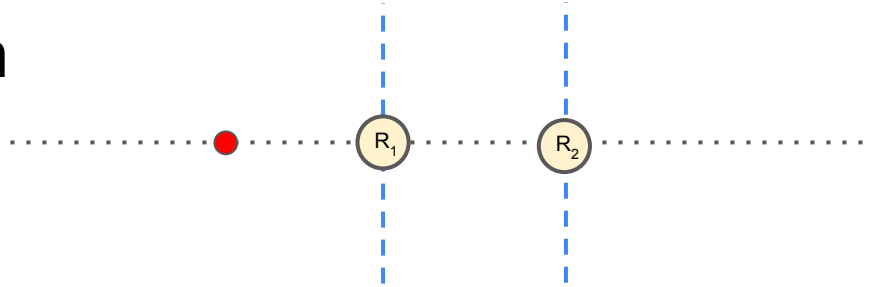
**C -** center of receptors axis

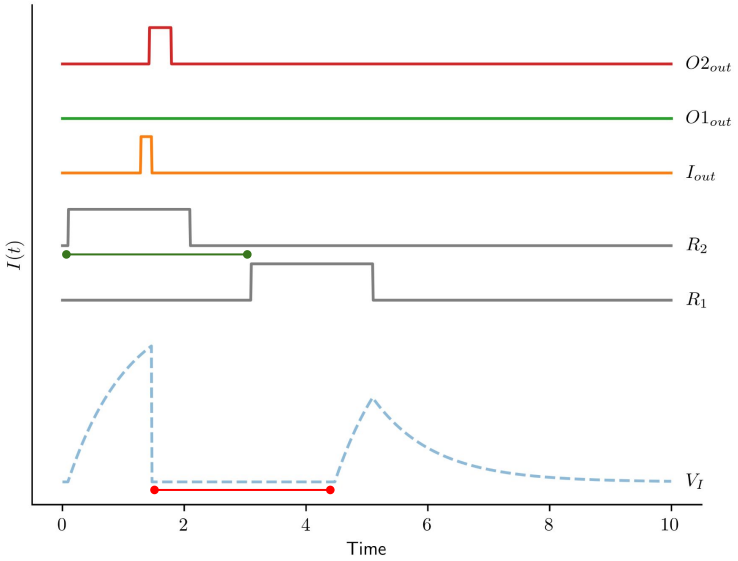
# Owl living in a line

