

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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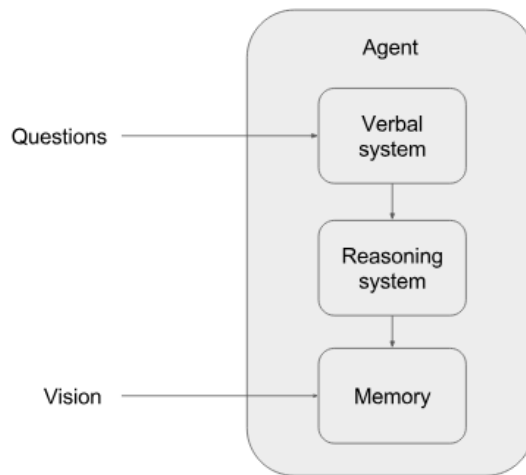
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- Our intuition is CS/AI could benefit from a deeper understanding of philosophy
 - But telling people to read more books/papers is not how to make this happen
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 - So let's try to do it with code!
- Possibly benefit philosophy by bringing code-style concreteness
 - (TBD, will let the philosophers in the room speak to this!)
- (Disclaimer: our backgrounds are CS/AI)

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.

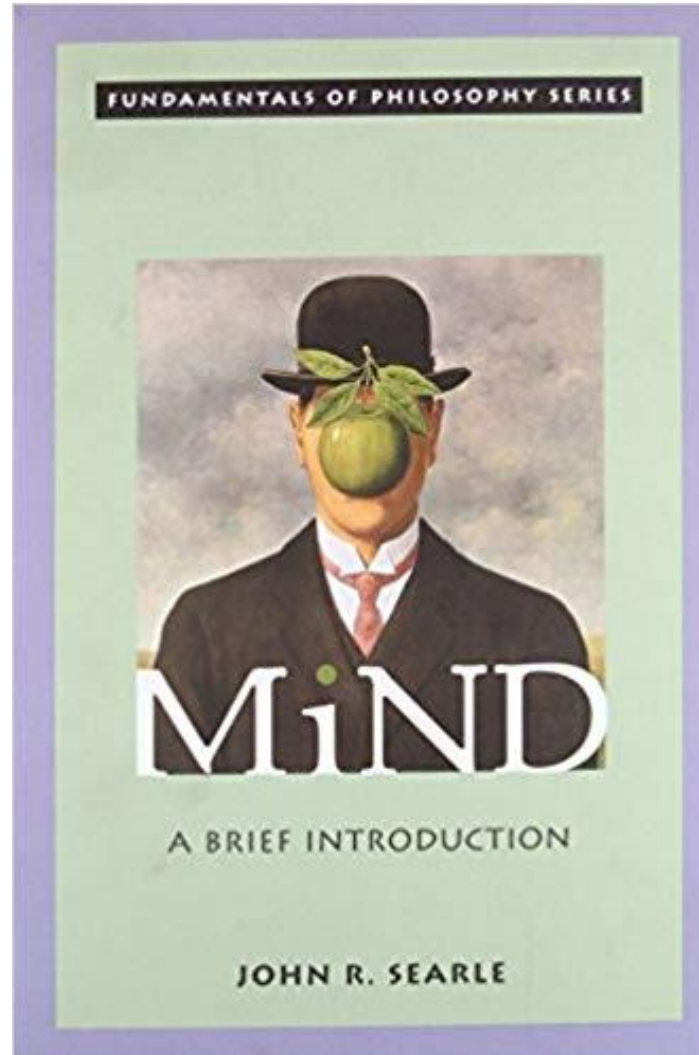
Q: Is it possible for Buck to have an illusion that he is having the experience of redness?
No, that's impossible.

Image from shlegeris.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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 - Enough disagreement that Searle wrote the paper: "Why I'm Not a Property Dualist"

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 - Consciousness is causally reducible to brain states but consciousness is ontologically irreducible to brain states
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- Let's unpack this with code!

What we're not doing

- Not trying to
 - Propose a cognitive architecture
 - Propose a new AI or machine learning algorithm
 - Claim that the software agent is conscious
 - Convince anyone these are the correct/best/most useful definitions of consciousness or brain states
 - 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 the system must do
- Design – how will we build the system to meet the requirements
- Implementation – building the system consistent with the design

Requirements: unpacking Searle's view

- Consciousness is causally reducible to brain states
- Consciousness is ontologically irreducible to brain states

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 - The full physical-chemical state of the brain and nervous system
 - Third person, objective

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 - Representations, goals, rewards, observations, actions, etc.
 - Subjective

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 - Beliefs, desires, thoughts, perceptions, emotions, knowledge, etc.
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- Mental state
 - Beliefs, desires, thoughts, perceptions, emotions, knowledge, etc.
 - 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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Requirements: unpacking Searle's view

- Searle's view
 - Consciousness is causally reducible to brain states
 - Consciousness is ontologically irreducible to brain states
- V2
 - Conscious mental states are causally reducible to brain states
 - Conscious mental states are ontologically irreducible to brain states
- V1
 - Mental states are causally reducible to brain states
 - Mental states are ontologically irreducible to brain states
- V0
 - Internal states are causally reducible to brain states
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Requirements: unpacking Searle's view

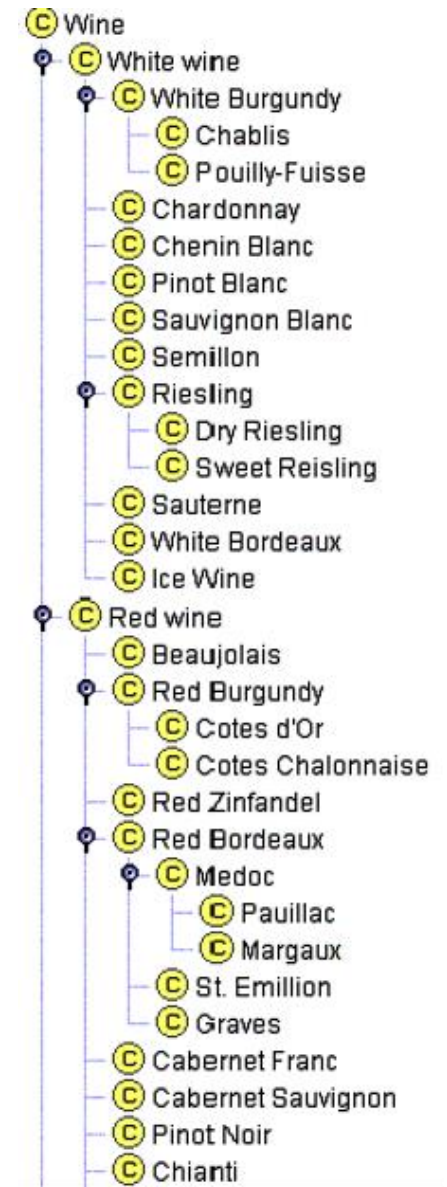
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Phenomena of type A are ontologically reducible to phenomena of type B
if and only if A's are nothing but B's

