On attempting to reify a few of the things we may mean by "consciousness" with code

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Why attempt to reify philosophy with code

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  - Mind, awareness, imagination, reasoning, consciousness, etc.

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- Possibly benefit philosophy by bringing code-style concreteness
  - (TBD, will let the philosophers in the room speak to this!)

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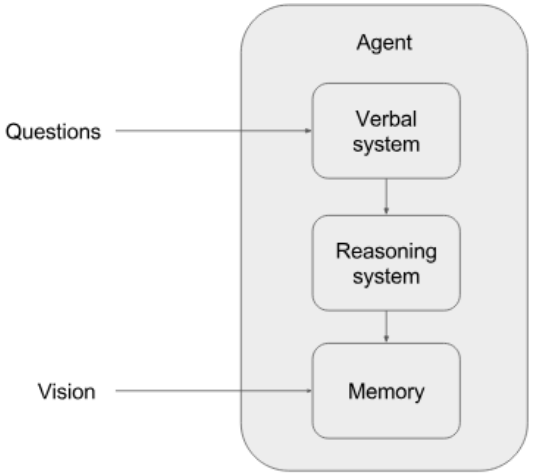
Reifying philosophy with code

- Muehlhauser, Shlegeris: A Software Agent Illustrating Some Features of an Illusionist Account of Consciousness
- An agent that observes the world and uses a theorem prover to answer questions asked of it




```
Q: What's 2 + 2?
4

Q: Suppose there are two agents Bob and Jane, do they have the same qualia associated with every color?
Both that statement and its negation are possible.

Q: For all y, does there exist an x such that x = y + 1?
Yes.

Q: For all two agents, do they see colors the same?
Both that statement and its negation are possible.

Q: Are your memories at timestep 0 and 1 of the same color?
Yes.

Q: Are you seeing the same color now as you saw at timestep 0?
No.

Q: Is it possible for an agent to have an illusion of red?
Yes.

Q: Is it possible for you to have the illusion that Buck is experiencing a color?
Yes.

Q: Is it possible for Buck to have an illusion that he is having the experience of redness?
No, that's impossible.
```

Image from shlegris.com

Dialog from https://github.com/bshlgrs/consciousness/blob/master/README.md

Reifying philosophy with code

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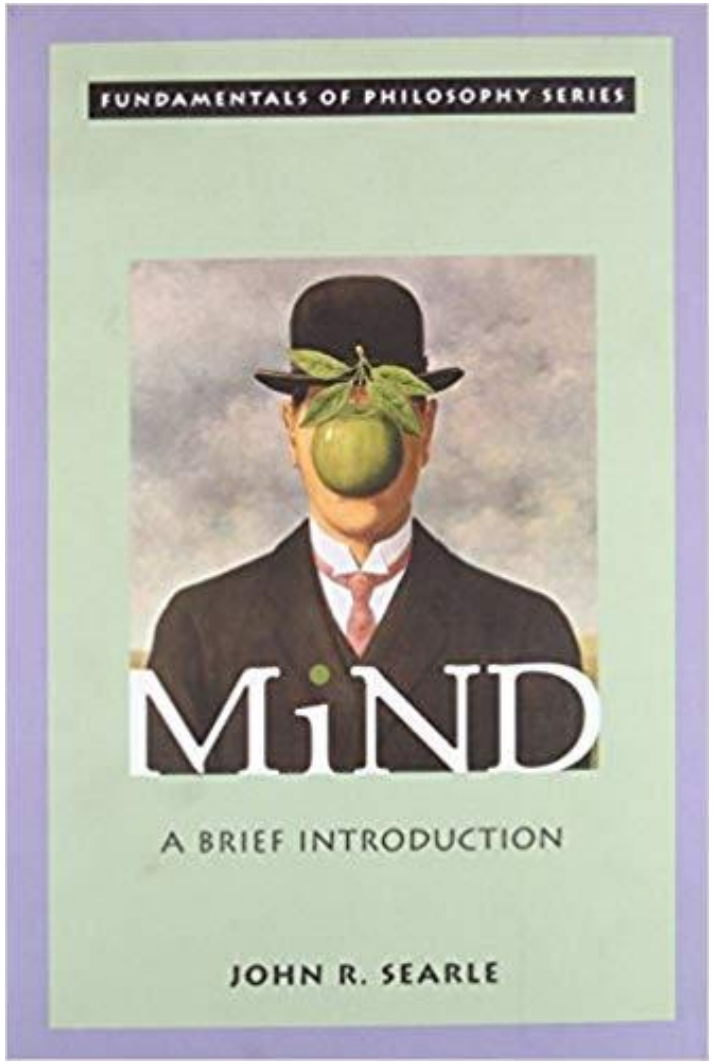

Reifying philosophy with code

- Searle's view of the relationship between consciousness and brain states

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    - ...what does that mean?
- Generally is some confusion
  - Enough disagreement that Searle wrote the paper: "Why I'm Not a Property Dualist"
- Let's unpack this with code!

What we're not doing

- Not trying to propose a cognitive architecture
- Not trying to propose a new AI or machine learning algorithm
- Not trying to claim that the software agent is conscious
- Not trying to convince anyone these are the correct/best/most useful definitions of consciousness or brain states
- Not trying to convince anyone Searle is right or wrong

What we're trying to do

- Trying to create a software agent that is consistent with Searle’s view on consciousness
  - (or at least a simplified version of Searle’s view)

What we're trying to do

- Trying to create a software agent that is consistent with Searle’s view on consciousness
  - (or at least a simplified version of Searle’s view)
- (Hopefully) gain a bit deeper understanding of what we may mean by consciousness, brain states, causal reduction, and ontological reduction along the way

Software Engineering, 101

- Requirements – what must the agent do
- Design – how will we build an agent to meet the requirements
- Implementation – the built agent consistent with the design

Agent requirements: unpacking Searle's view

- Consciousness is causally reducible to brain states
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  - Third person, objective

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  - First person, subjective
- Conscious mental state
  - A mental state in which it is "something it's like to be in"
  - First person, subjective character of experience, phenomenal

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Ontologies in Computer Science

- Class-instance distinction

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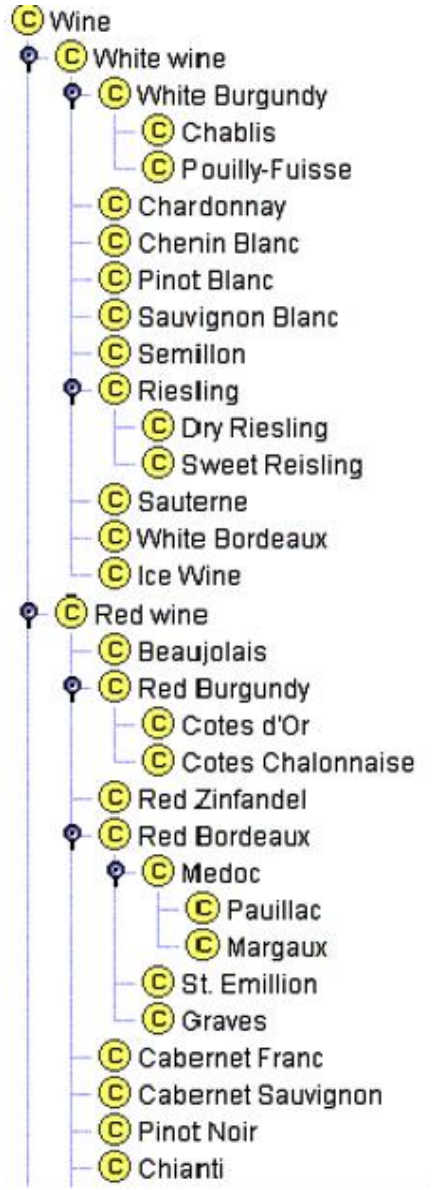

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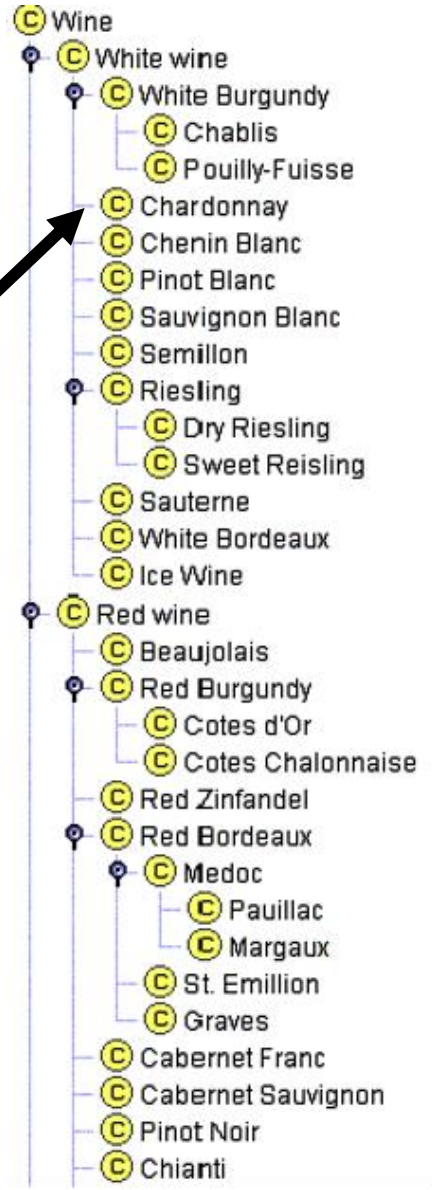

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Ontologies in Computer Science

- Class-instance distinction

- Wine
  - White wine
  - Rose wine
  - Red wine
  - White Burgundy
  - Chenin Blanc
  - Chardonnay
  - Pinot Blanc
  - Sauvignon Blanc
  - Ice Wine
  - White Zinfandel
  - Beaujolais
  - Red Burgundy
  - Red Zinfandel
  - Pauillac
  - Margaux
  - St. Emillion
  - Graves
  - Red Bordeaux
  - Sauterne
  - Cabernet Franc
  - Cabernet Sauvignon
  - Medoc
  - Semillon
  - Pinot Noir
  - Chianti
  - Petite Syrah
  - Sancerre
  - Muscadet
  - Port
  - Sweet Reisling
  - Chablis
  - Dry Riesling

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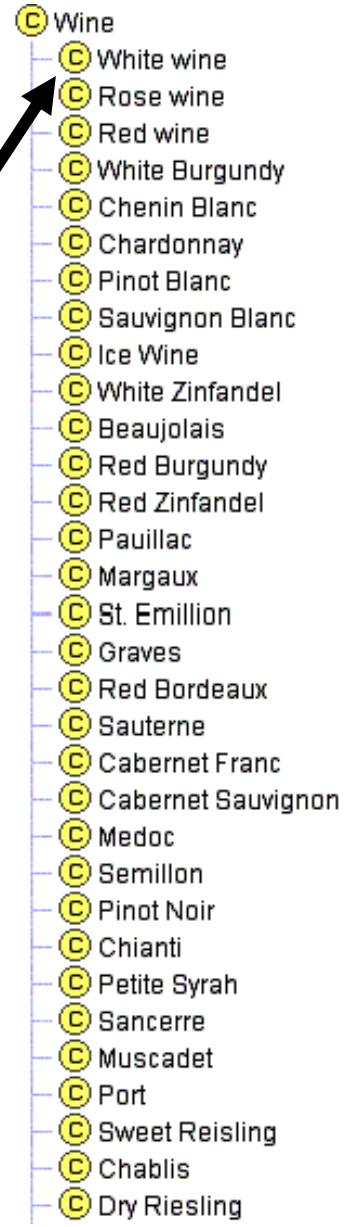

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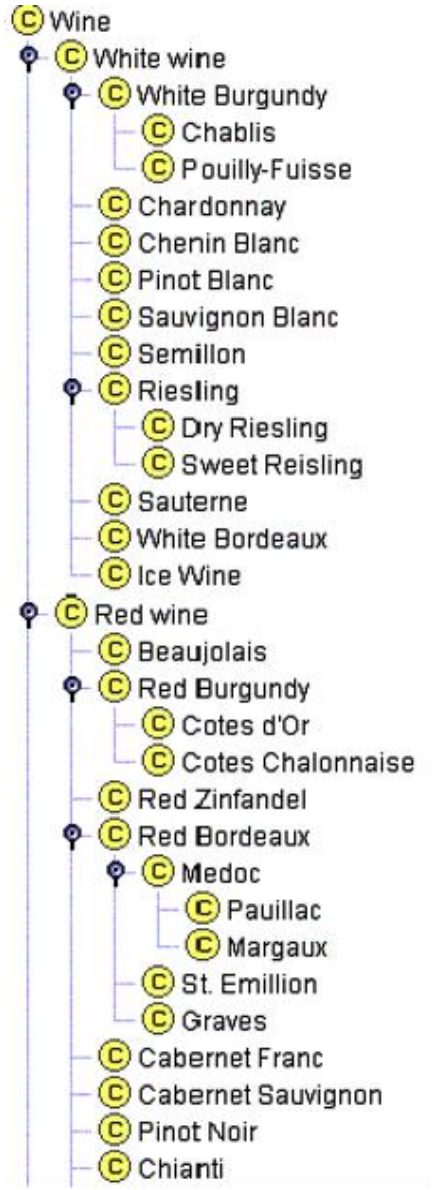
- Type-token distinction



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- Class-instance distinction
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  - "They drive the same car“
    - They drive the same car type
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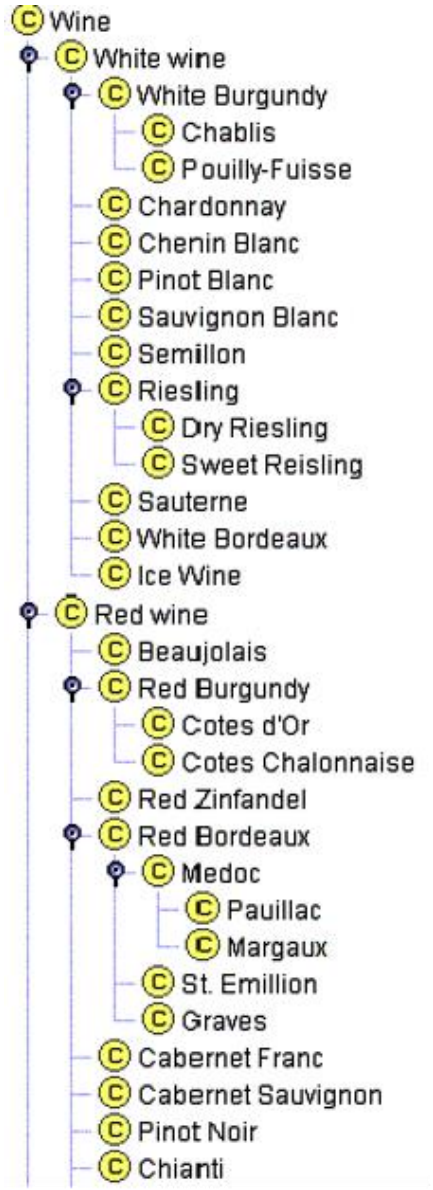
      - (the 2003 Toyota Corolla with VIN: 2QFBORHE4KP911561)