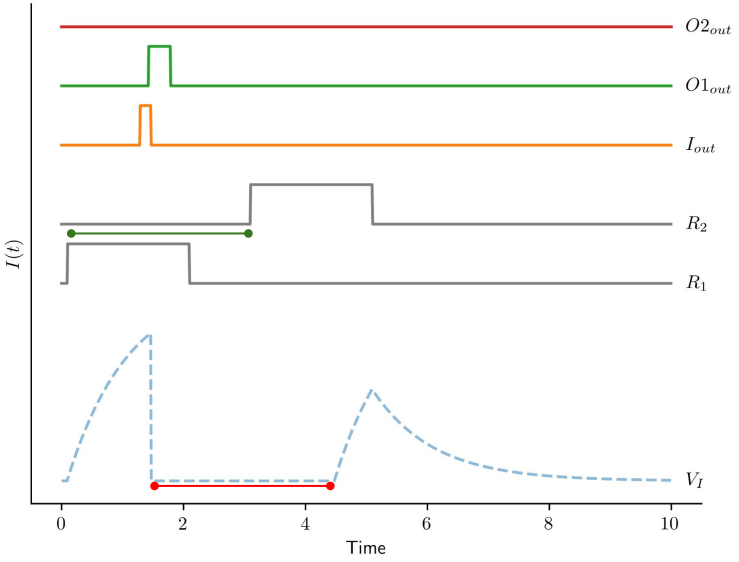


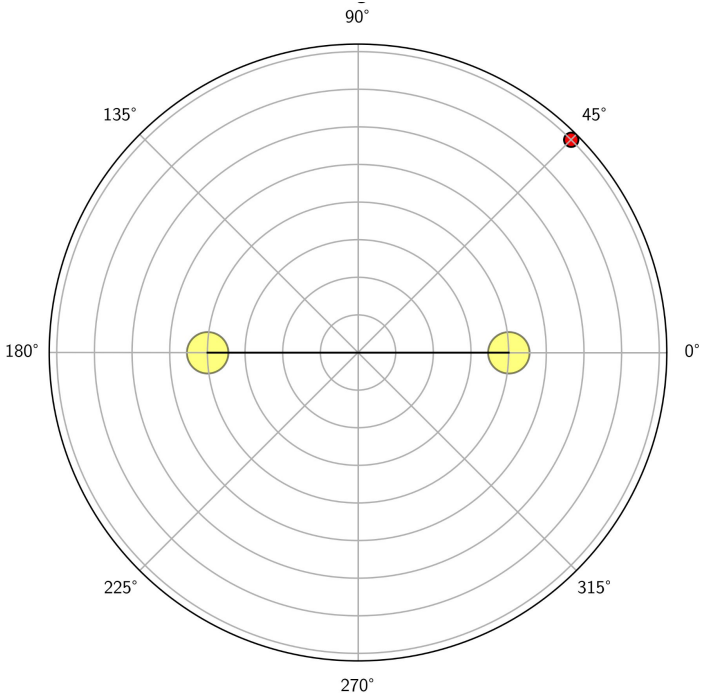
# Owl living in a line: Simulation