Ontologies in Computer Science



(C) A set of wine bottles

(C) Case of wine

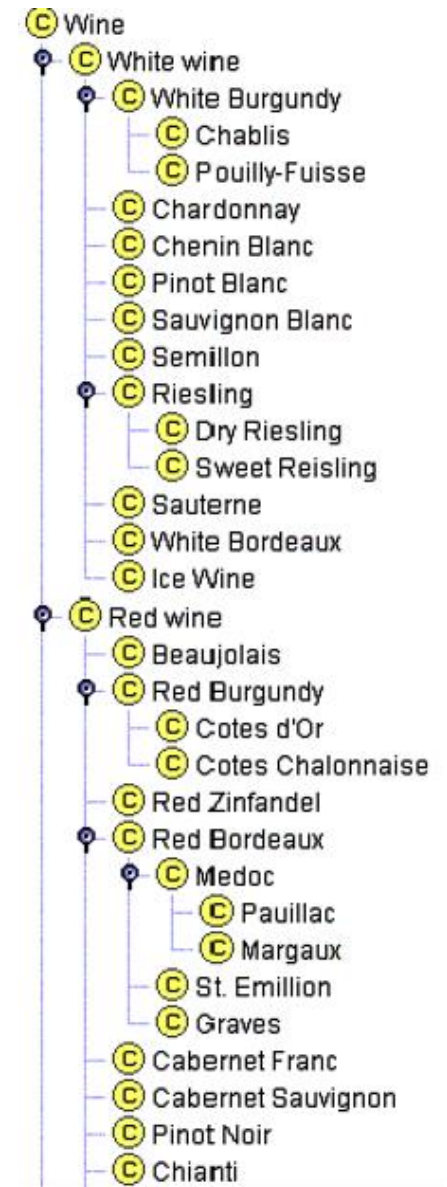
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Ontologies in Computer Science

- Class-instance distinction



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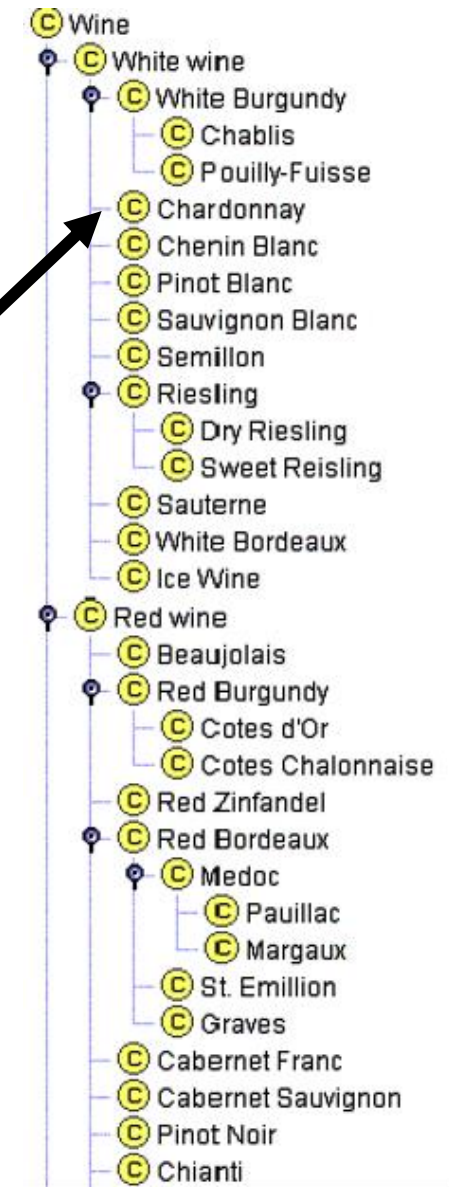
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Ontologies in Computer Science

- 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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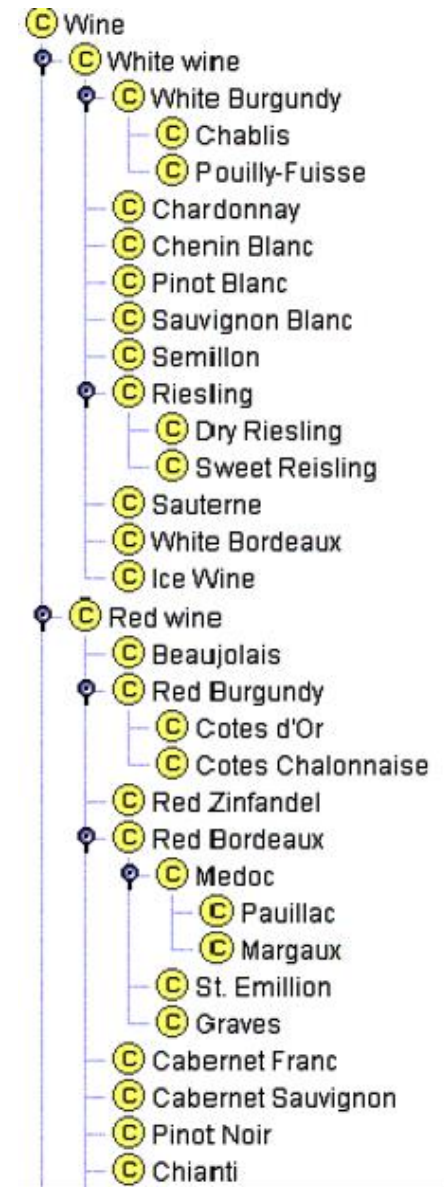
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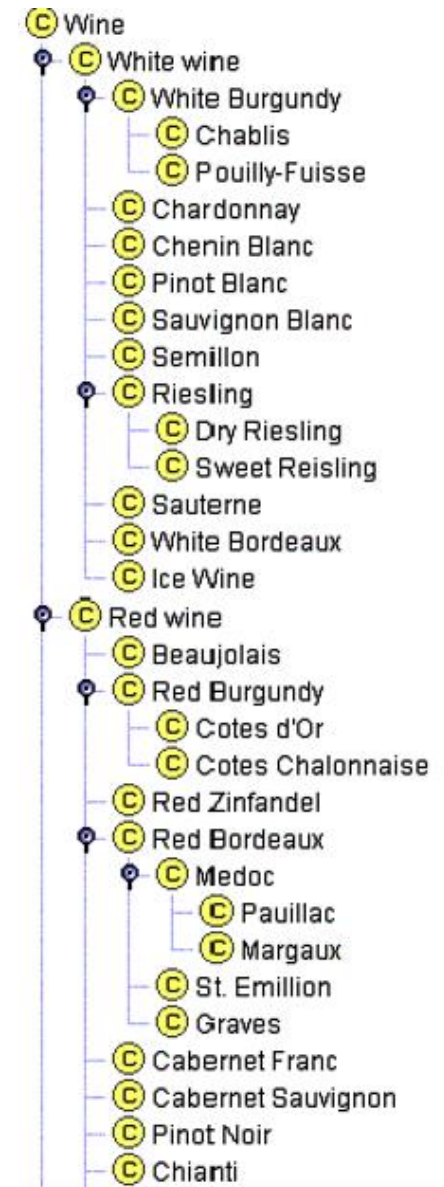
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Ontologies in Computer Science