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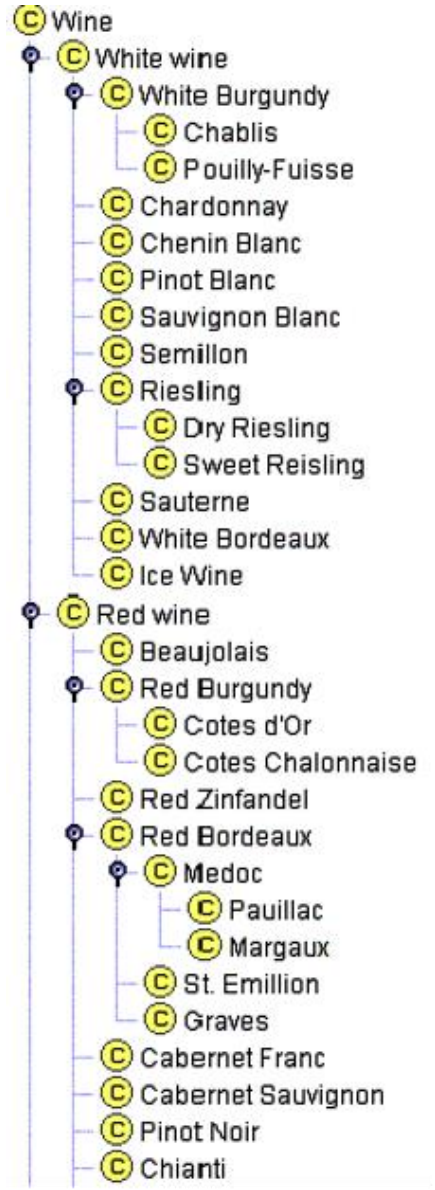

(C) A set of wine bottles

(C) Case of wine

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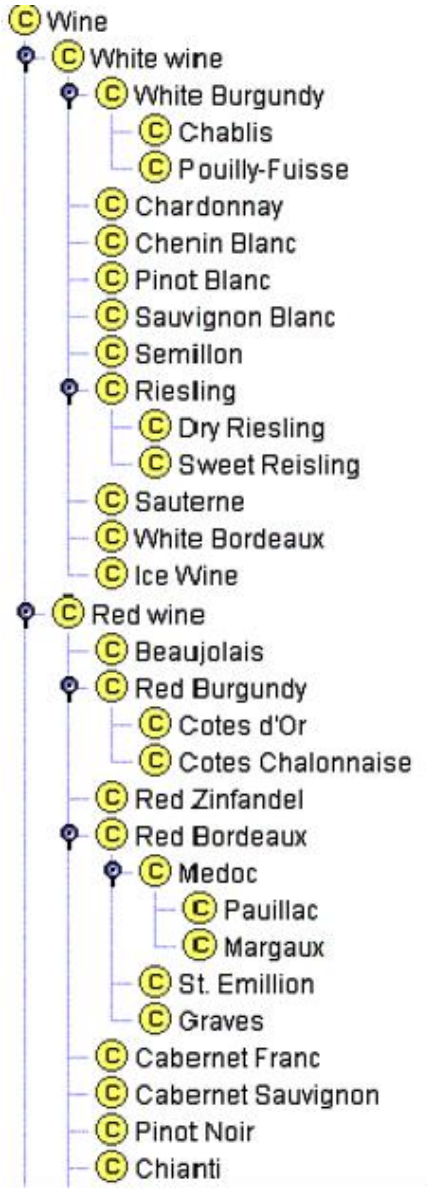

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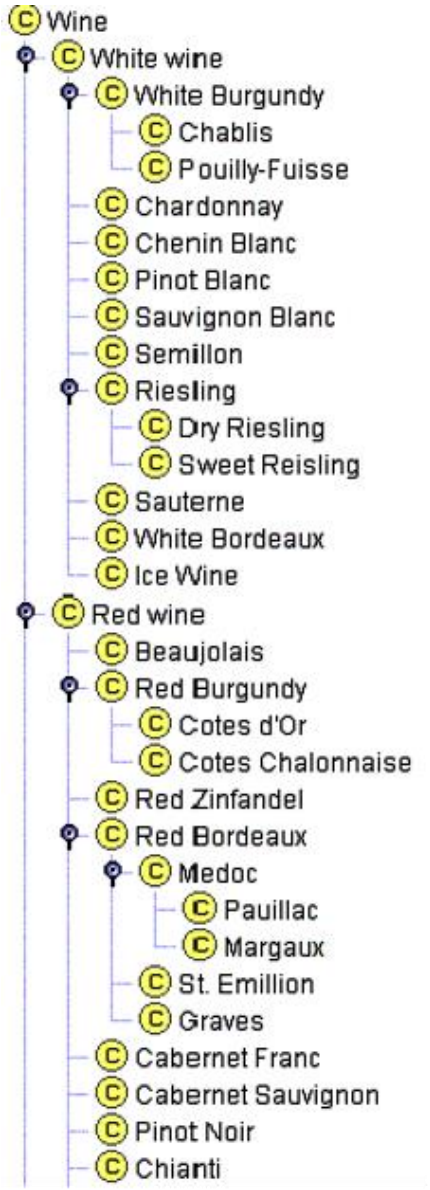

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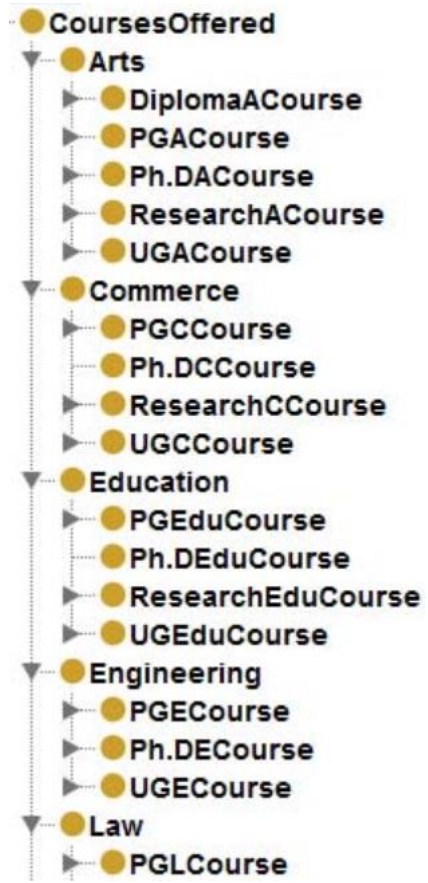

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Agent requirements: unpacking Searle's view

- V0
  - Internal states are casually reducible to brain states
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Phenomena of type A are causally reducible to phenomena of type B if and only if:

- the behavior of A's are entirely casually explained by the behavior of B's
- A's have no causal powers in addition to the powers of B's

Agent requirements, V0

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Design, V0

- Design decisions

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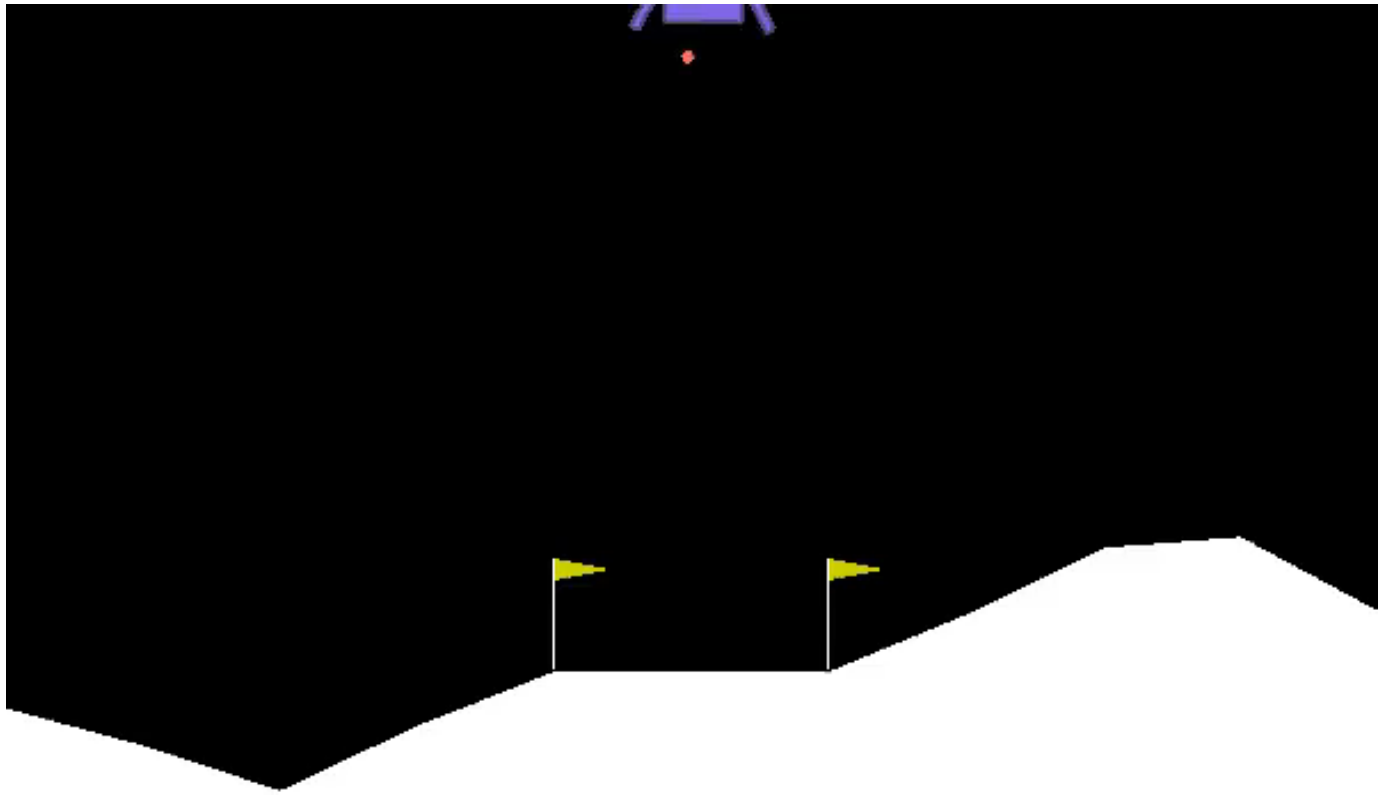
  - Environment and the agent's "physical" form

Design, V0

- OpenAI's LunarLander benchmark environment



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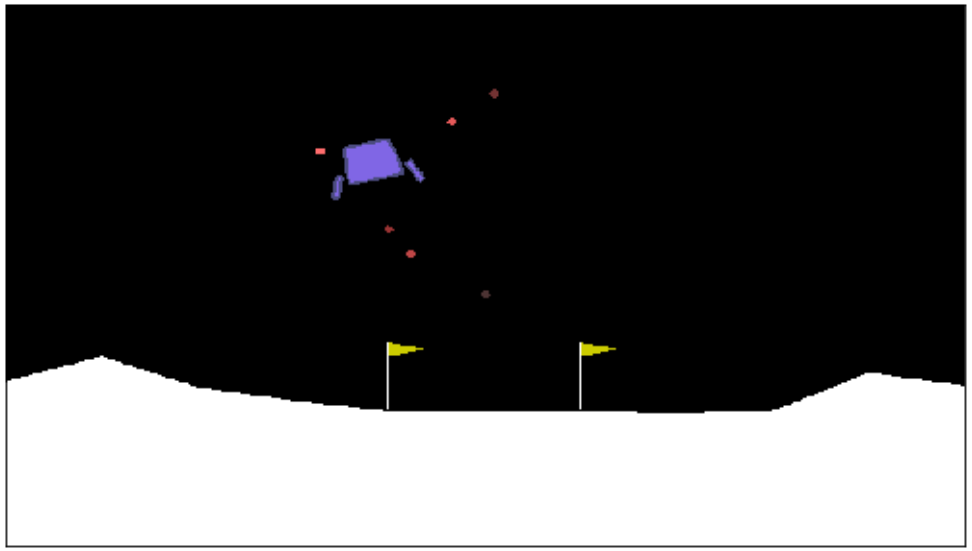

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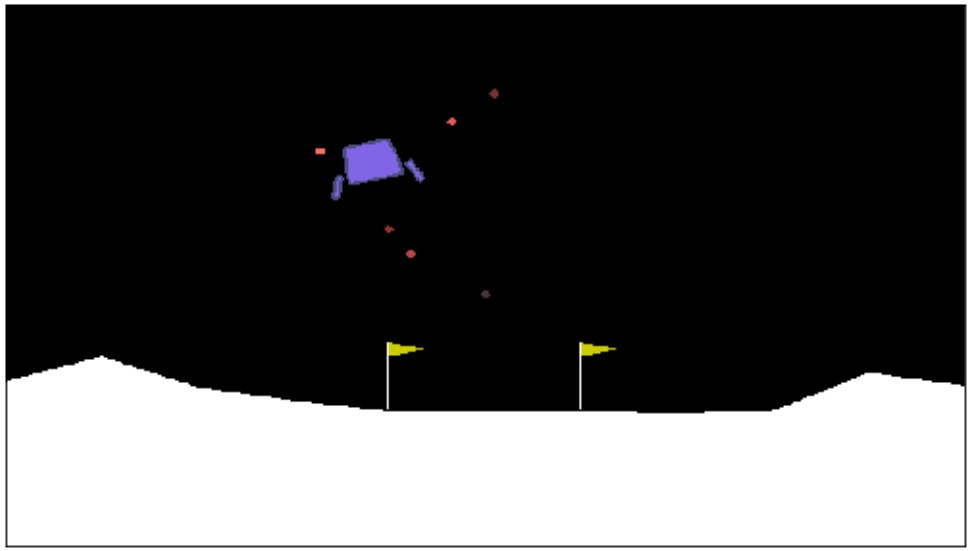

