Minimizing the Impact of Information Latency via "Outformation"

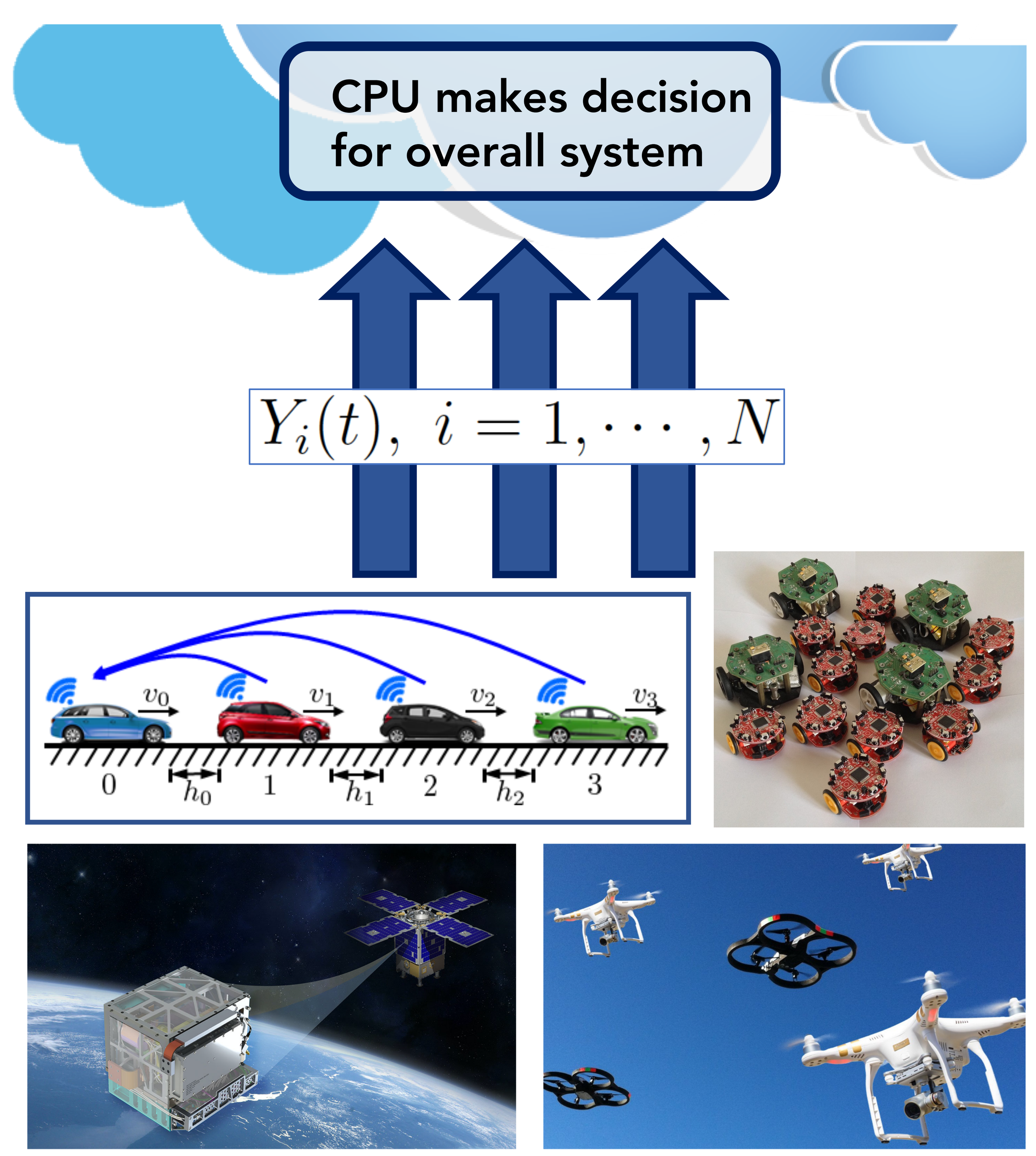
INformation Approach:

Problem Setting

CPU estimates process state $X(t)$ as $\hat{X}_{\mathrm{CPU}}(t)$

Sensor i observes $Y_i(t) = h_i(X(t))$

Robotic examples: sensor fusion, connected vehicles, collaborative tasks (e.g., CubeSAT, disaster response-and-relief)