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



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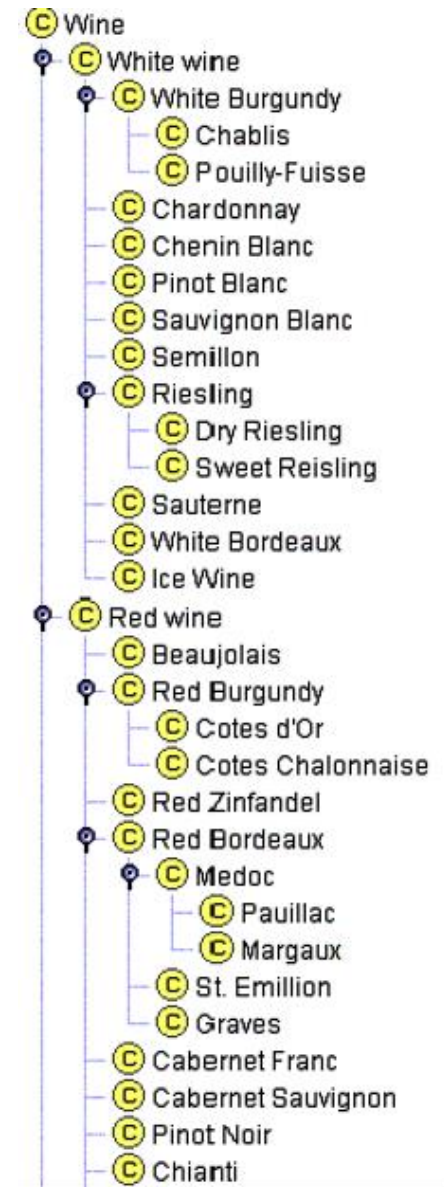
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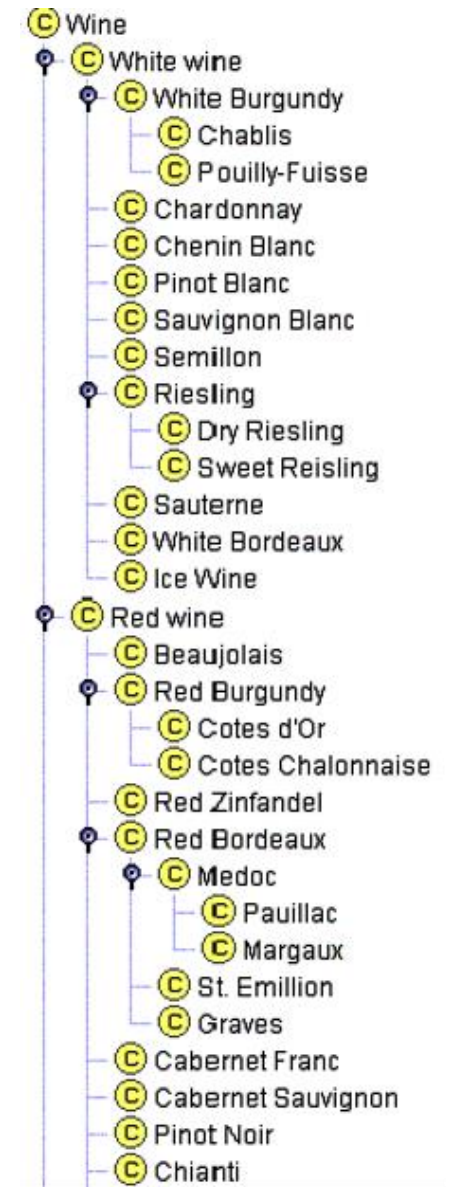
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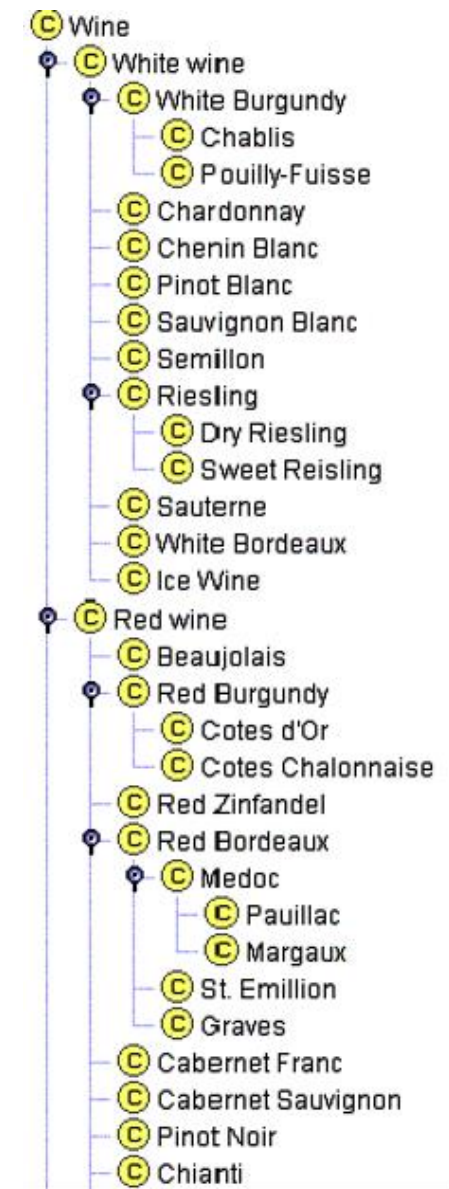
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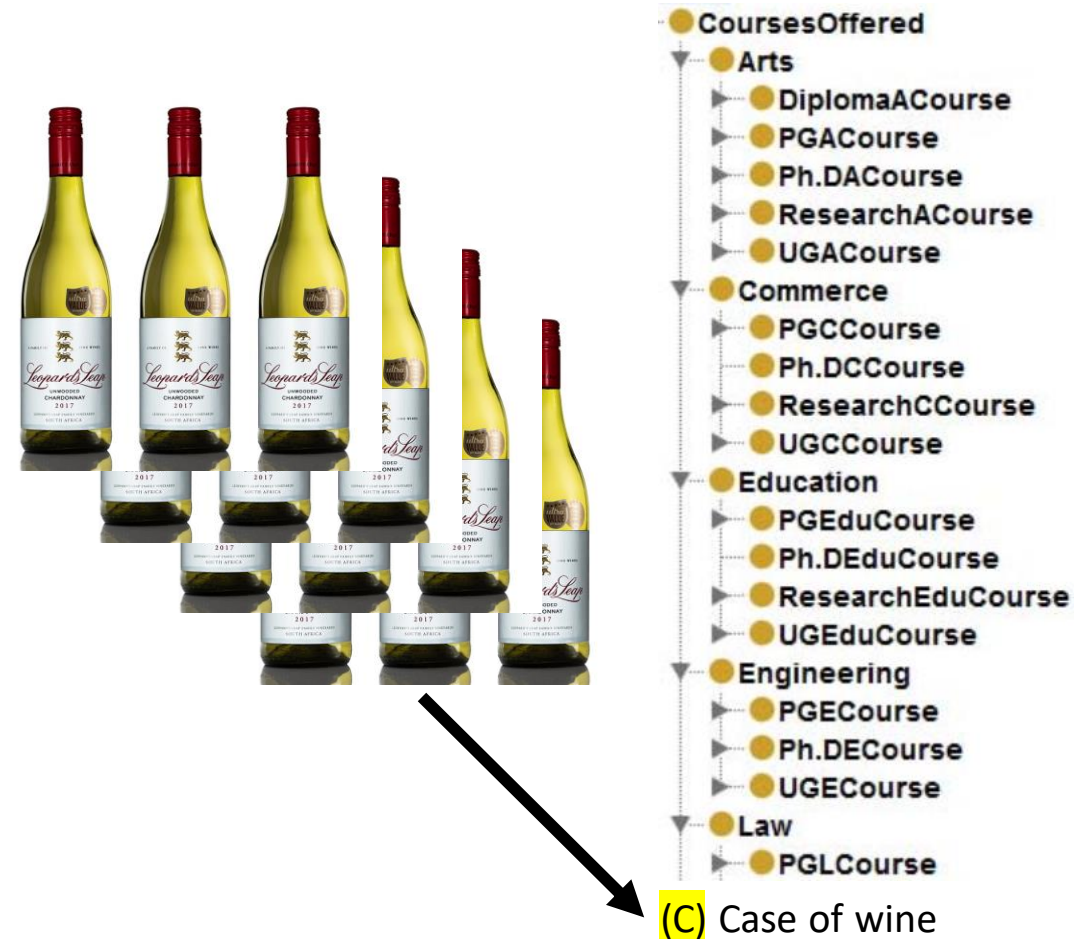
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Phenomena of type A are causally reducible to phenomena of type B if and only if:

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

Requirements, V0

- Internal states are causally reducible to brain states
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Design, V0

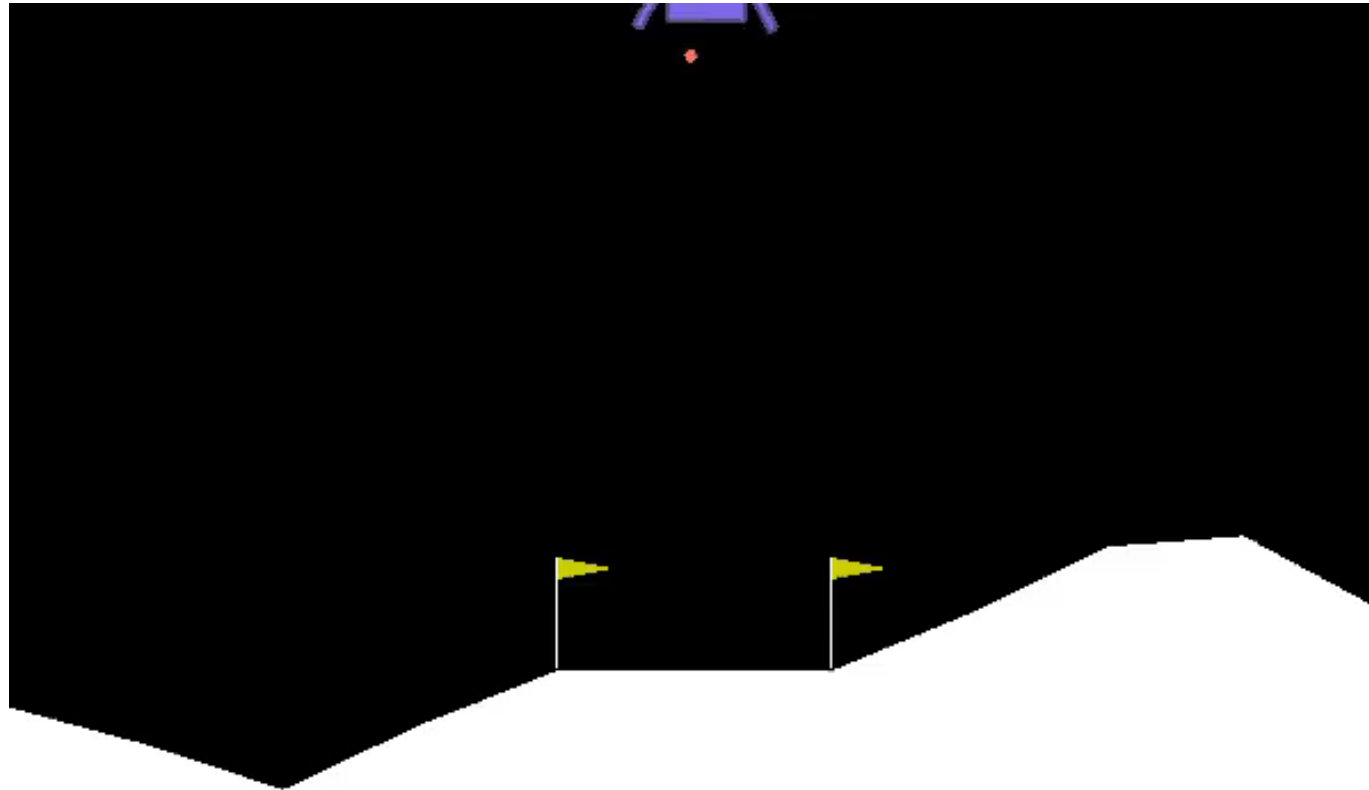
- Design decisions

Design, V0

- Design decisions
 - Environment and the agent's “physical” form

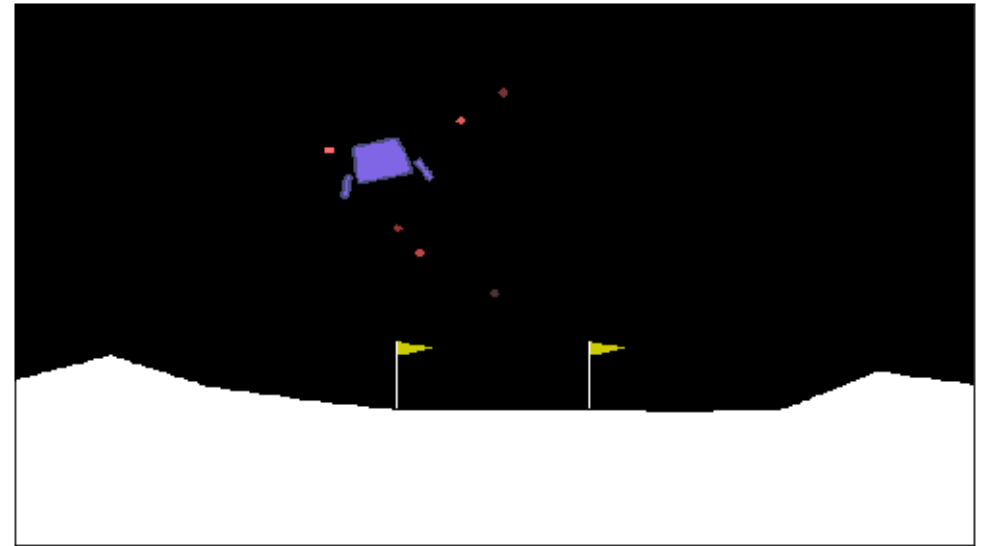
Design, V0

- OpenAI's LunarLander benchmark environment



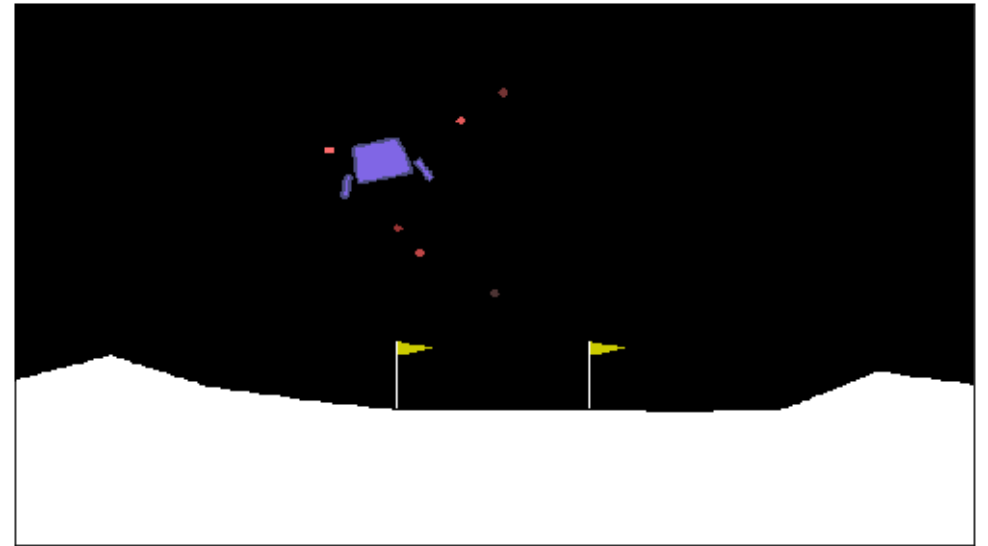