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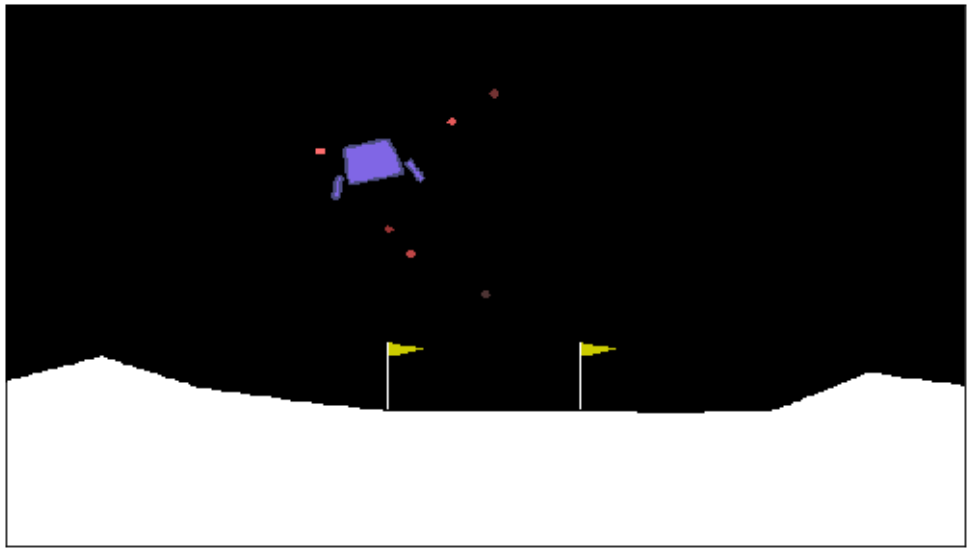

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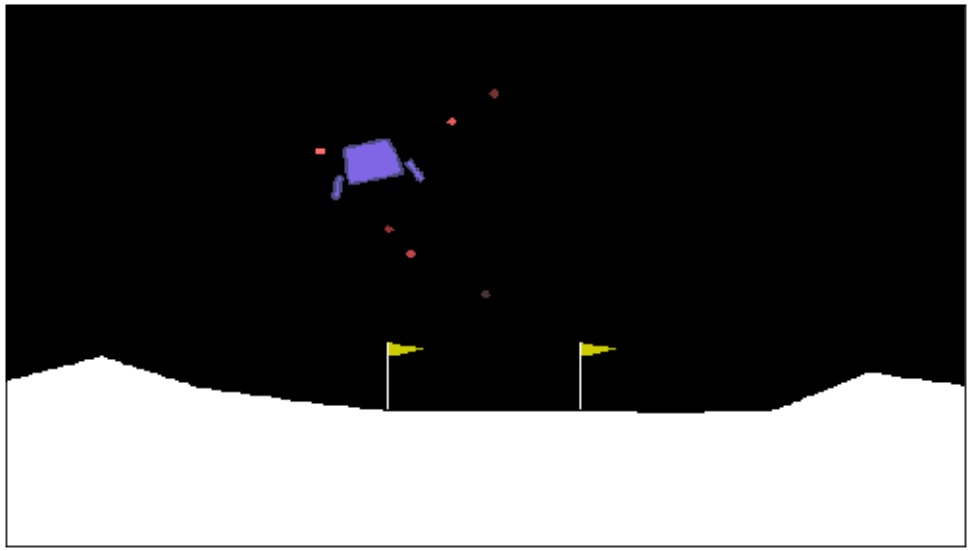

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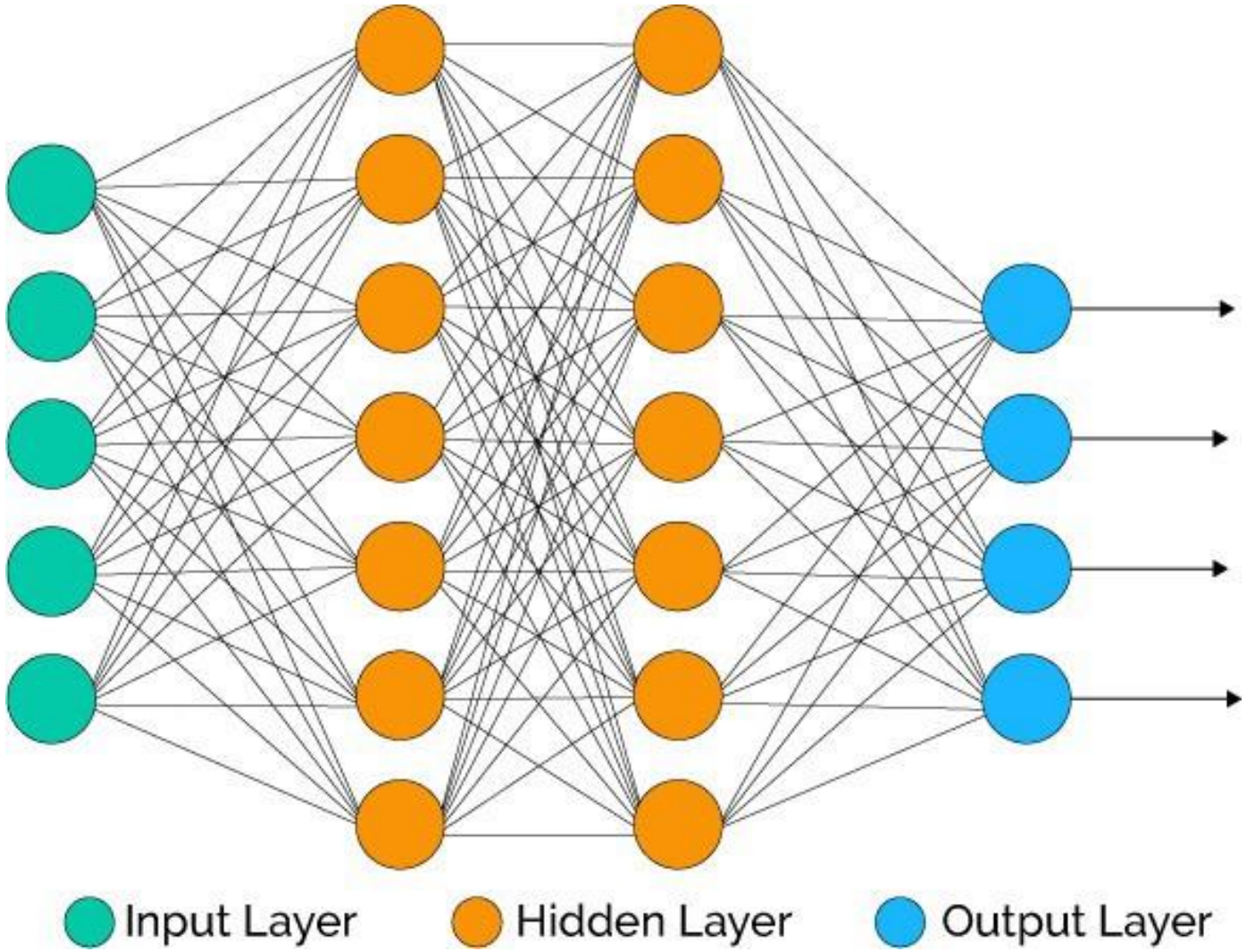
(Artificial) Neural networks



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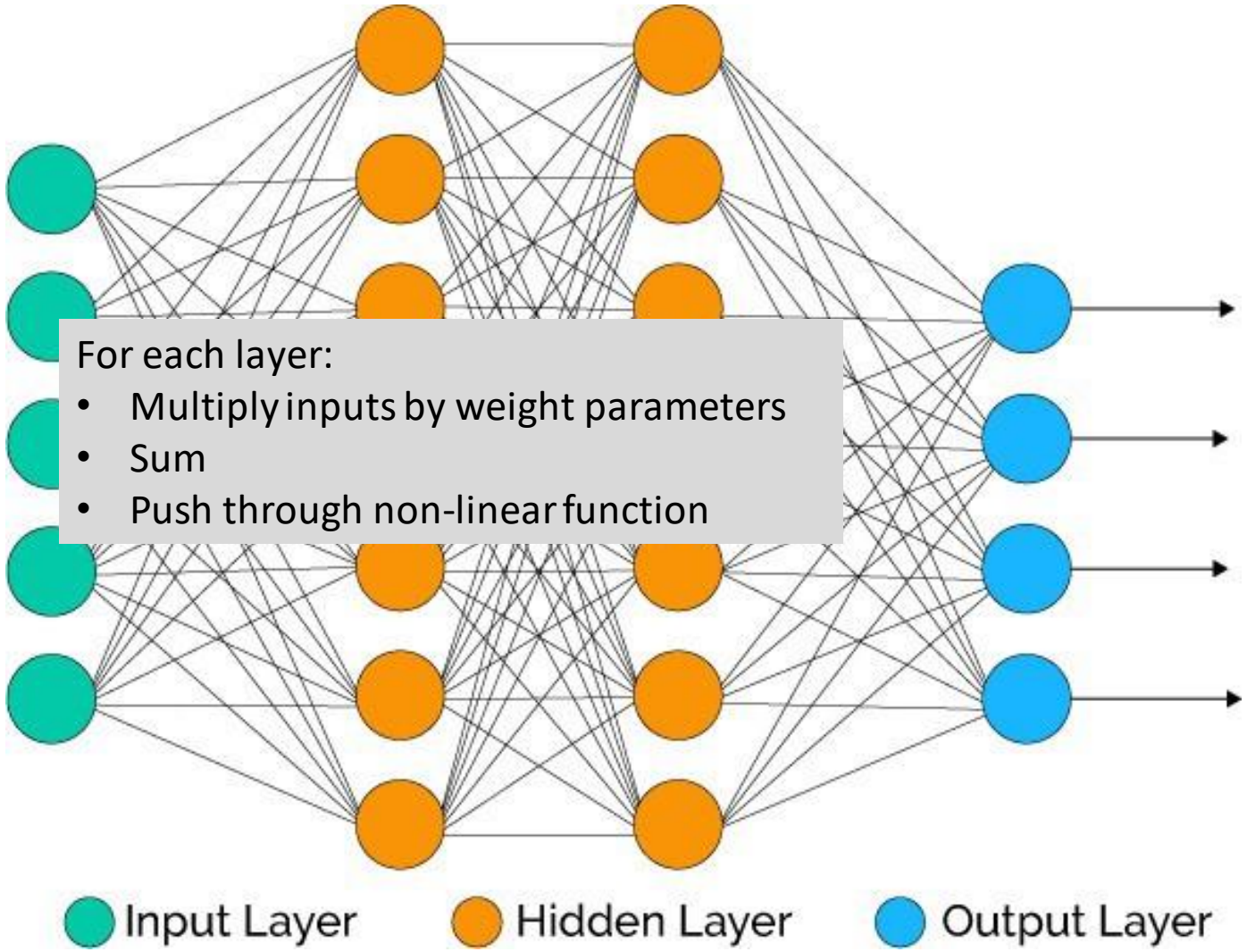

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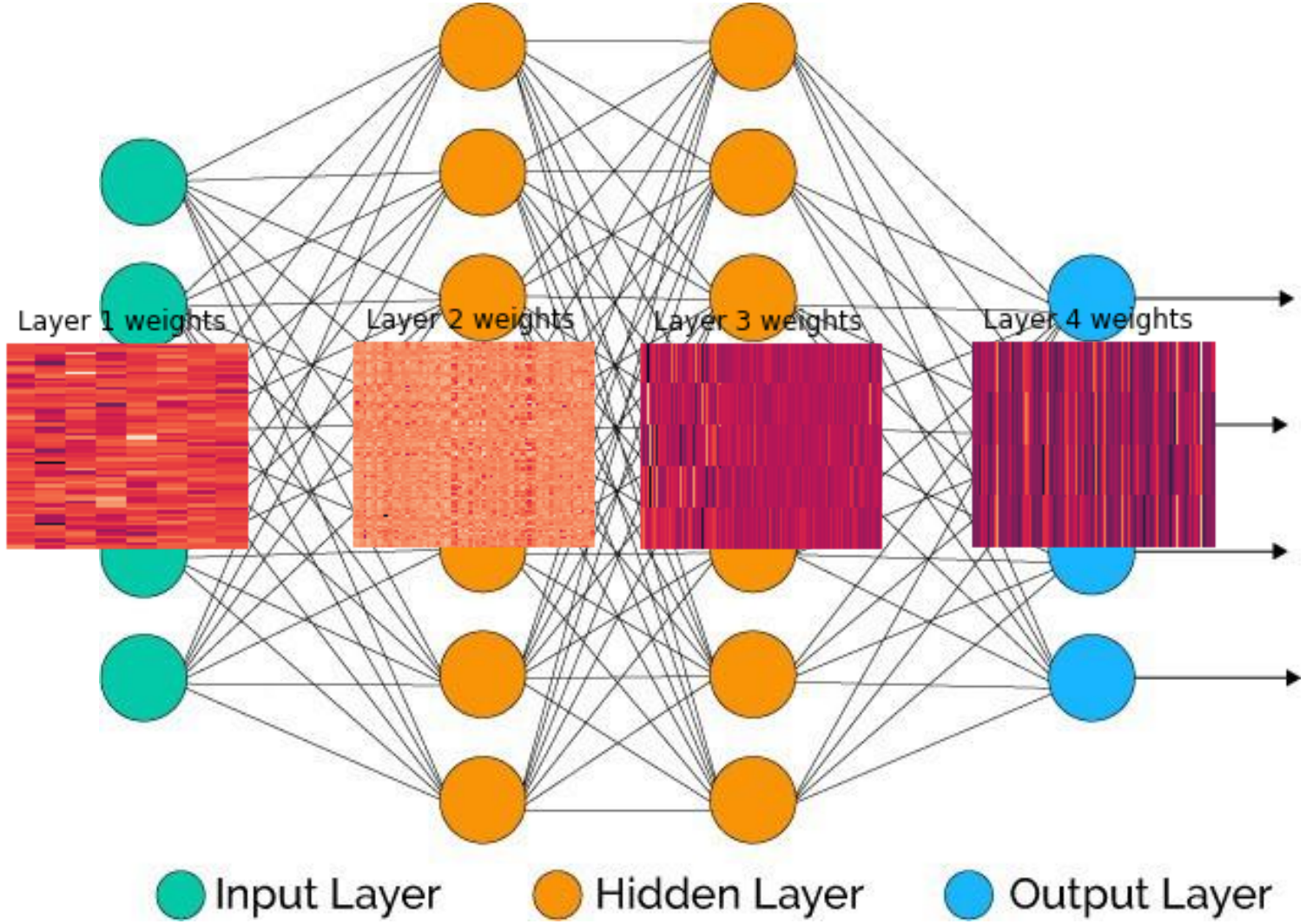