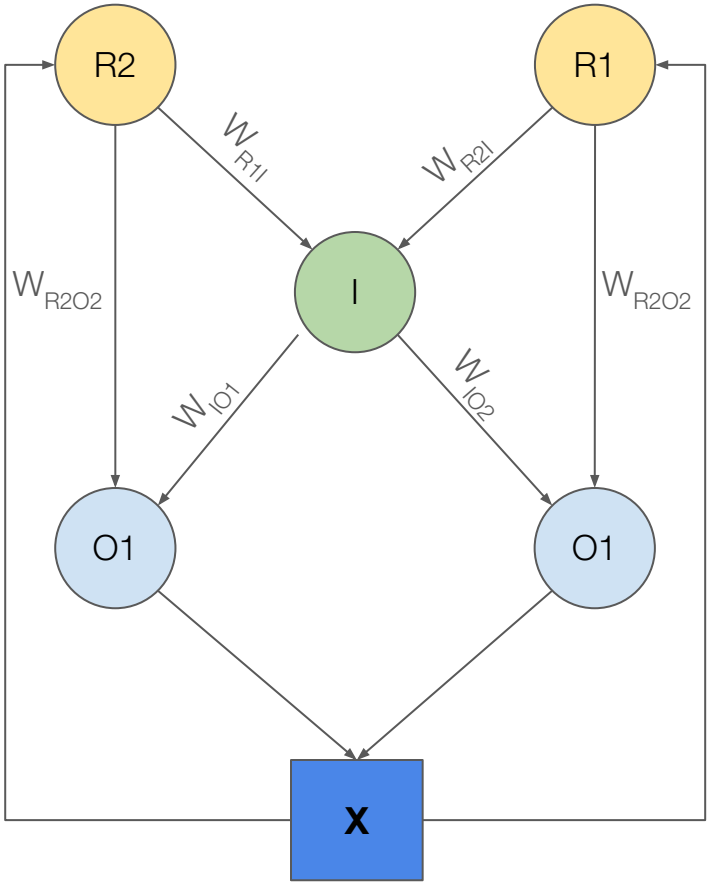


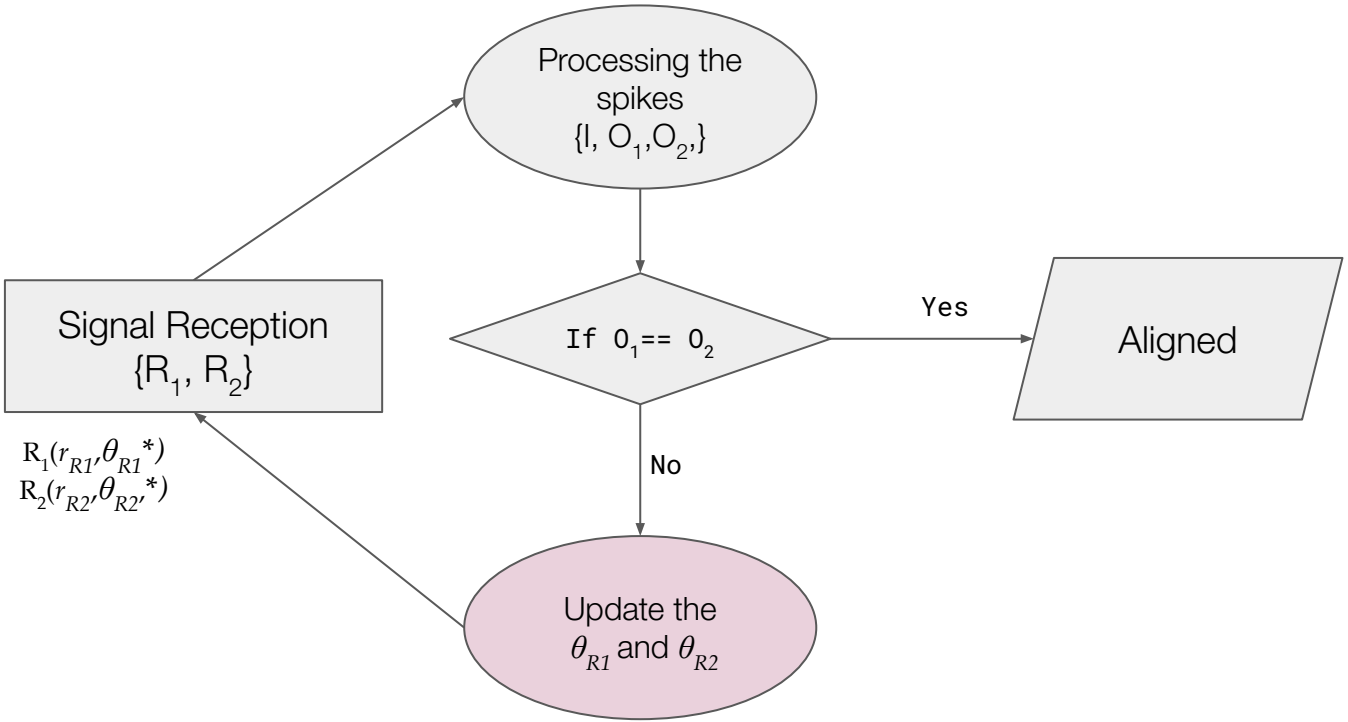



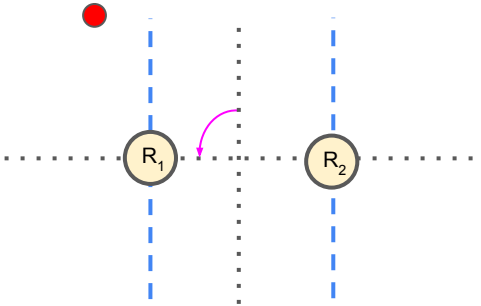
# New dimension unlocked!