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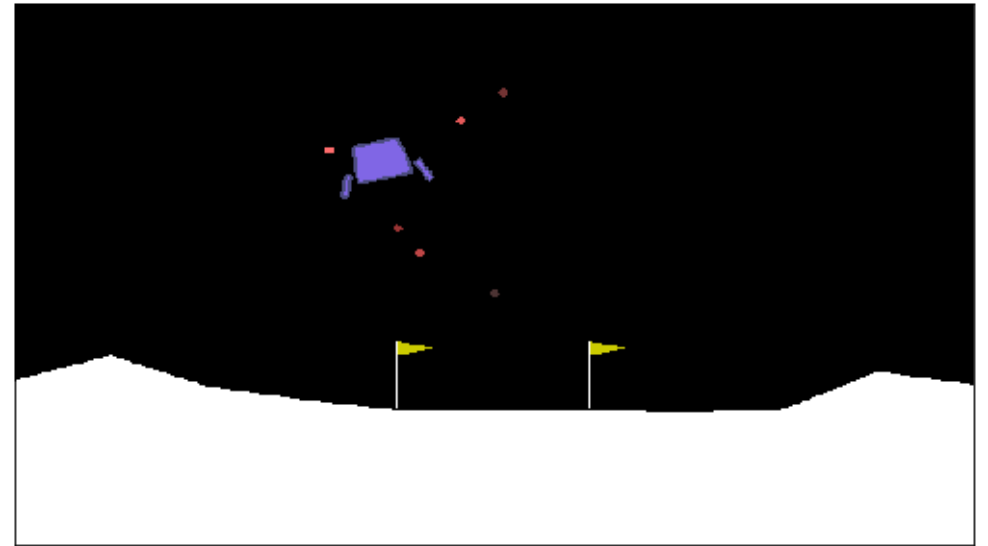
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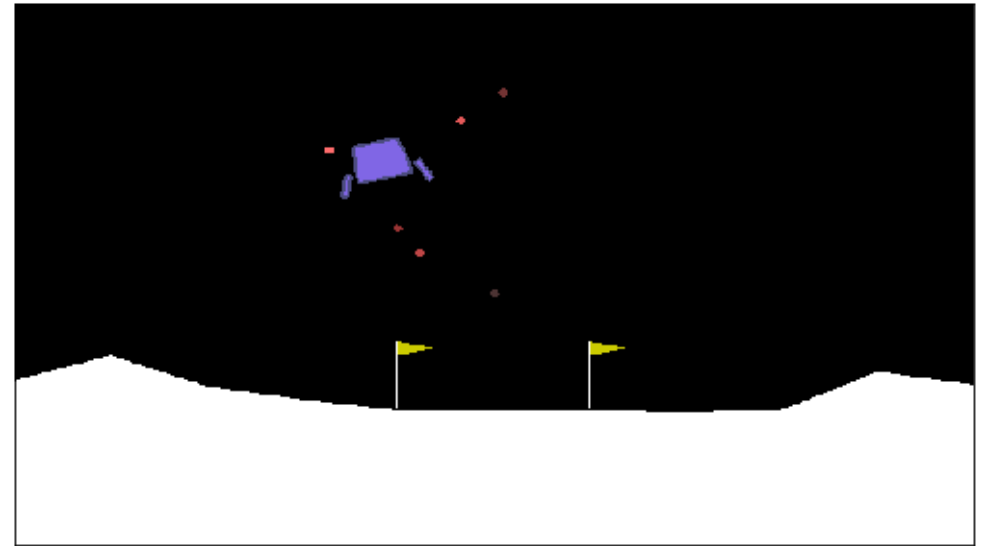
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 - Beliefs about itself relative to semantically important regions



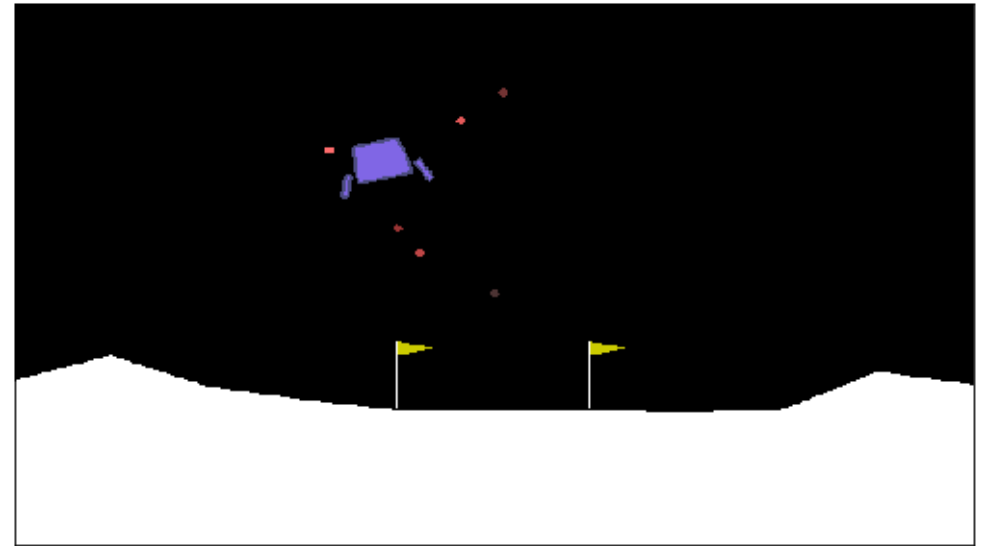
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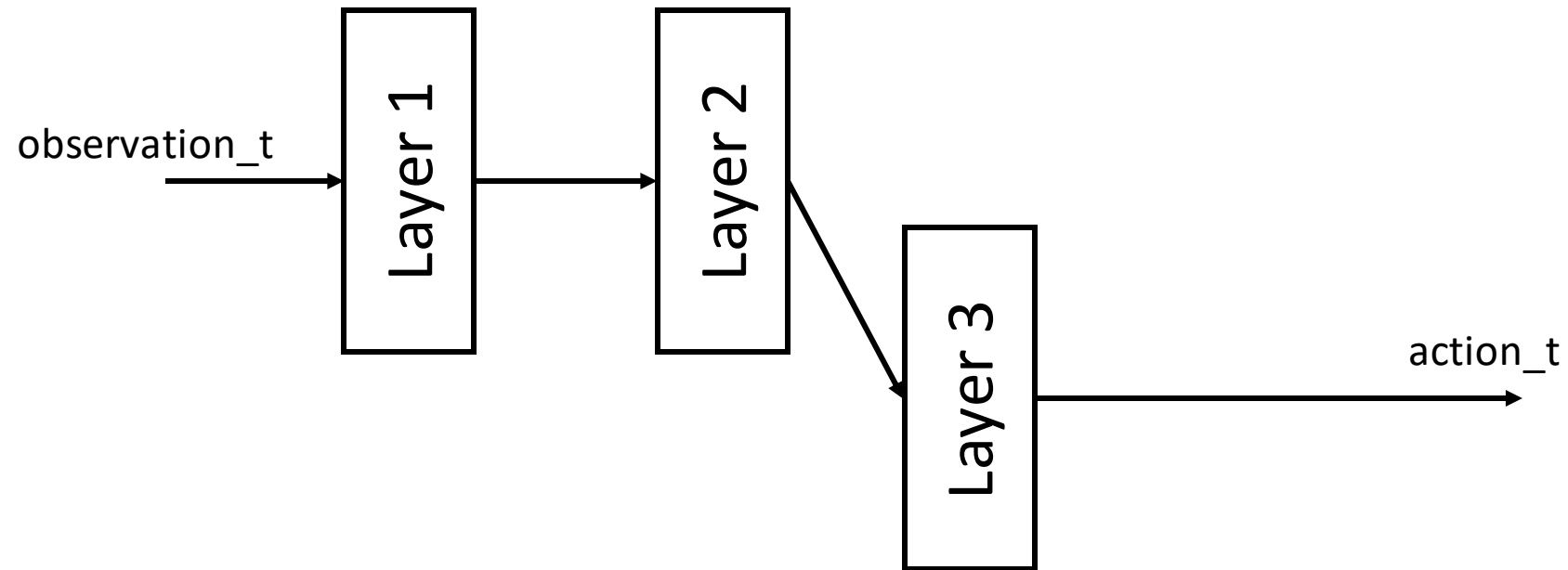