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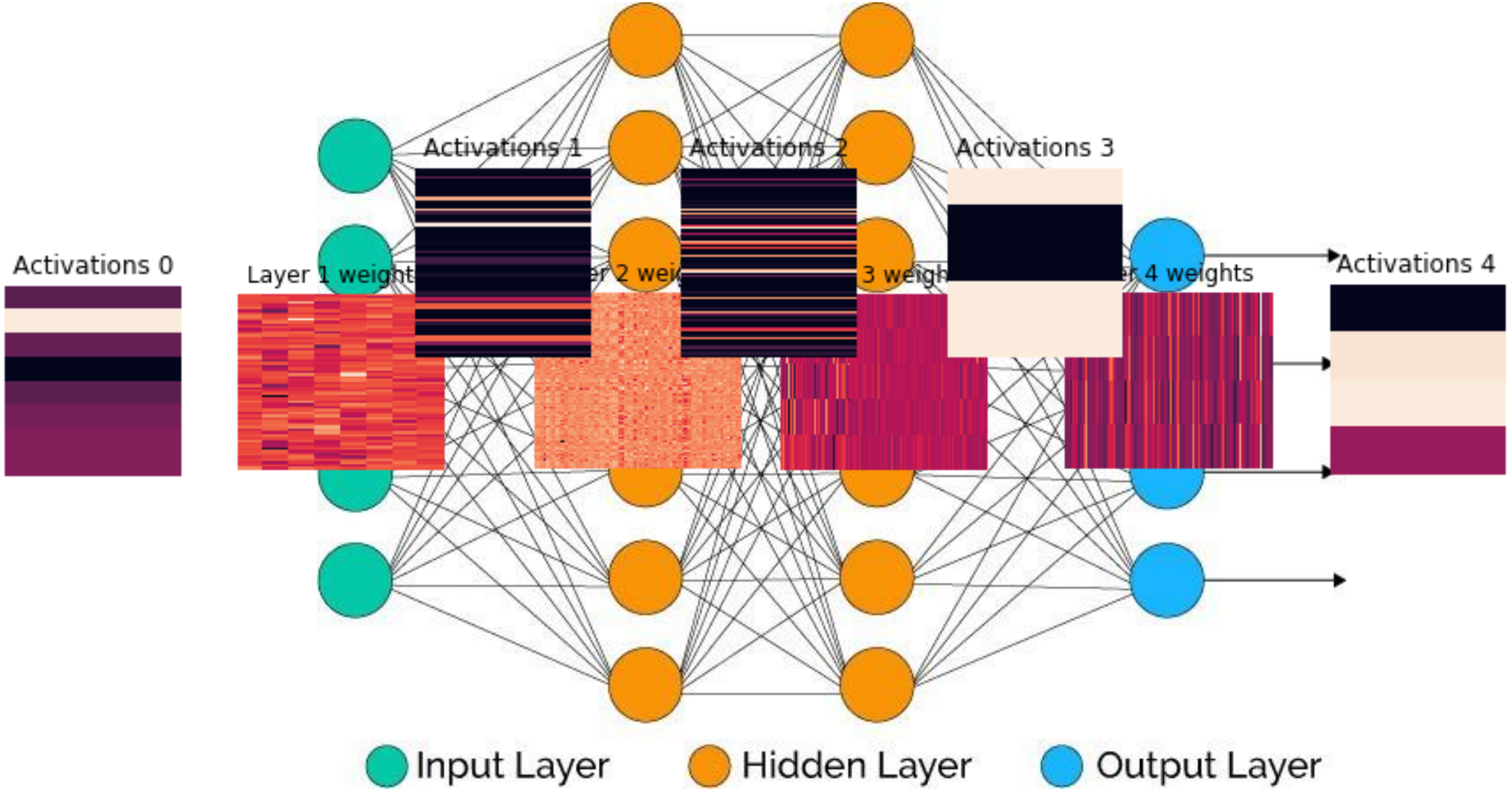

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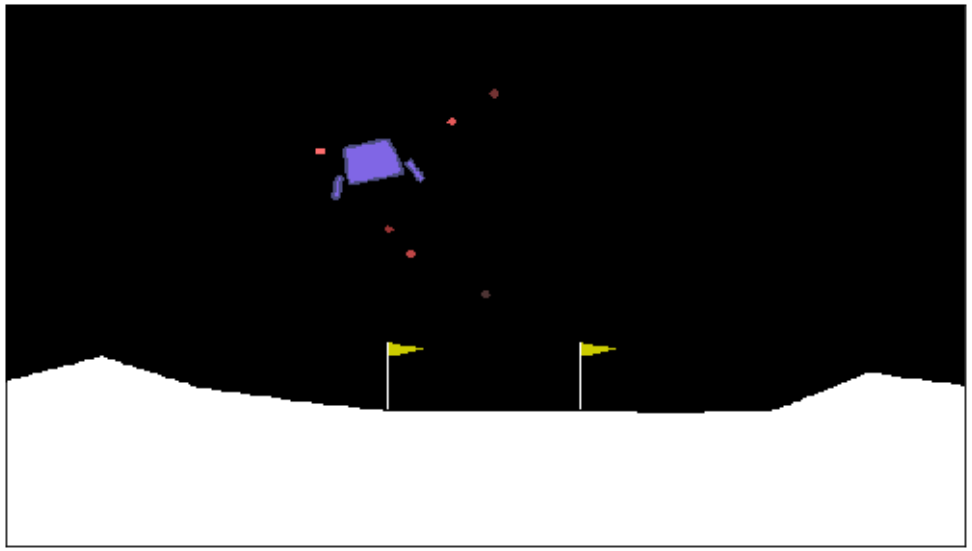

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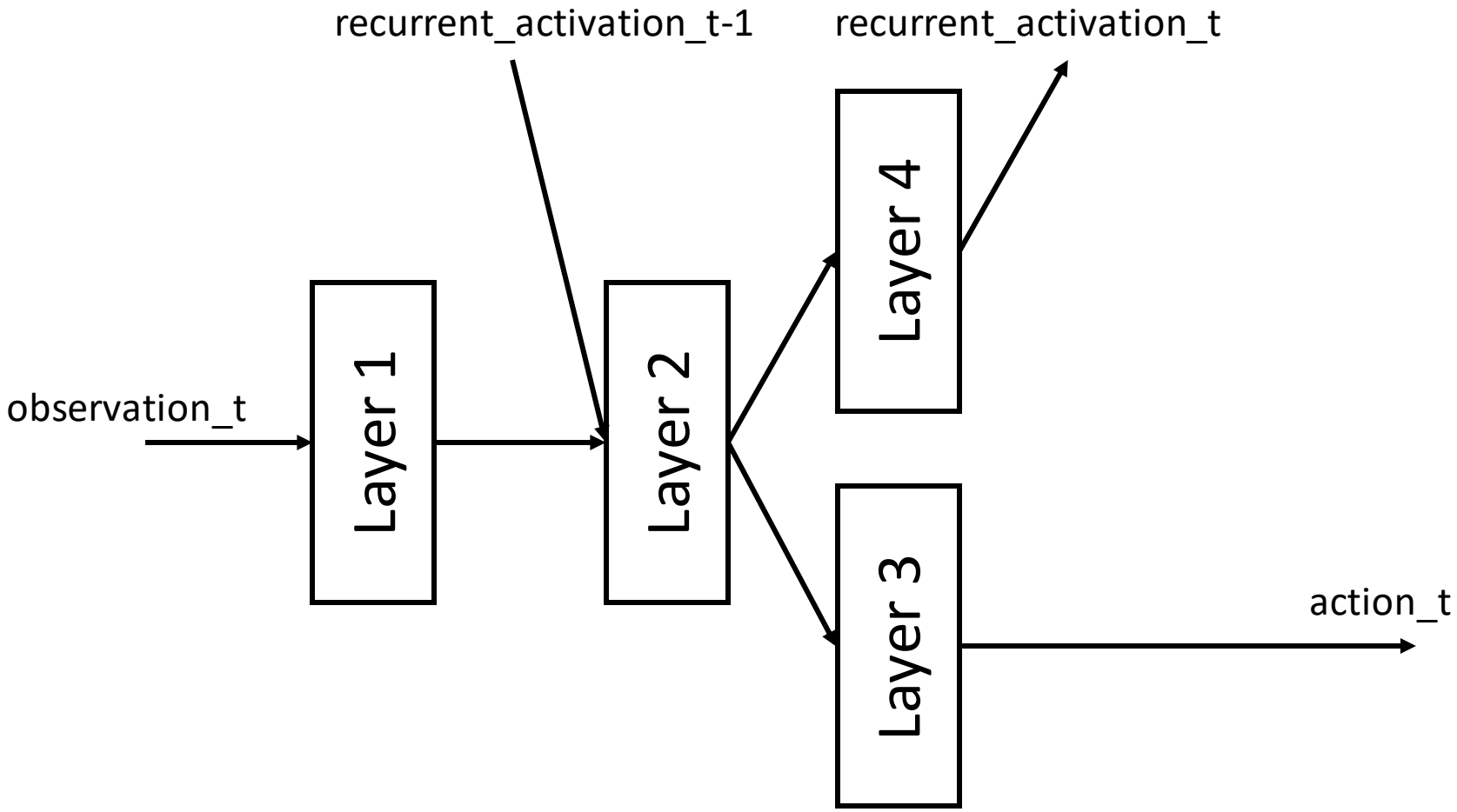
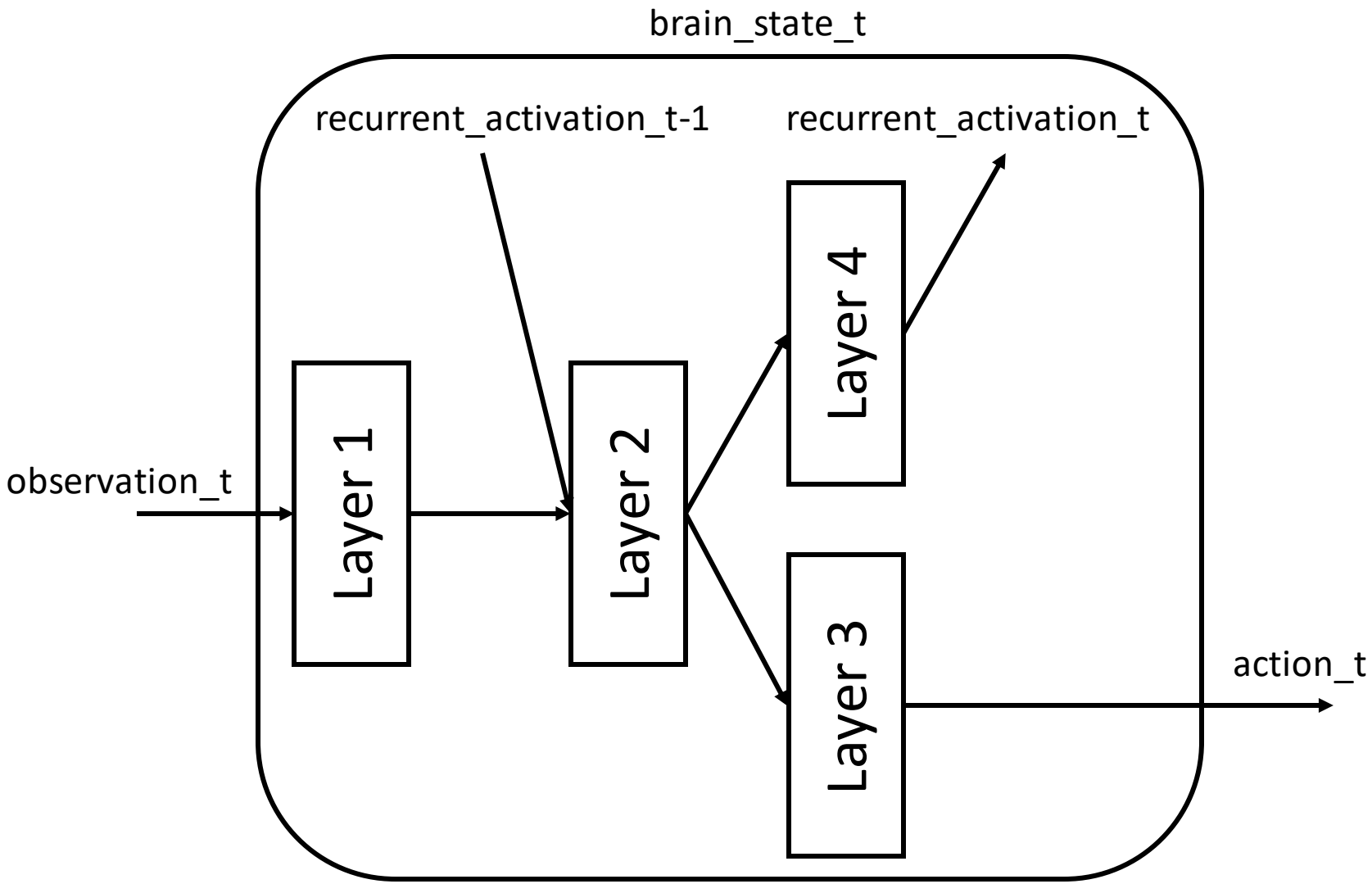
Design, V0


recurrent_activation_t-1
recurrent_activation_t
observation_t
Layer 1
Layer 2
Layer 4
Layer 3
action_t

