

Efficient bio-inspired sensing

Drawing inspiration from nature

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14/09/2022

The biological brain

- Extremely energy efficient
- Receives many sensory inputs at once
- Outperforms computers on many real-world tasks



The artificial brain

- High energy consumption
- Performs best on few types of input

The auditory system:

Pressure waves are sensed and processed into electrical signals



The visual system:

Photons are sensed and processed into electrical signals



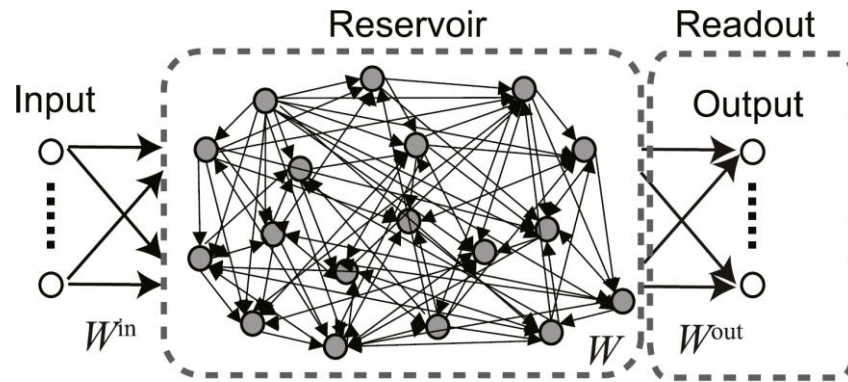
The auditory system:

Pressure waves are sensed and processed into electrical signals



- Extreme amplitude and frequency sensitivity
- Tonotopic fine structure
- Spontaneous otoacoustic emissions
- Nonlinear and active process to improve performance

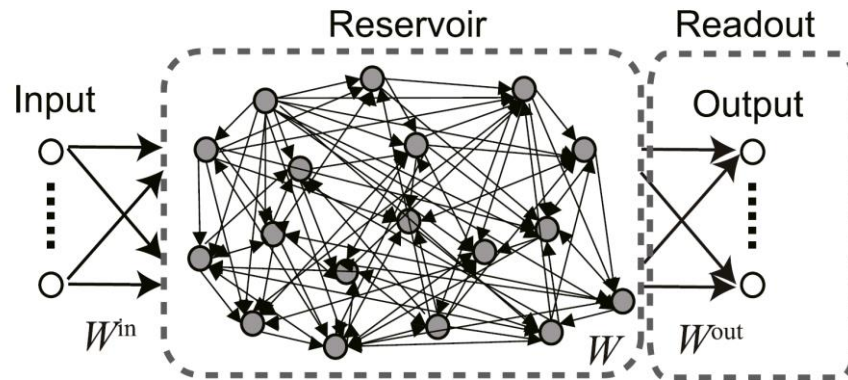
Conventional



Reservoir requirements:

- High dimensionality
- Nonlinearity
- Fading memory

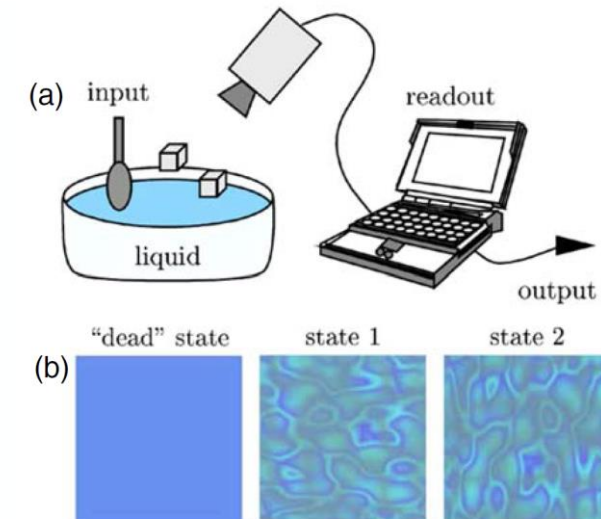
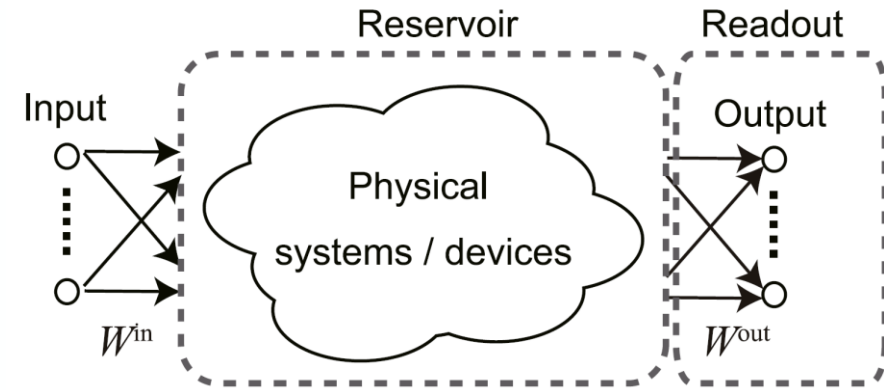
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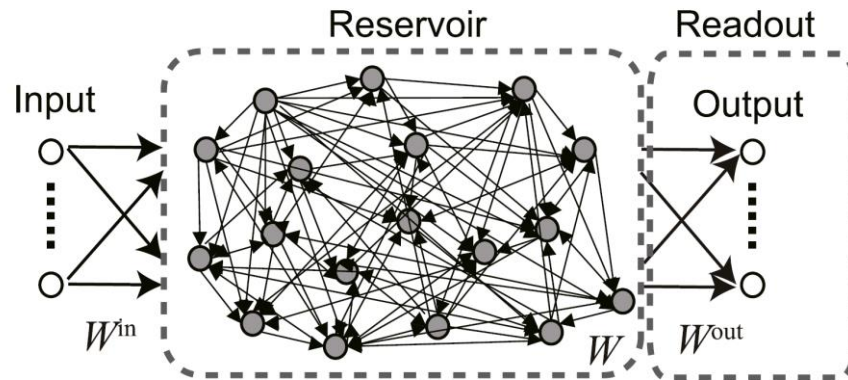
Reservoir requirements:

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Physical



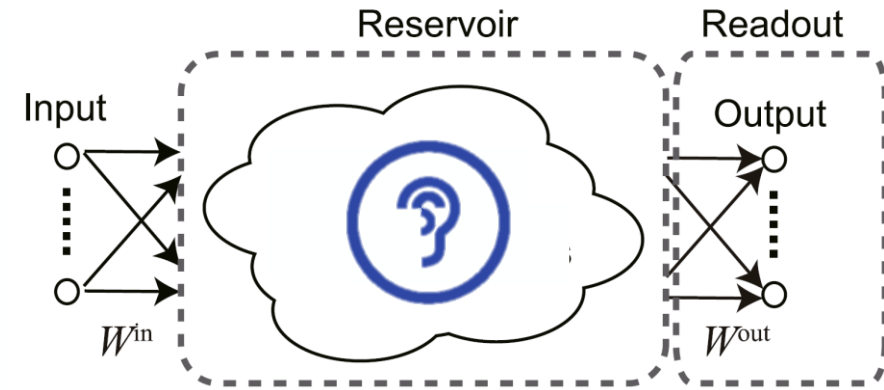
Conventional



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Physical

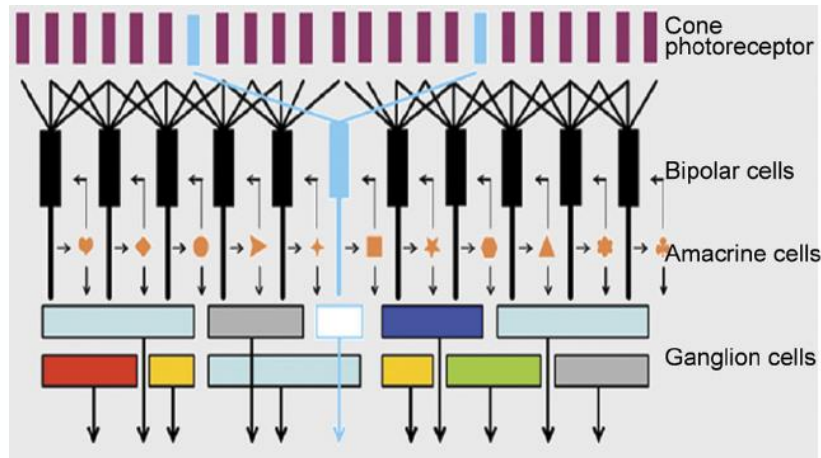
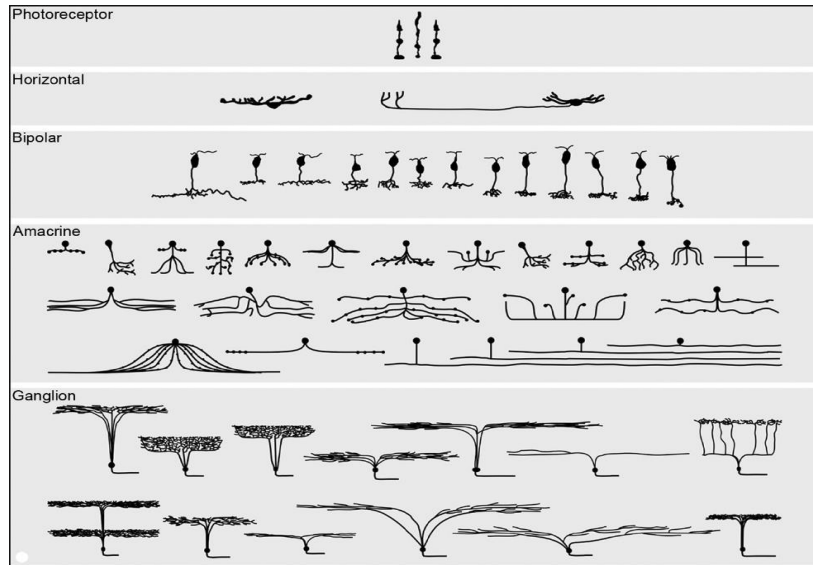