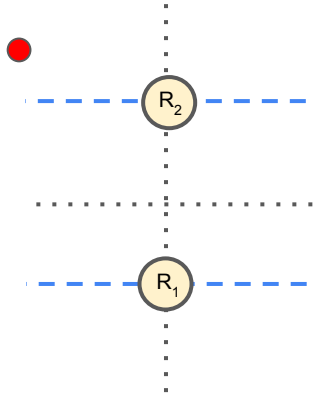


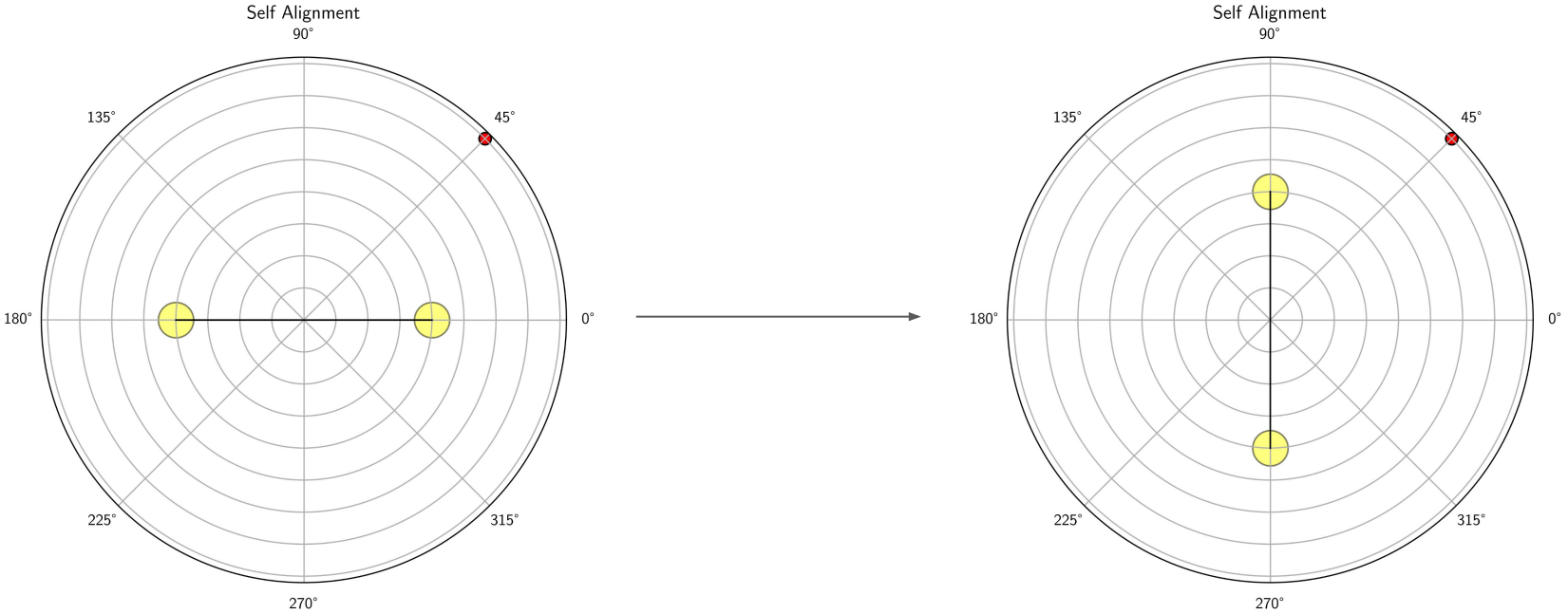
# Owl living in a plane.