Design, V0


brain_state_t
recurrent_activation_t-1
recurrent_activation_t
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Layer 1
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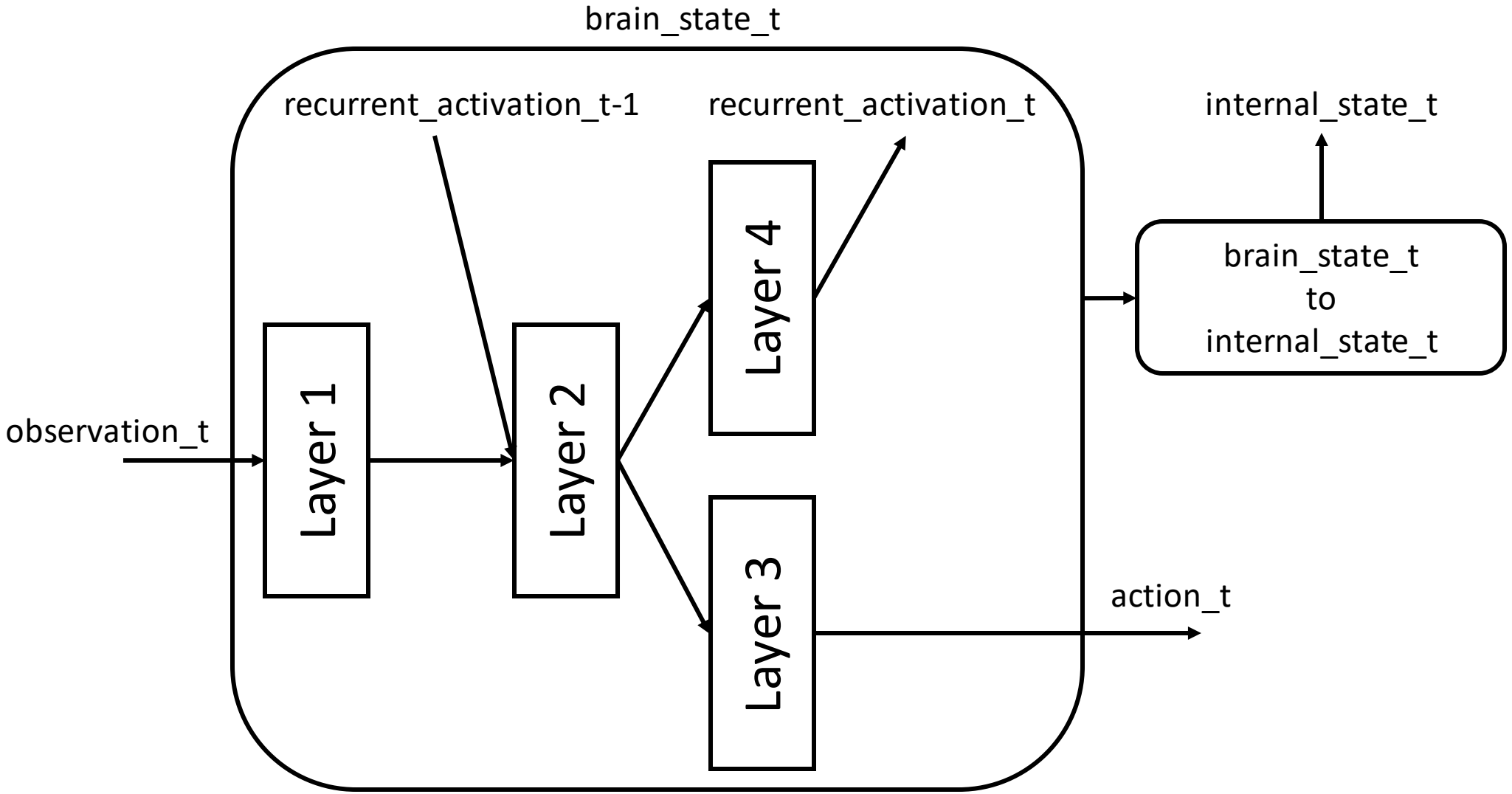
brain_state_t
recurrent_activation_t-1
recurrent_activation_t
internal_state_t
brain_state_t
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internal_state_t
observation_t
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Layer 4
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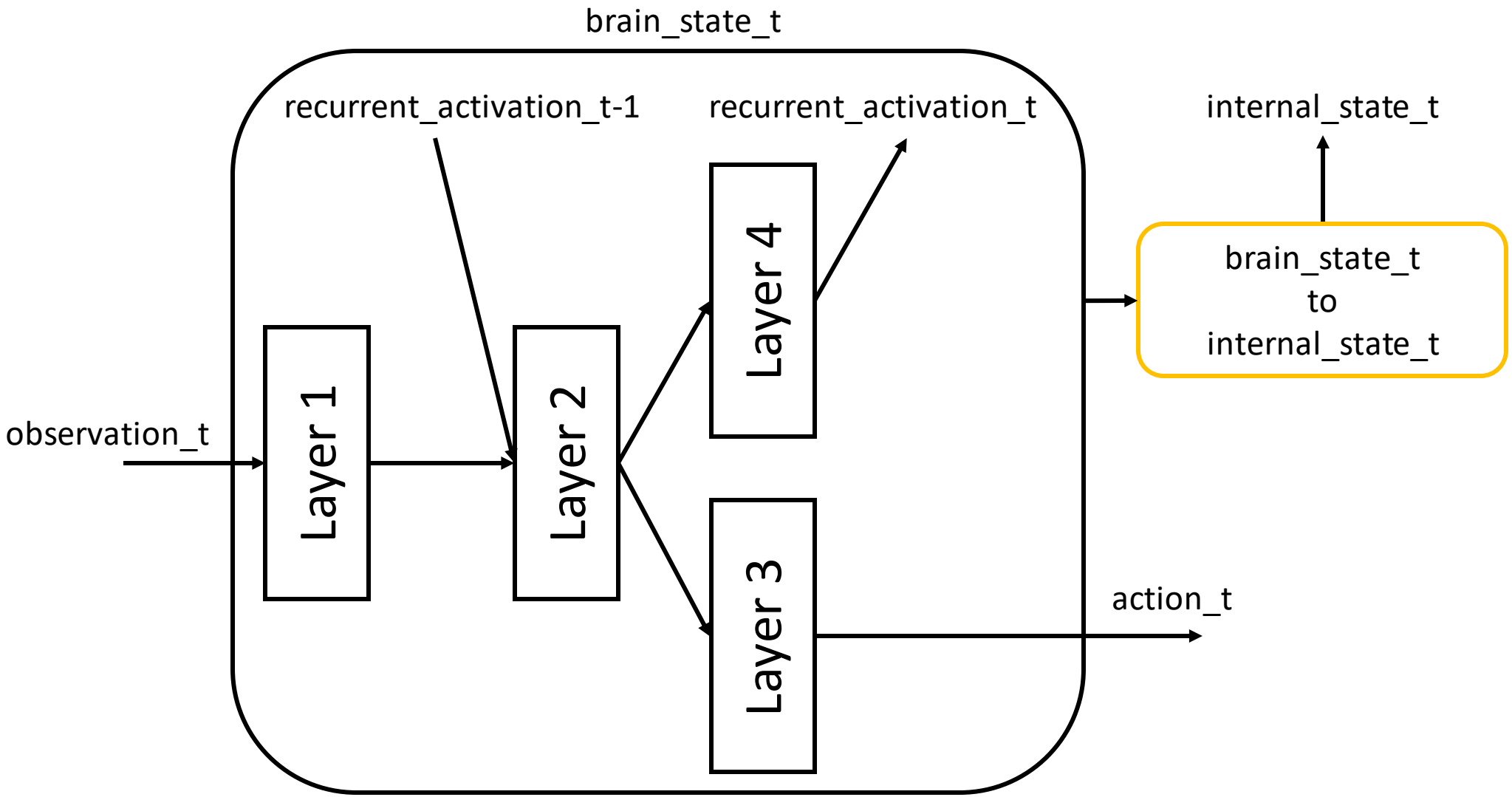
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recurrent_activation_t-1
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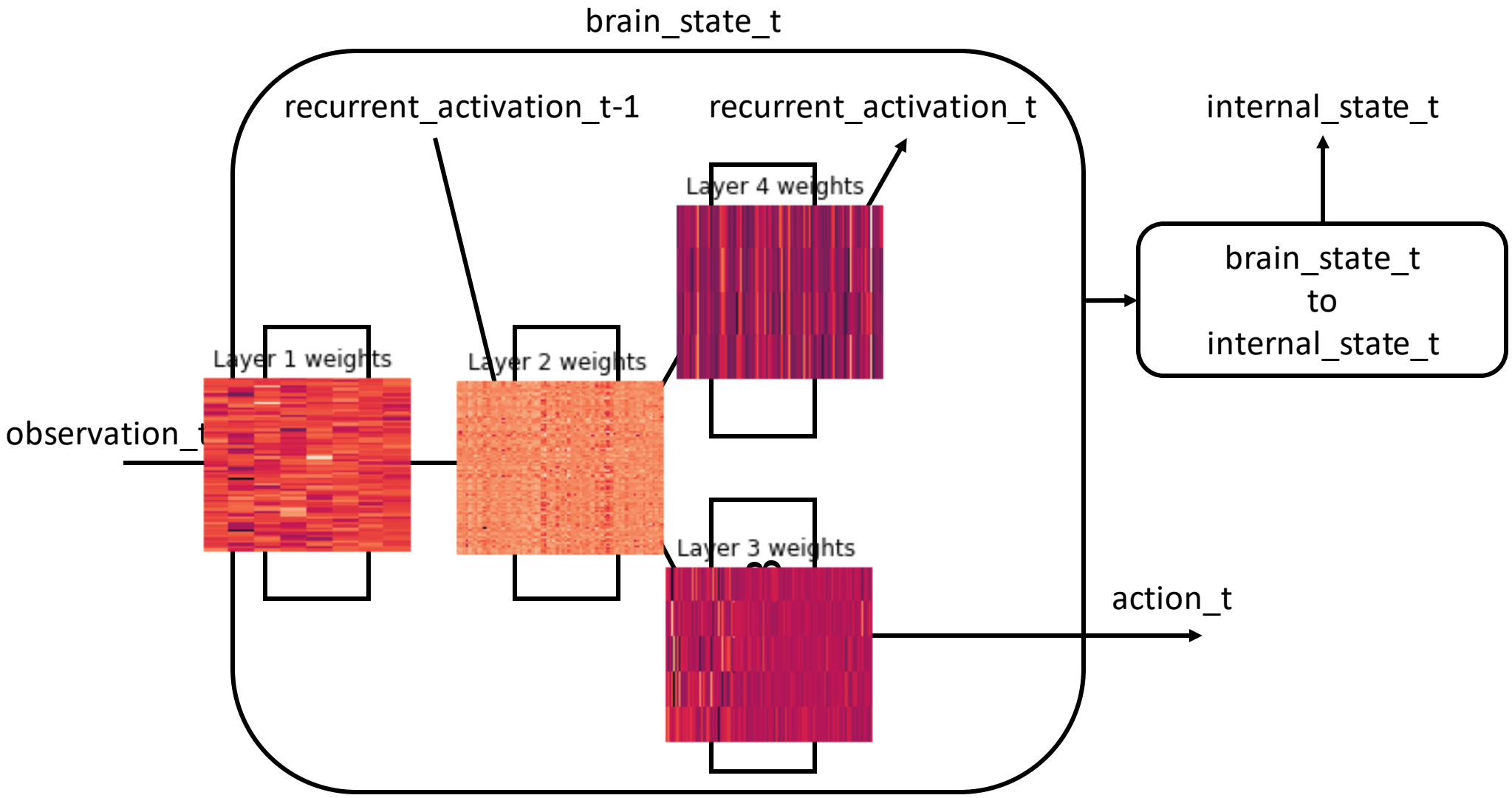
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recurrent_activation_t-1
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internal_state_t
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brain_state_t
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observation_t
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action_t

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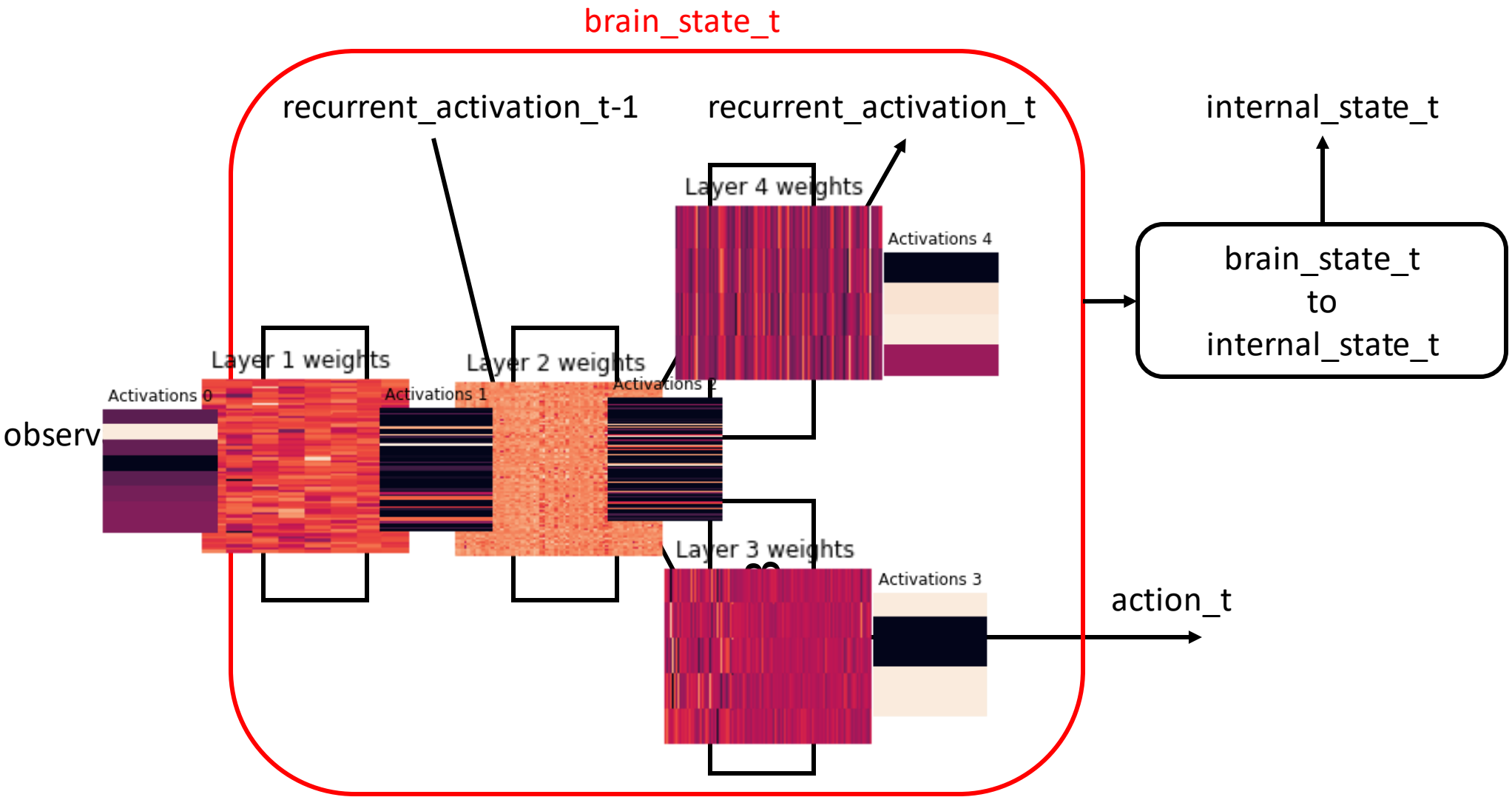
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Activations 0
Activations 1
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Activations 3
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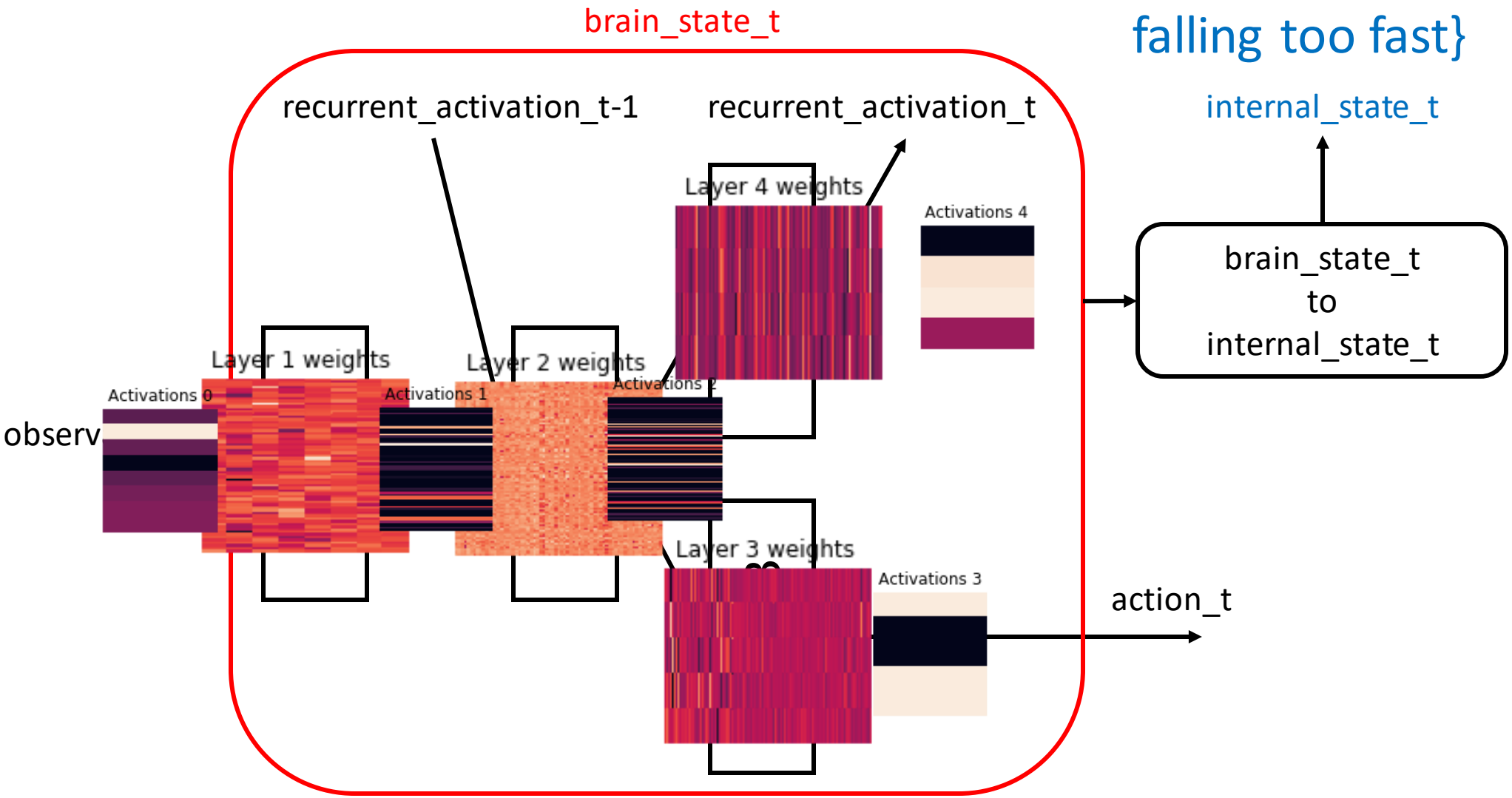