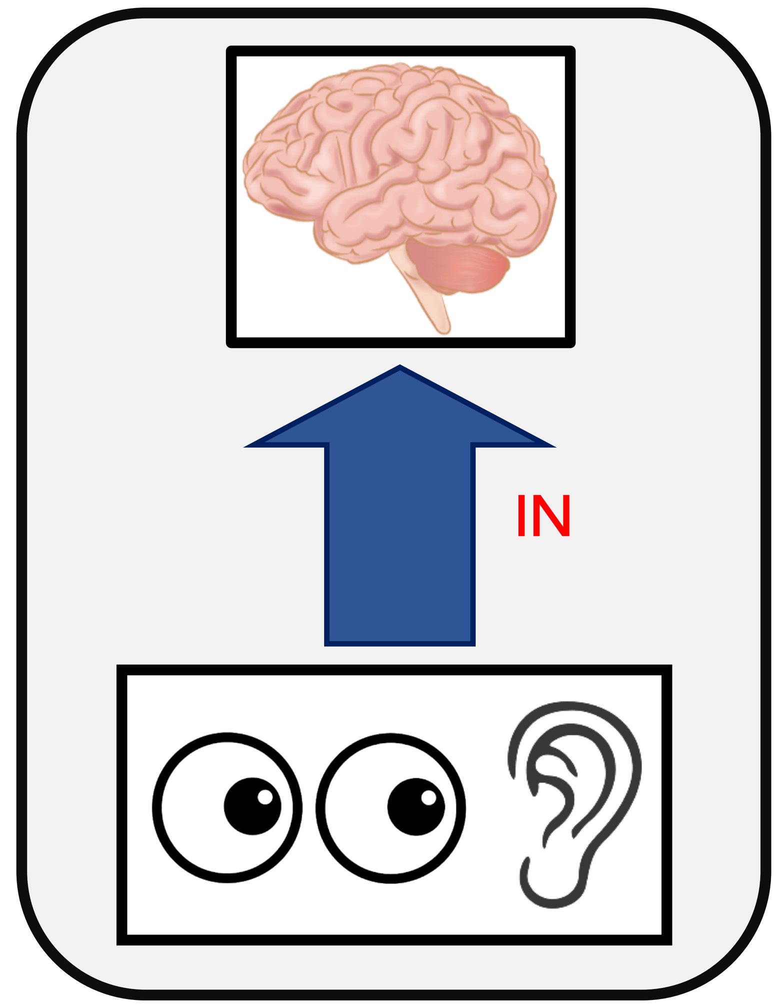


External sensors transmit observations to CPU

However…

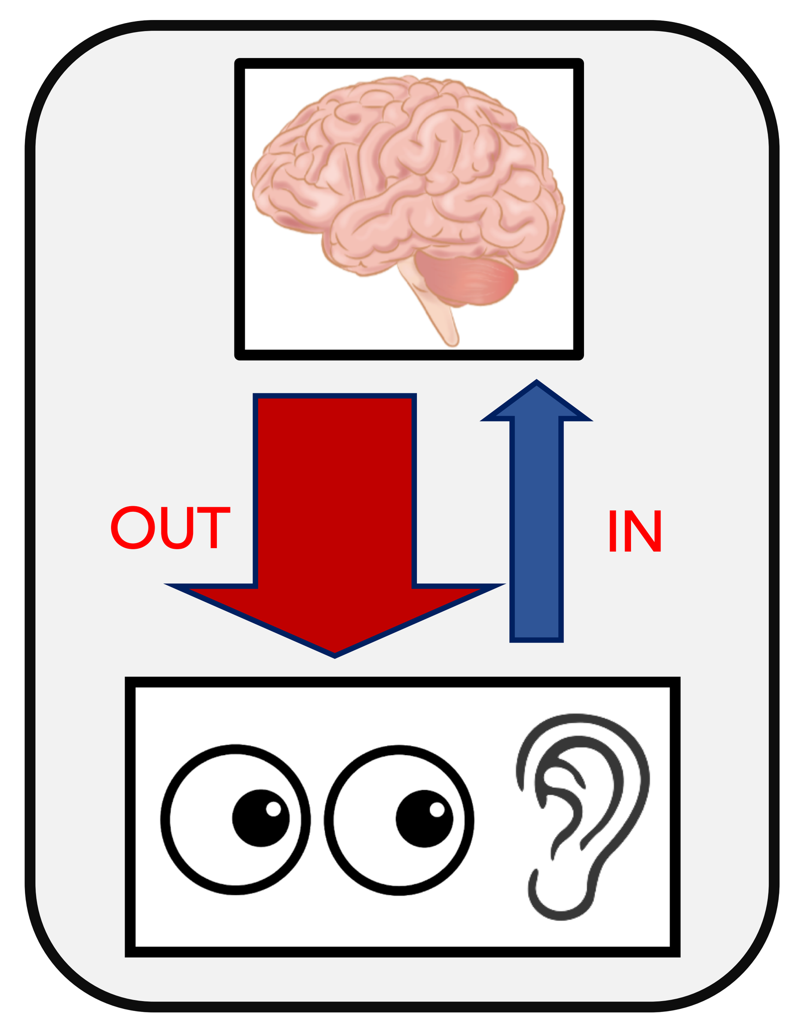
- High bandwidth → slow & expensive with large N.
- Redundant information across sensors.