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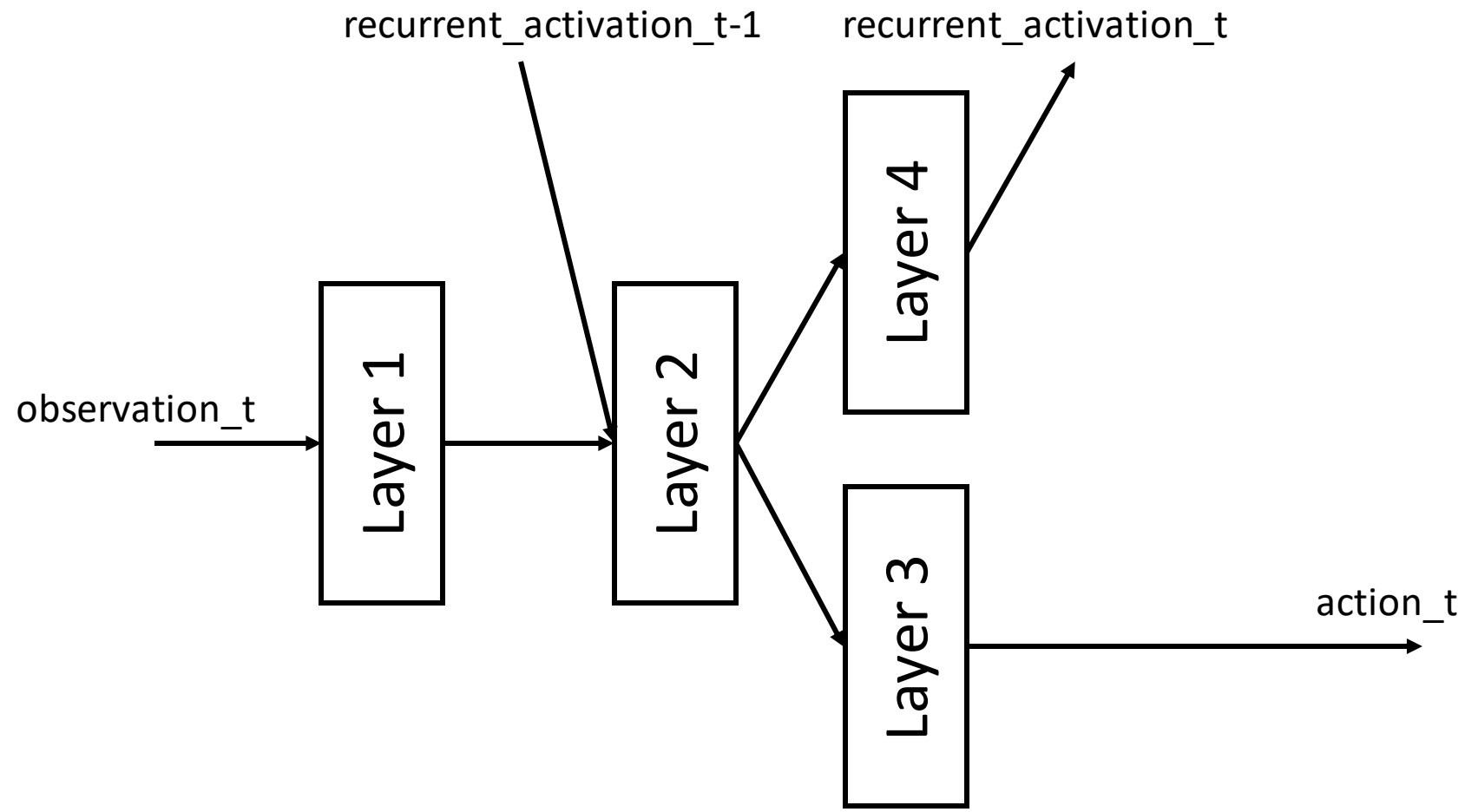
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 - Brain state of the agent