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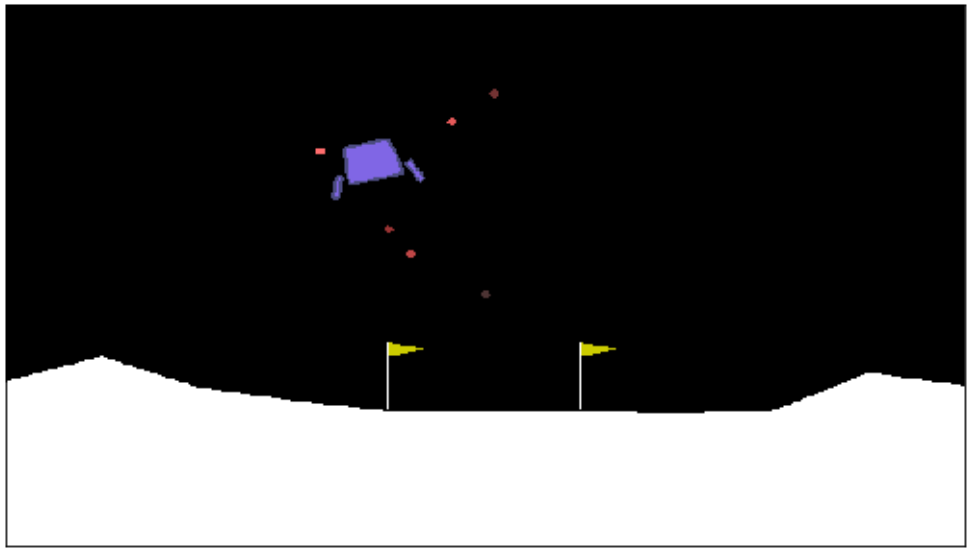

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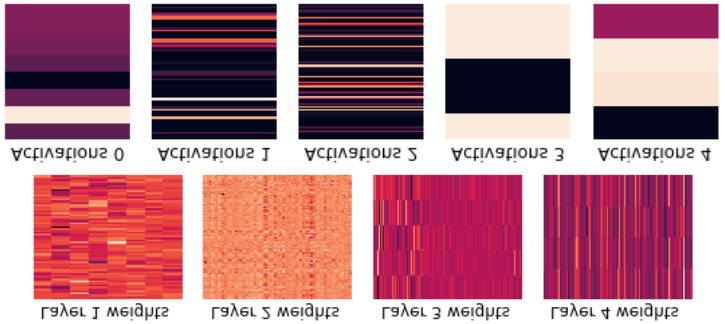

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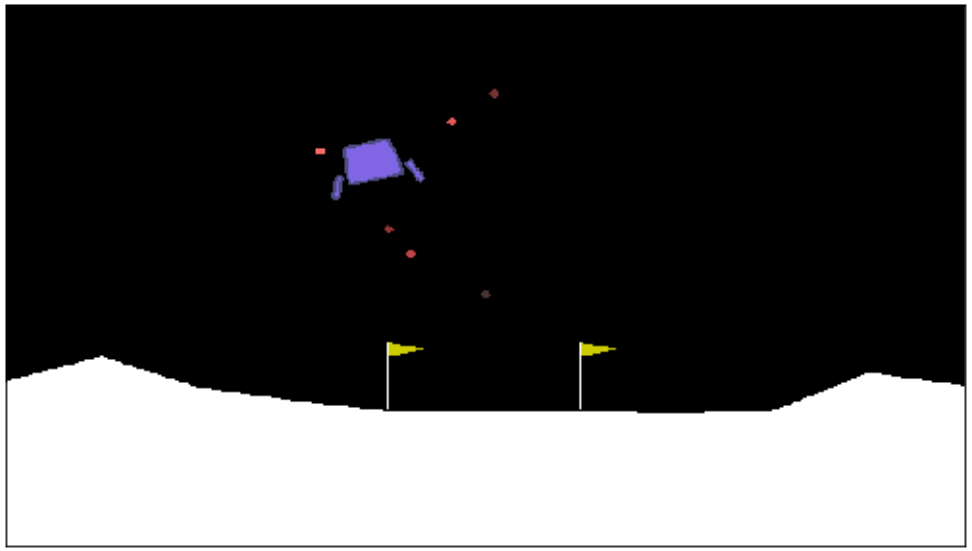

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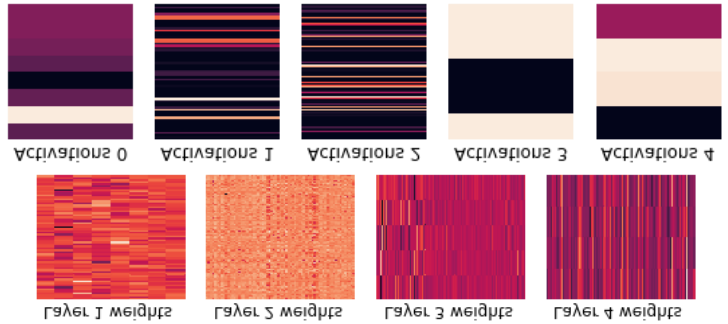

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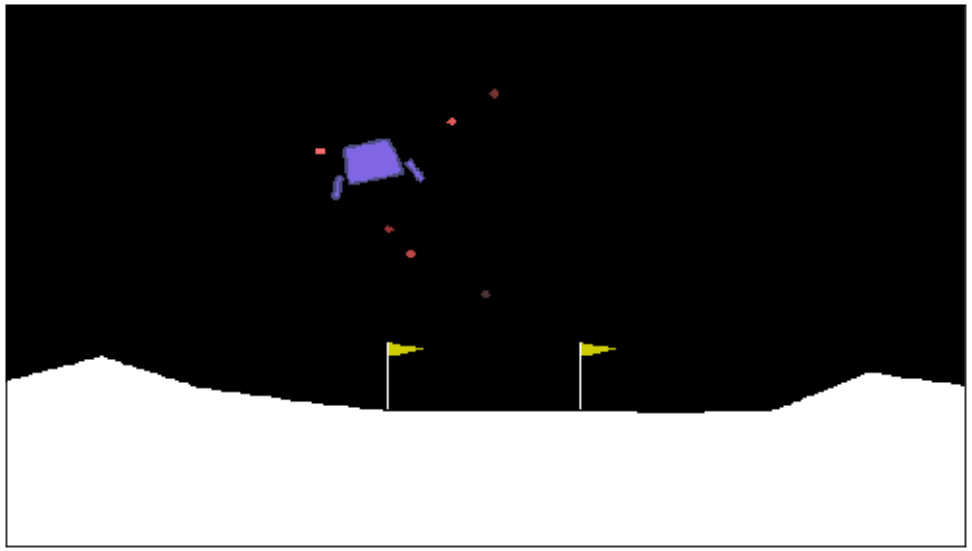

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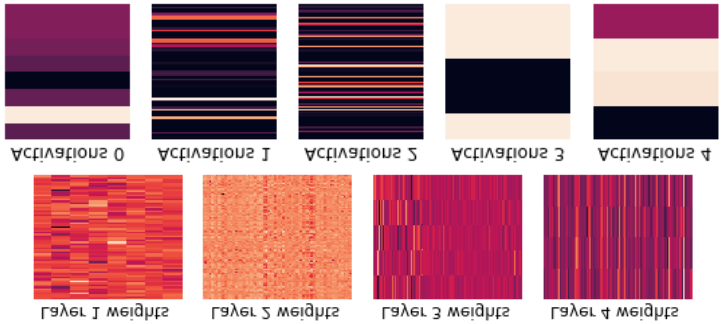

Reinforcement learning

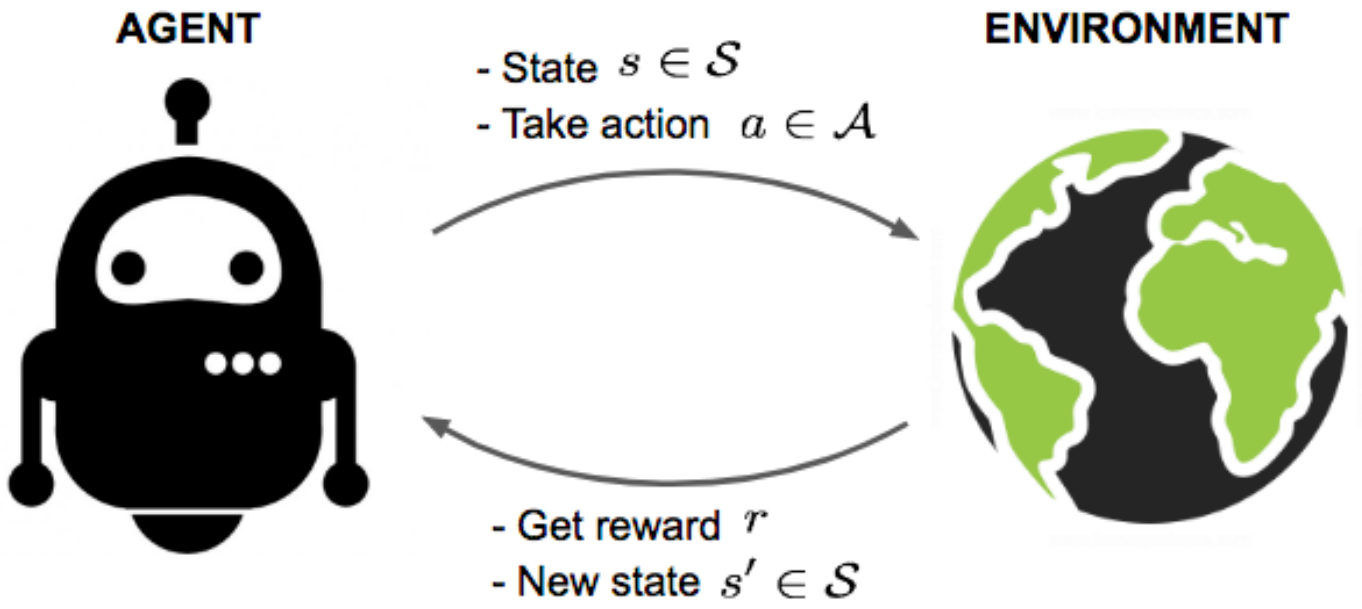

Image from:
https://lilianweng.github.io/lil-log/2018/02/19/a-long-peek-into-reinforcement-learning.html

Implementation, V0

- Jupyter notebook time!
  - http://localhost:8888/notebooks/notebooks/TSC-2019.ipynb
  - https://github.com/Josh-Joseph/tsc-2019/blob/master/notebooks/TSC-2019.ipynb

Did we satisfy our requirements?