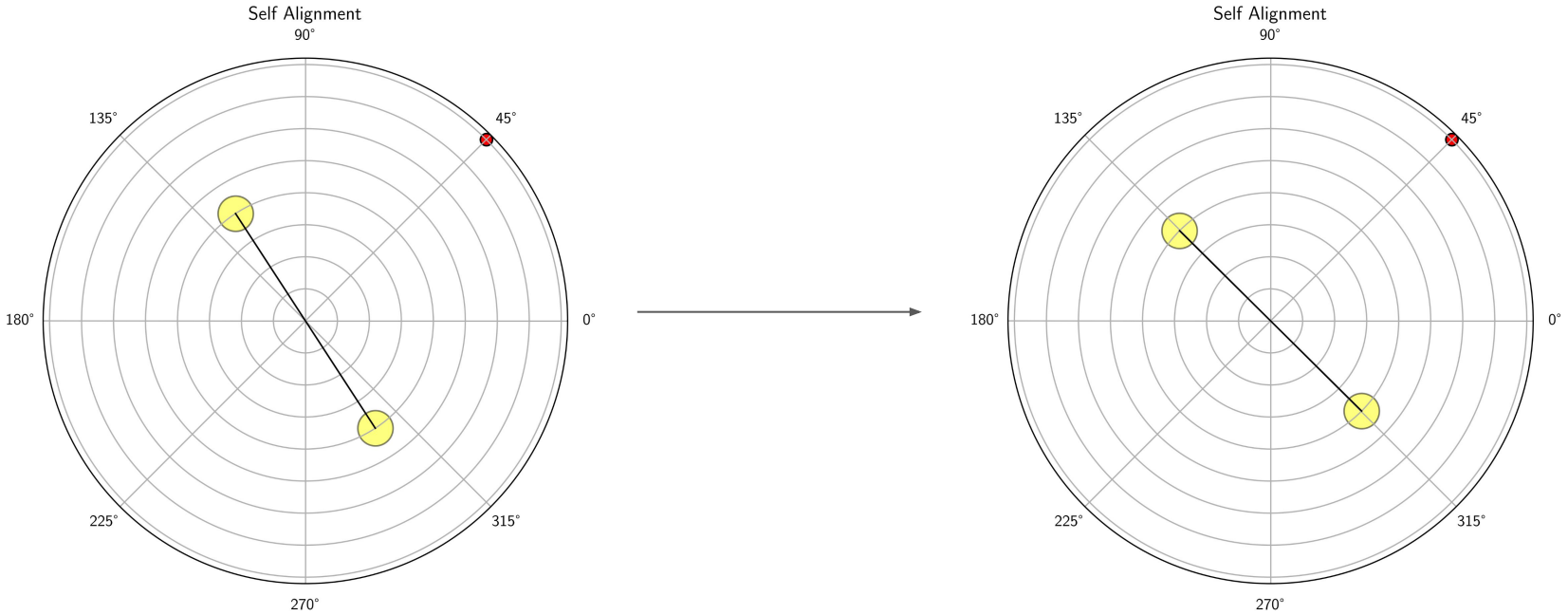



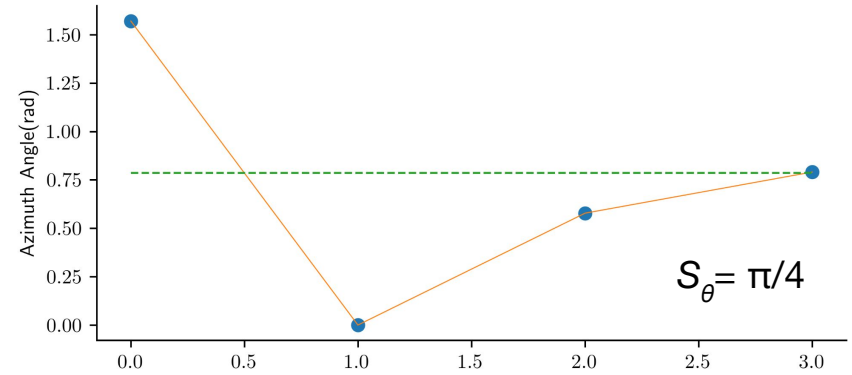
# Owl living in a plane.