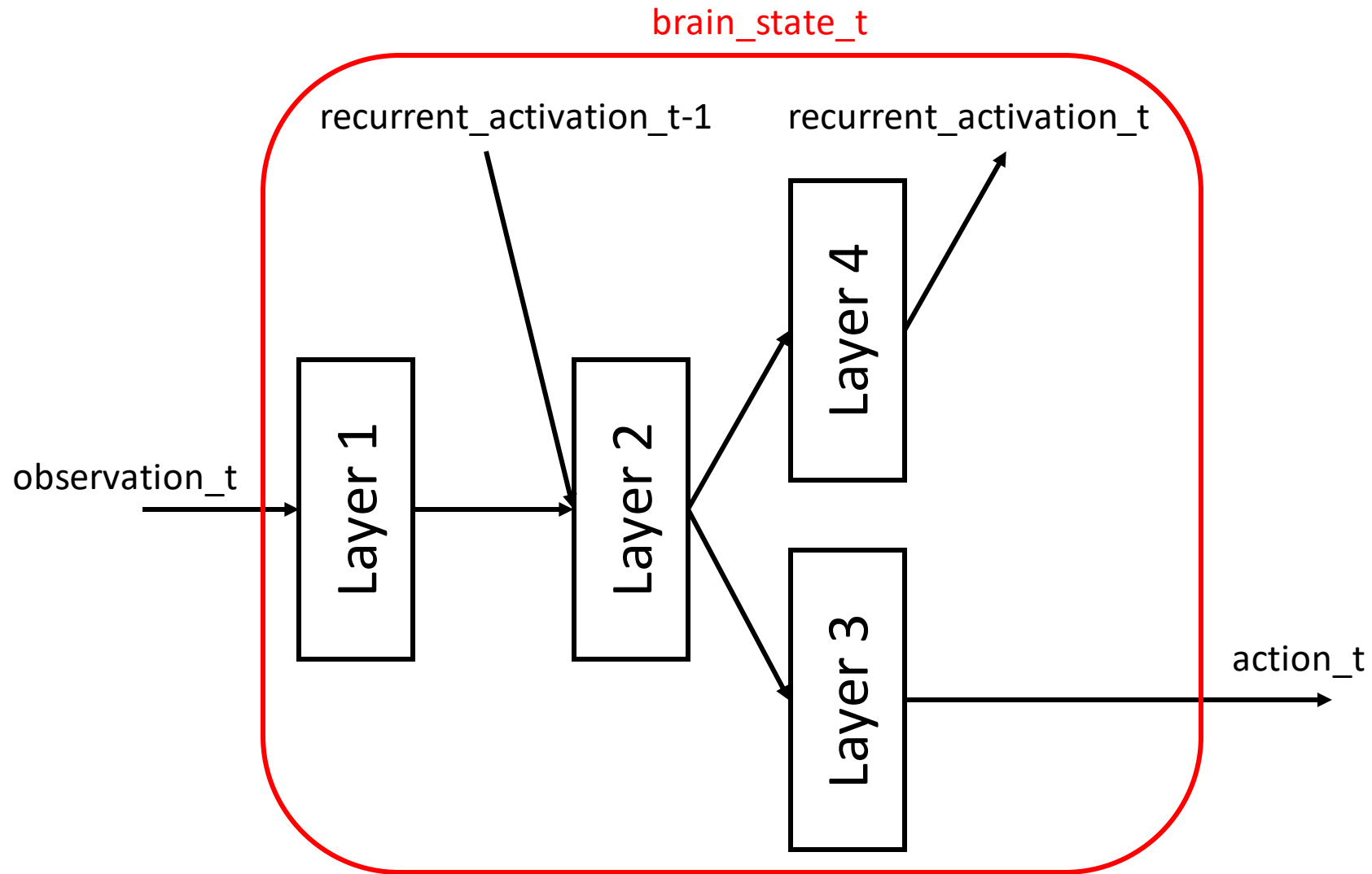
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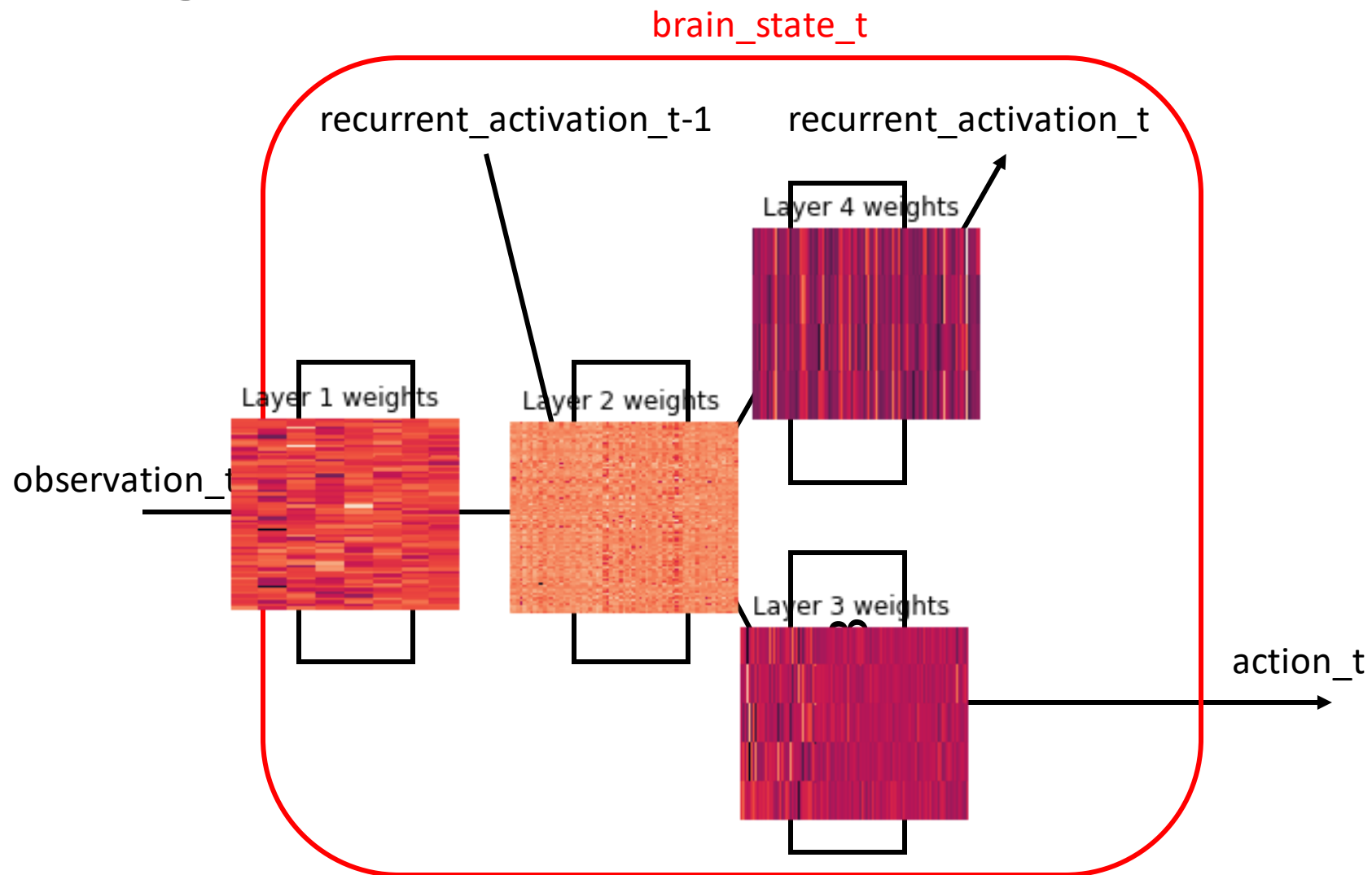
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