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  - Internal states are casually reducible to brain states
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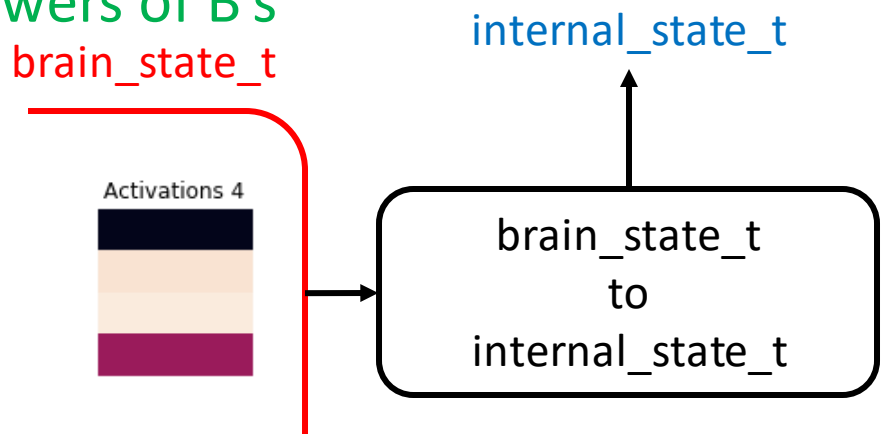

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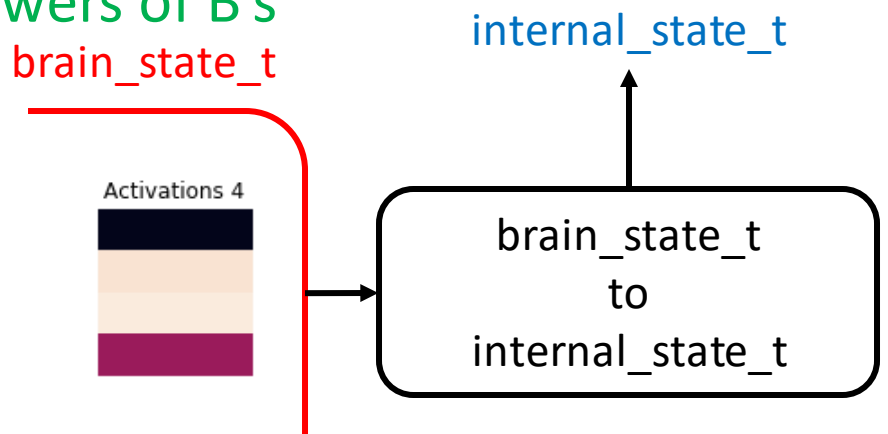
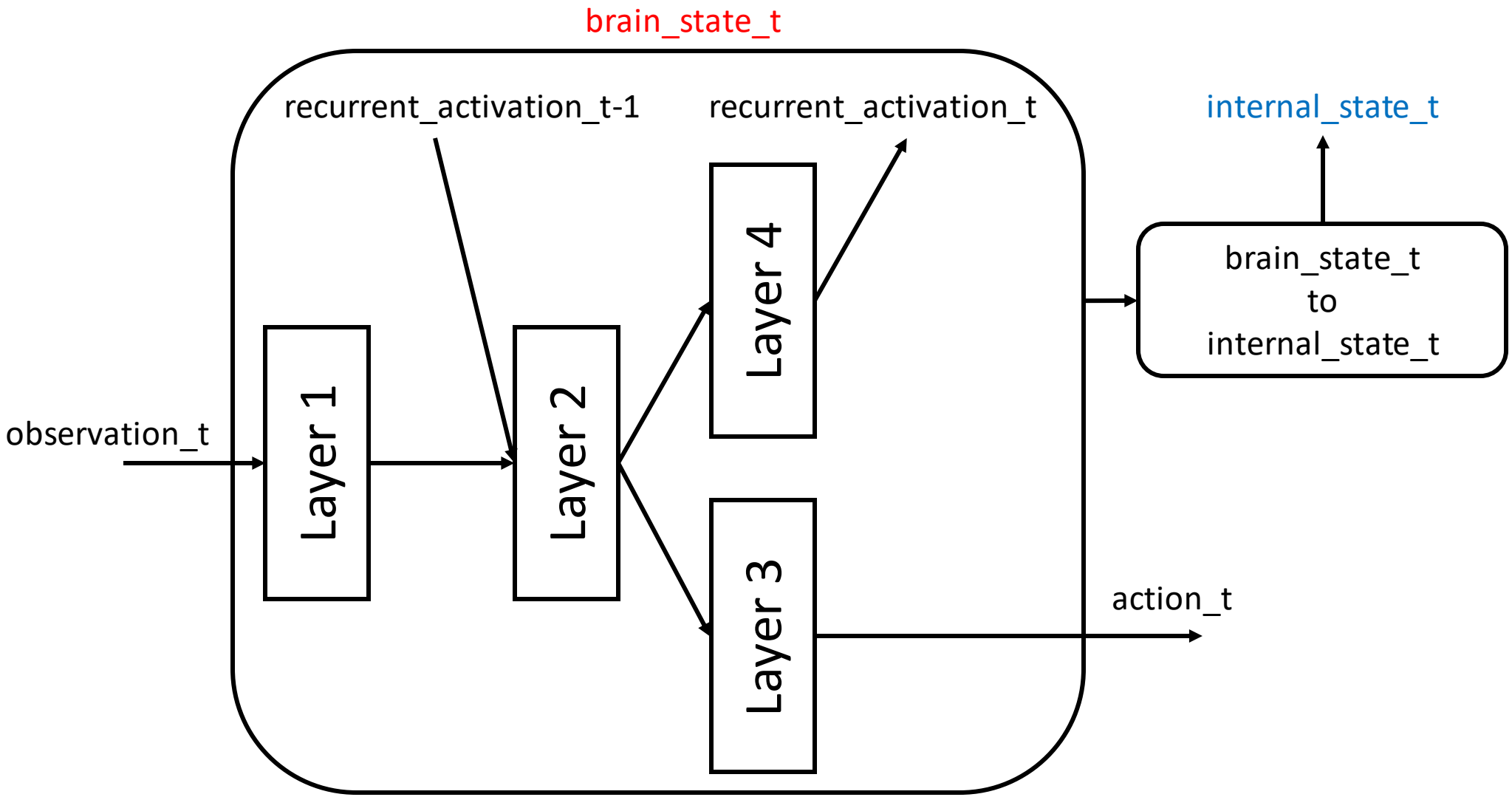


Design, V0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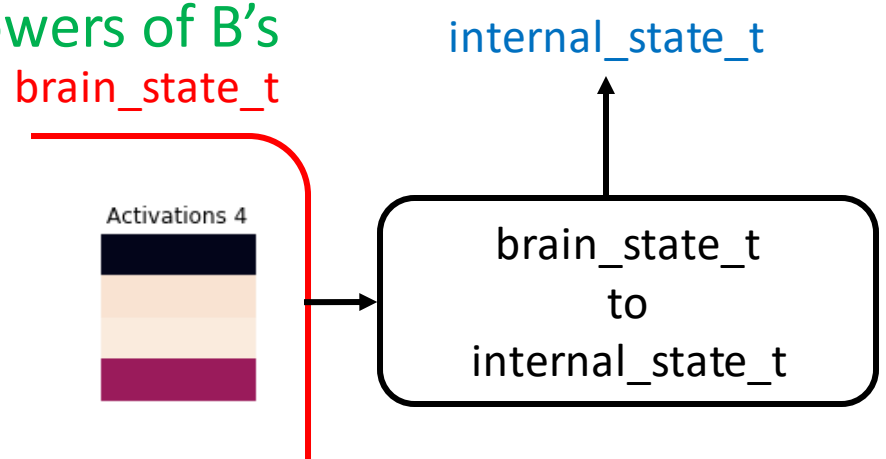

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- Layer weights of the neural network
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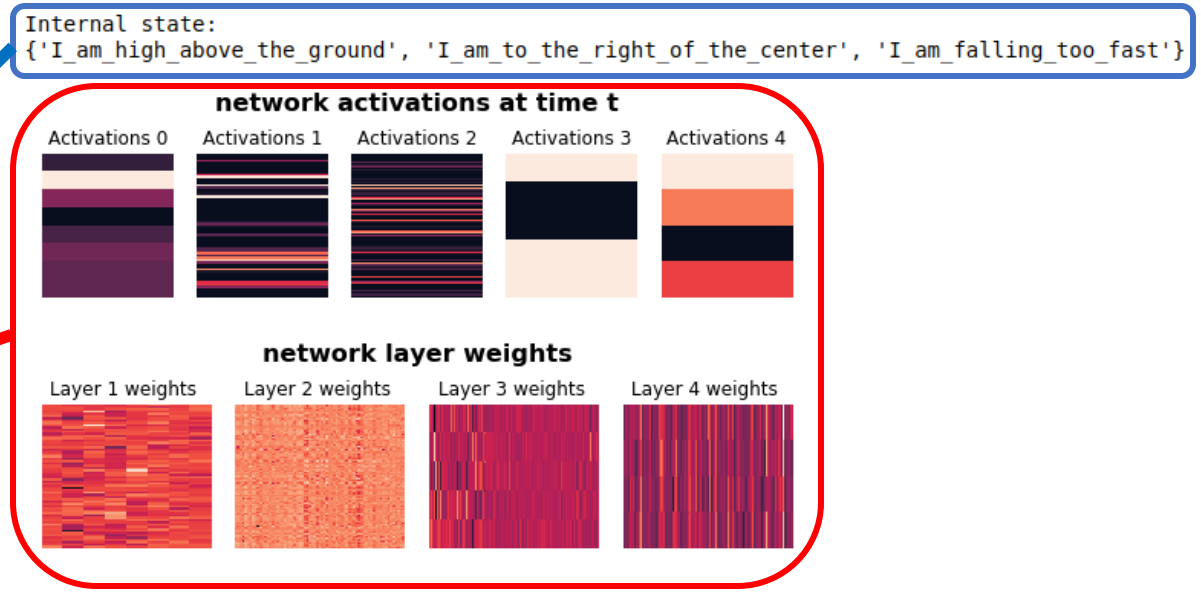

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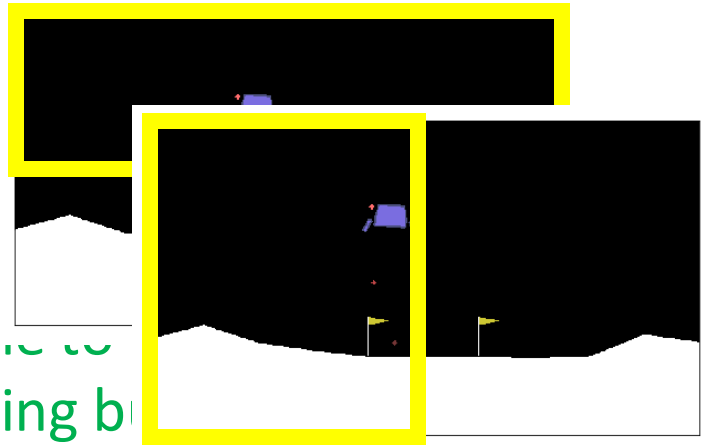

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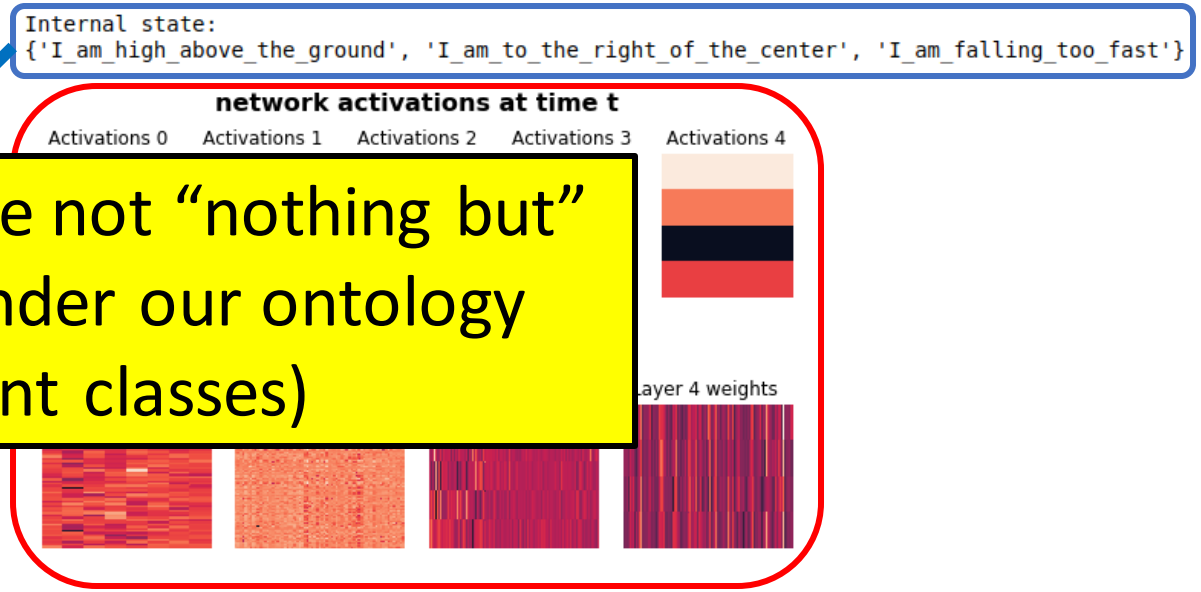
Internal state instances are not "nothing but" brain state instances under our ontology (they are different classes)



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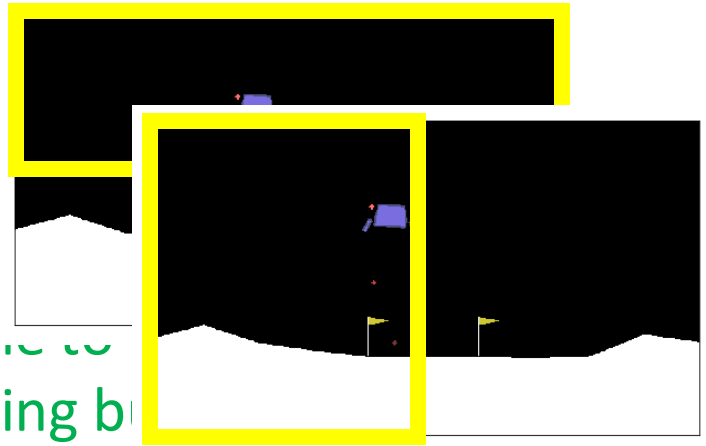

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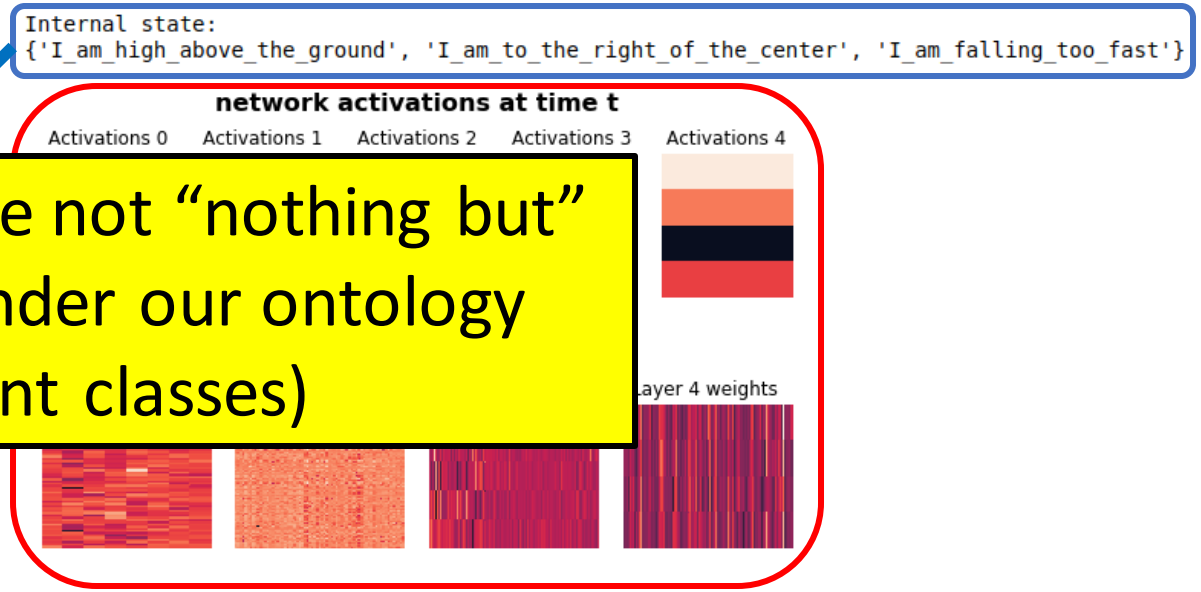