The auditory system:

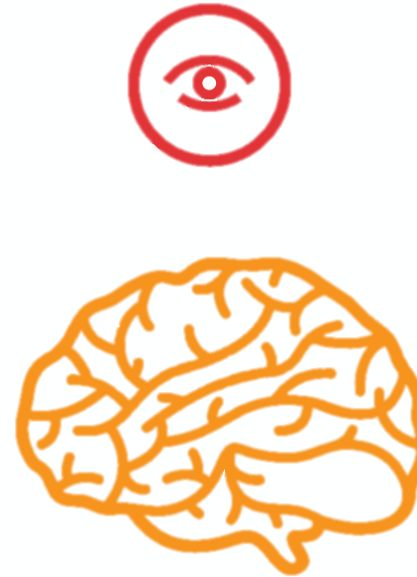
- High dimensionality ✓
- Nonlinearity ✓
- Fading memory ✓

Reservoir with tonotopic order and active nodes

The visual system: understanding the structure



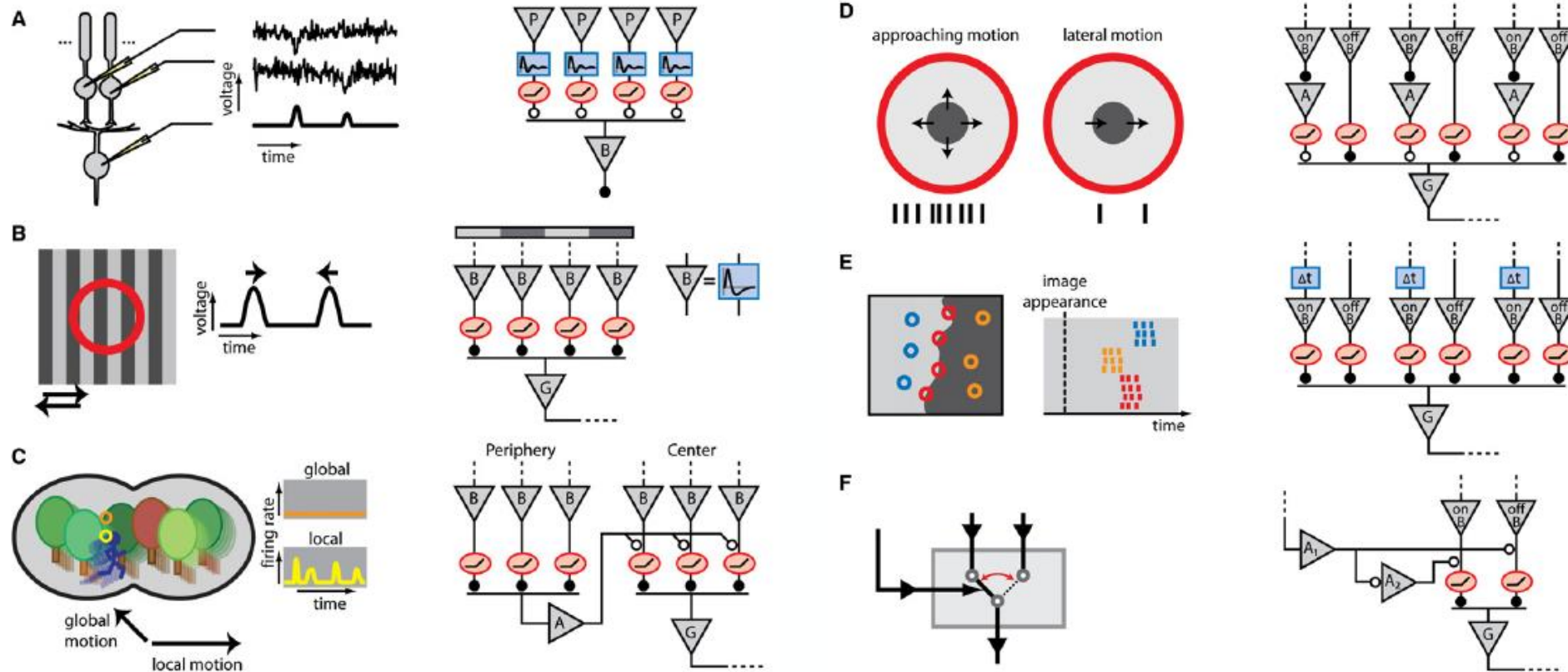
Masland (2011) *Cell populations of the Retina*



The visual system:

- Photons are sensed and converted into electrical signals
- There is a clear hierarchy
- The principles are simple yet surprisingly effective

The visual system: understanding the functionality



Gollisch & Meister 2010 Eye smarter than scientists believed

The visual system: modelling