OUTformation in the Brain:



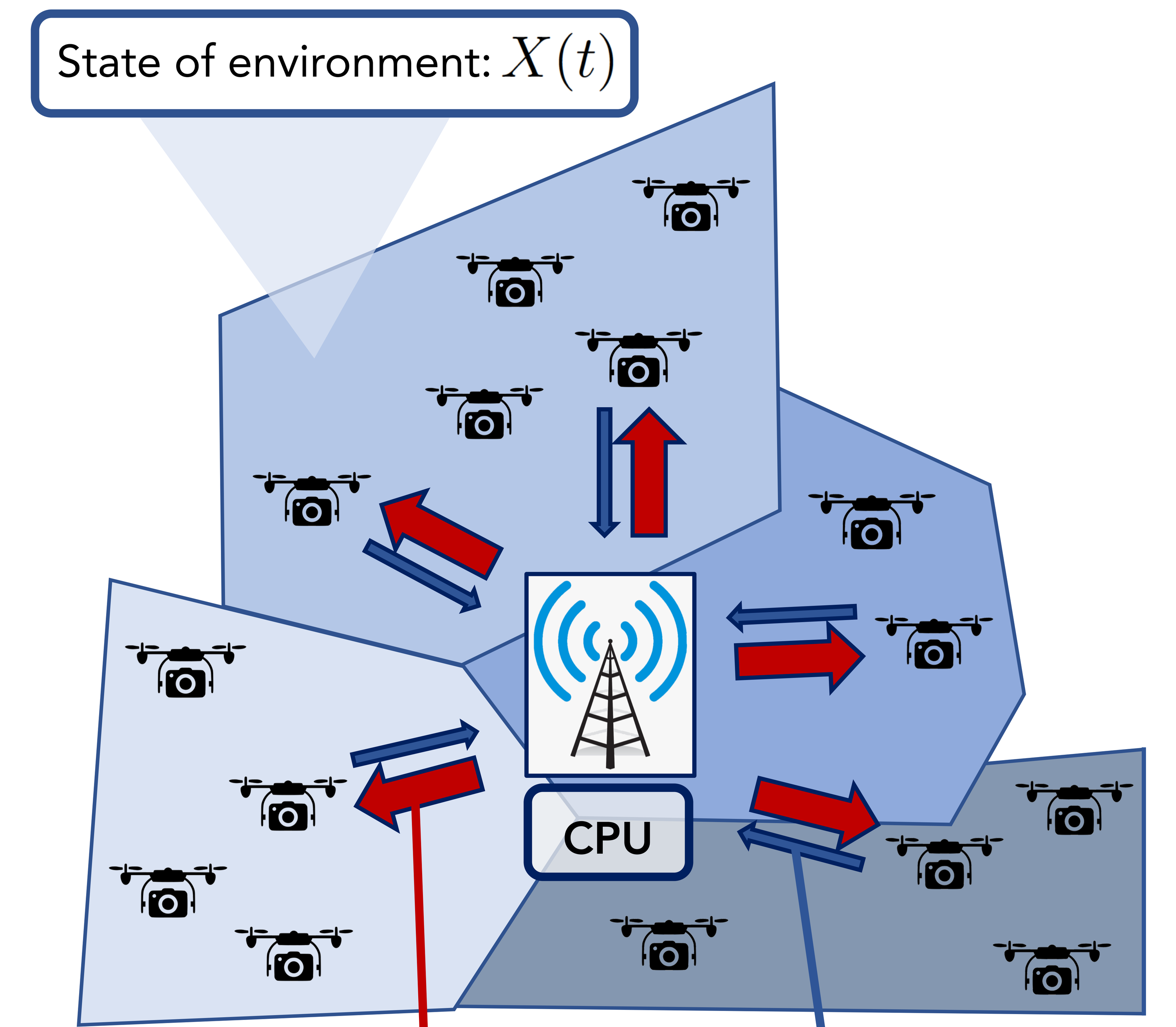
Conventional wisdom: information flows "IN" from eyes (sensors) to the central processor (brain)

TURNS OUT: *The percentage of feedback synapses in thalamic relay neurons are* ***much larger*** *than the feedforward ones.*



- *What advantages does OUTformation have for the brain?*
- *What does the OUTformation flow carry?*

OUTformation for Robotic Systems:



CPU broadcasts prediction $\tilde{X}_{\mathrm{CPU}}(t)$

Sensor transmits instead $Y_i(t) - \mathbb{E}[Y_i(t)|\tilde{X}_{\mathrm{CPU}}(t)]$

CPU updates prediction $\tilde{X}_{\mathrm{CPU}}(t)$ → new estimate $\hat{X}_{\mathrm{CPU}}(t)$

Goal: Use OUTformation Approach to *minimize latency* while maintaining same (or better) performance than INformation Approach.

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