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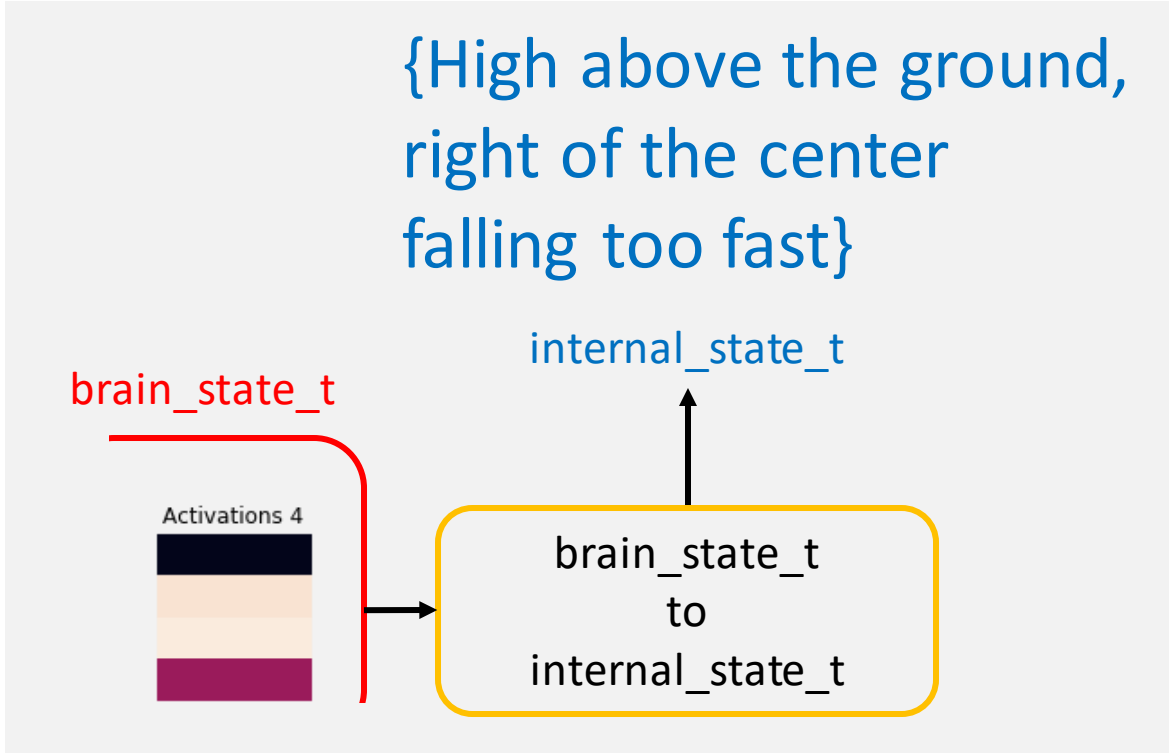
What's the deal with that function?

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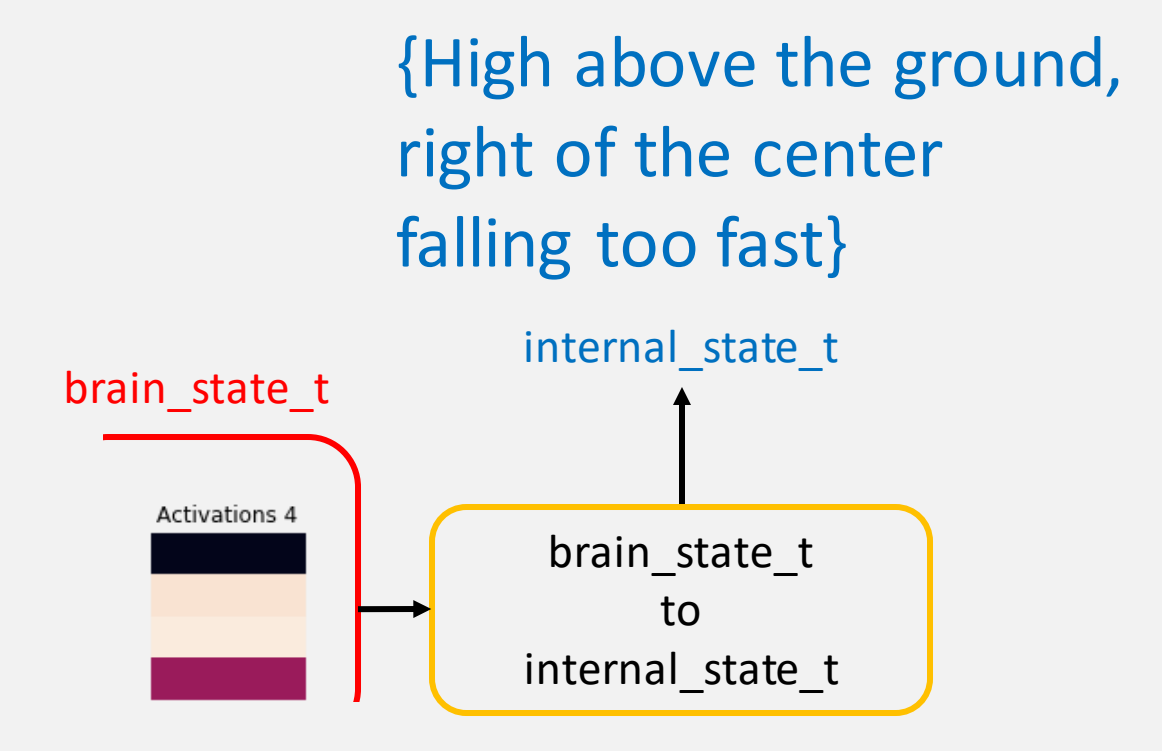


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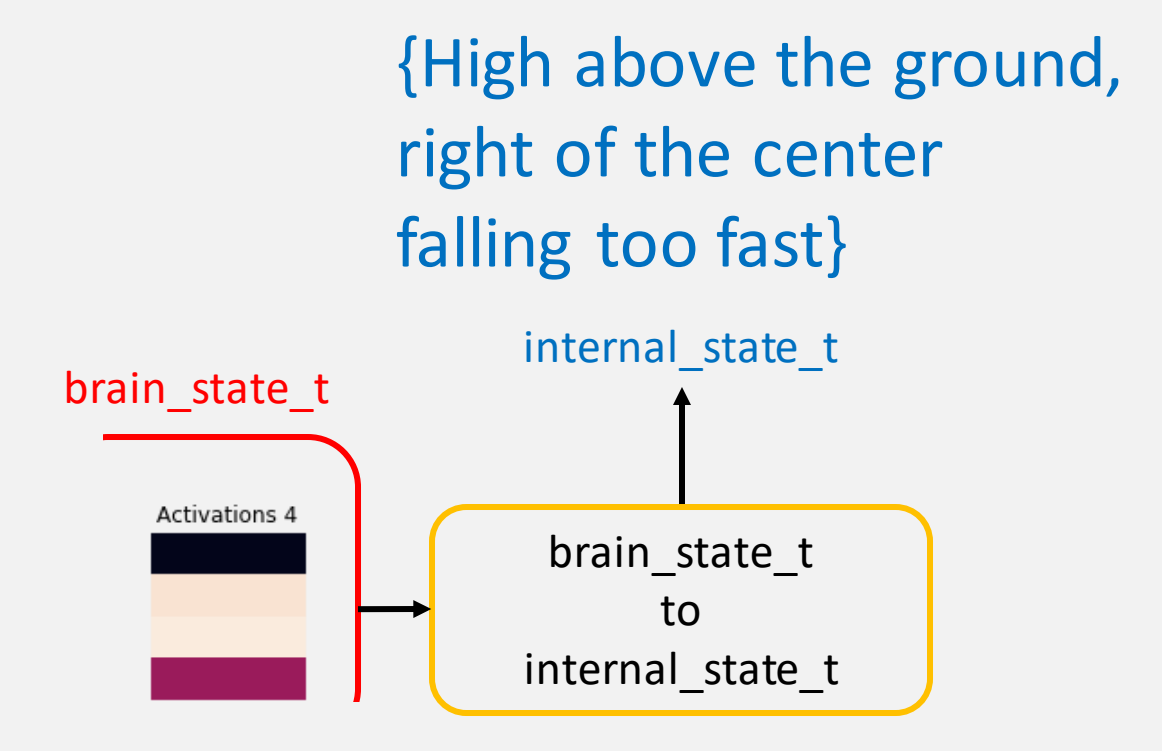


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- Is this just some representation of "data flow"?
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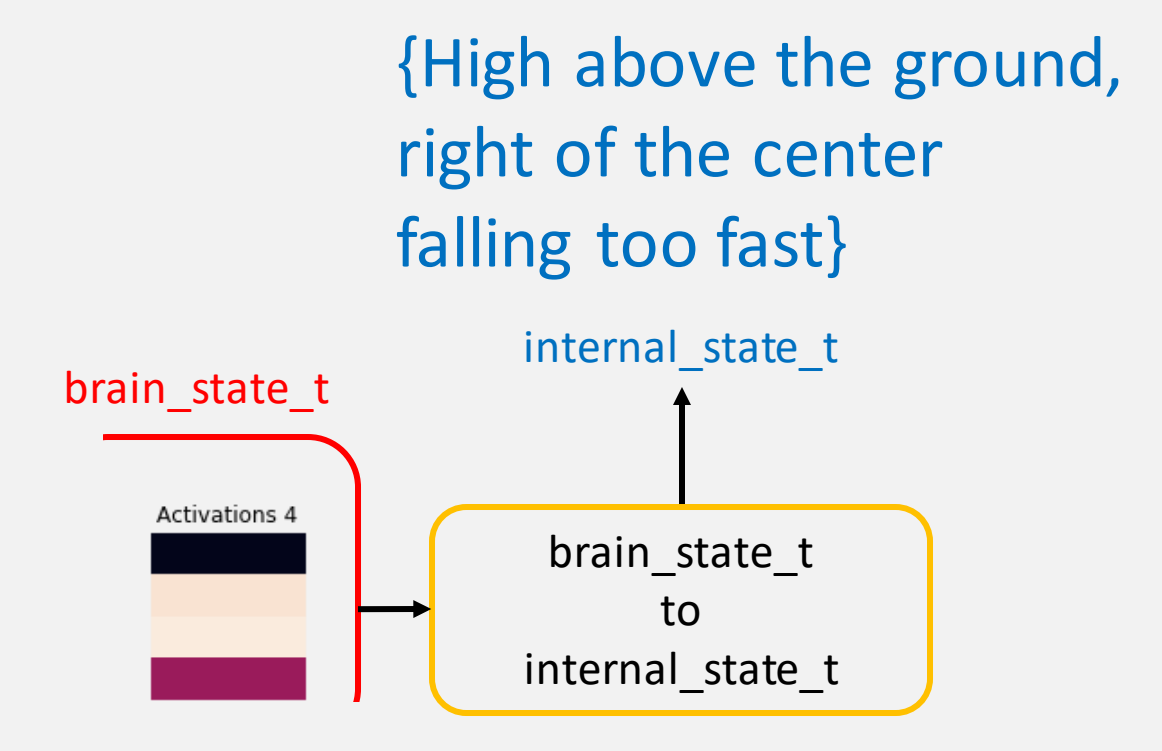


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def recurrent_activations_to_internal_state(brain_state):
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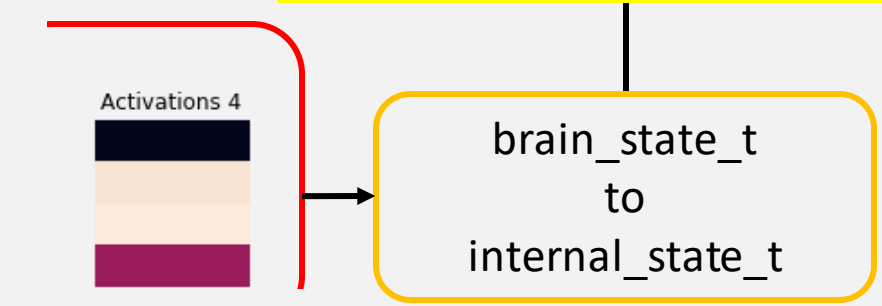
    recurrent_activations = brain_state['activations'][3]
    for activation, region in zip(recurrent_activations, regions):
        if activation > 0.5:
            internal_state.add(region.__name__)
    return internal_state
```

- Is this just some representation of "data flow"?
- Is this something closer to summarization?
- (or both?)

What's the deal with that function?

{High above the ground,

"The property dualist means that in addition to all the neurobiological features of the brain, there is an extra, distinct, nonphysical feature of the brain; whereas I mean that consciousness is a state the brain can be in, in the way that liquidity and solidity are states that water can be in."
- *Why I'm Not a Property Dualist*, Searle

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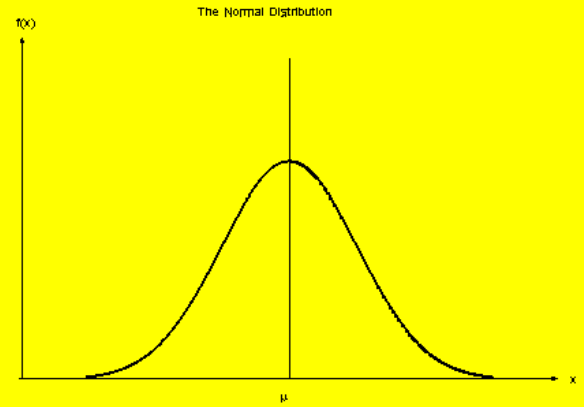
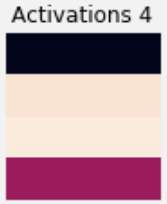
Just like a gaussian and its parameters...



$$\hat{\mu} = \bar{X} = \frac{1}{n}\sum X_i$$

$$\hat{\sigma}^2 = \frac{1}{n-1}\sum (X_i - \bar{X})^2$$

brain_state_t



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- Is this jus
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- (or both?)

Conclusion

- Software engineer style philosophy reifying seemed to work well
- Created a V0 software agent that demonstrates
  - Internal states are casually reducible to brain states
  - Internal states are ontologically irreducible to brain states
- Download and play with the code yourself
  - github.com/Josh-Joseph/tsc-2019
- Disagree with our implementation?
  - Great! Open an issue and/or submit a pull request in GitHub
- Thoughts on other theories of mind/consciousness that may be particularly well suited for this type of approach?