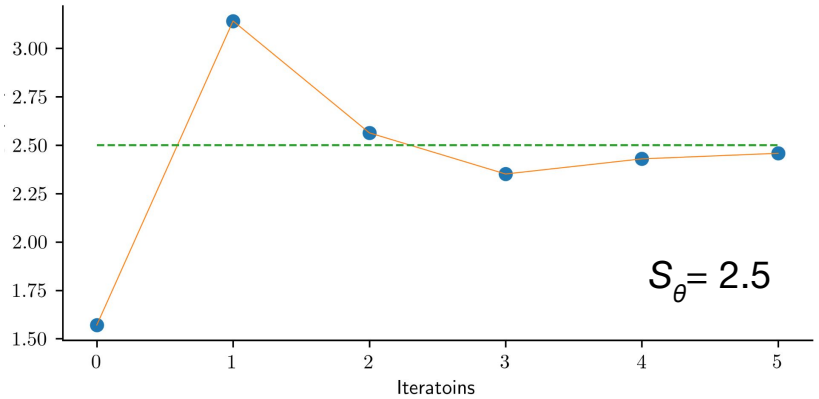


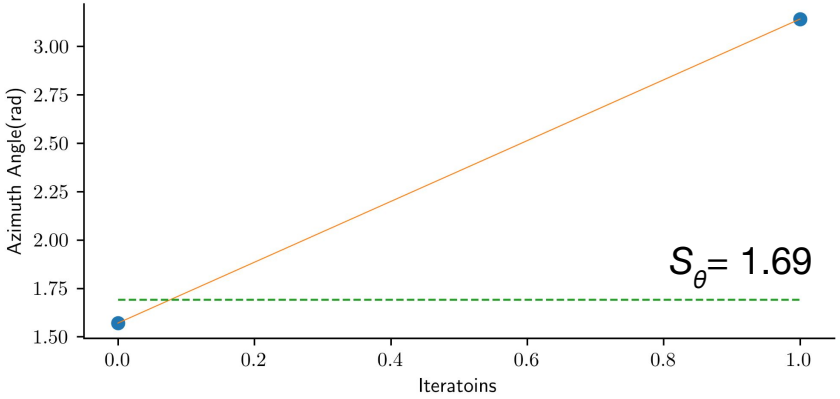
# Owl living in a plane.

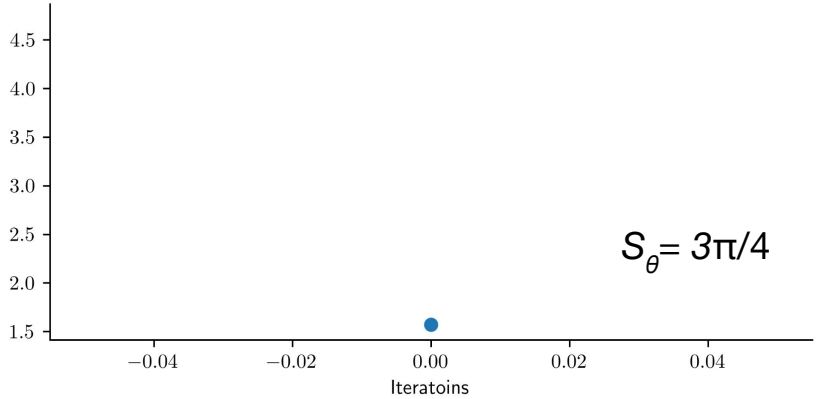


# Convergence of Azimuth



# There could be more!

- Extending to three dimension.
- Make the system more robust to perturbations.
- Develop alternate efficient architectures:
  - Mutually inhibiting receptors
- Self-aligning antenna and many more engg applications.

# Thank you!

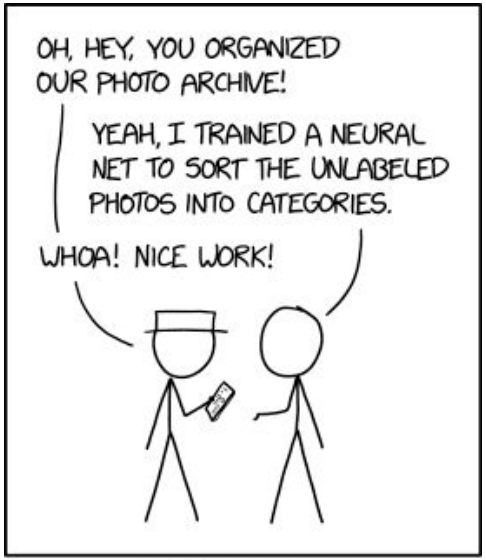
A lot of LLMs were abused during this project. In the possible event of an AI invasion, this shall be considered as my apology to them.

Of course, I'm kidding! Beautiful tech, but the people who run it steal data and accuse people for stealing data. Horrible!

If you are interested the code  is here:

`https://github.com/akshaysanjeevk/Acoustic-Localisation-BDC25`

https://xkcd.com/2173/



# References


- Mosadeghzad, Mohamad & Rea, Francesco & Tata, Matthew & Brayda, Luca & Sandini, Giulio. (2015). Saliency Based Sensor Fusion of Broadband Sound Localizer for Humanoids. 10.1109/MFI.2015.7295835
- Jeffress, L.A., 1948. A place theory of sound localization. Journal of Comparative and Physiological Psychology, 41(1), pp.35–39
- Payne R. ,Acoustic Localisation of Prey by Barn owls (*Tyto alba*). J. Exp. Biol. (1971), 54. S3S-573
- Ashida G.,  Barn owl and sound localization. Acoust. Sci. & Tech. 36, 4 (2015)
- Konishi M. Listening with two ears. Scientific American, Vol. 268, No. 4 (1993), pp. 66-73