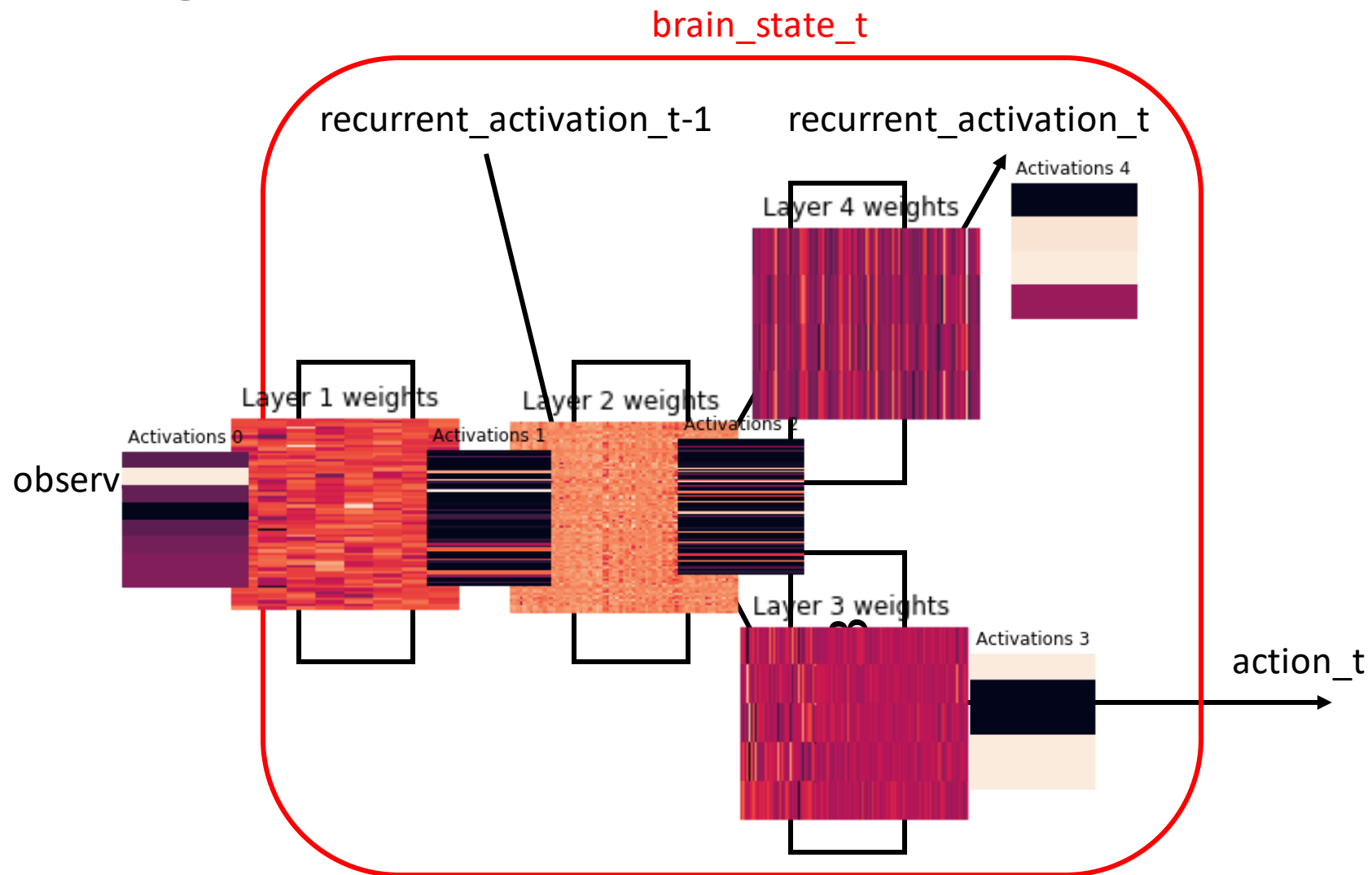
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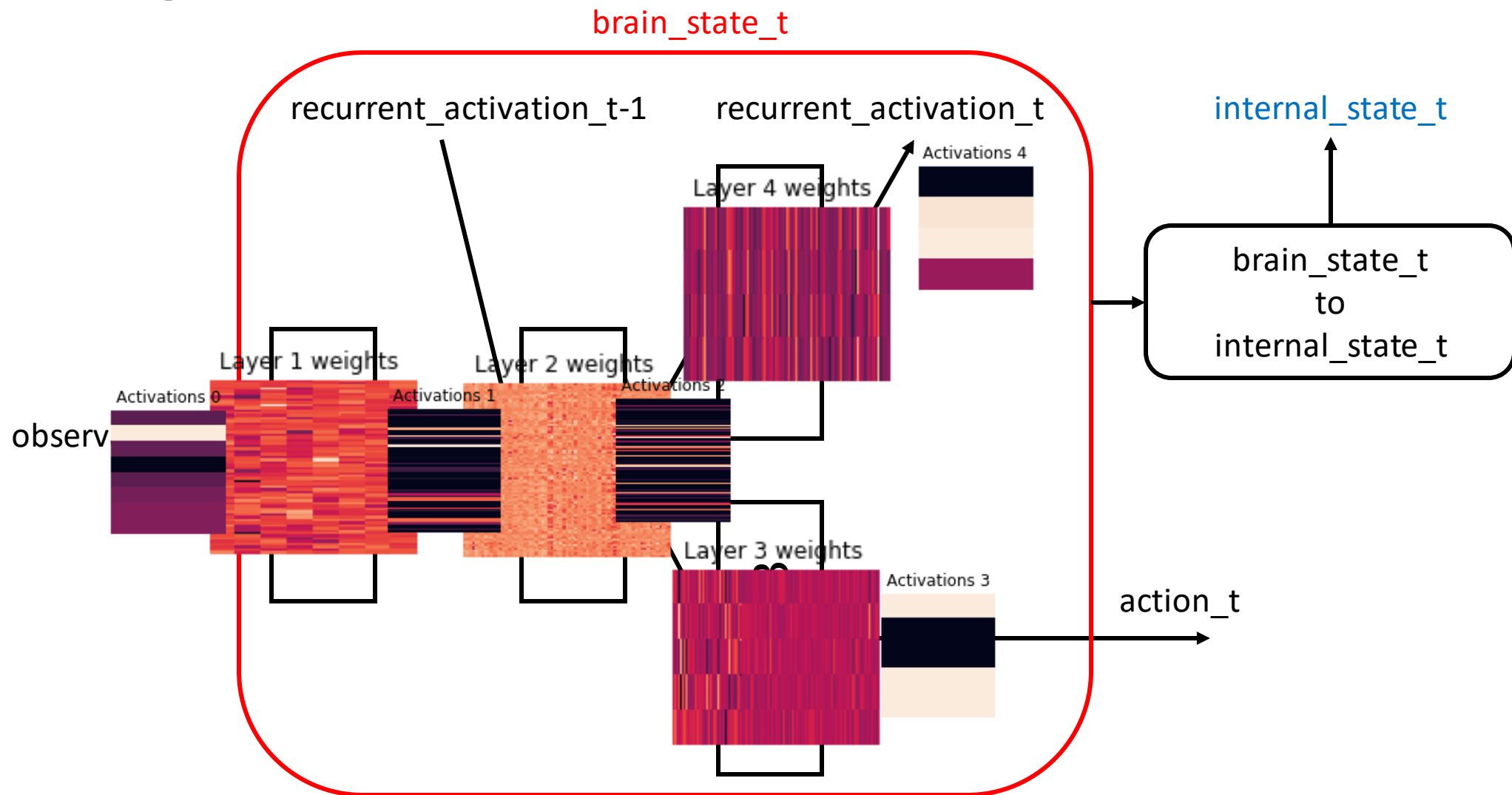
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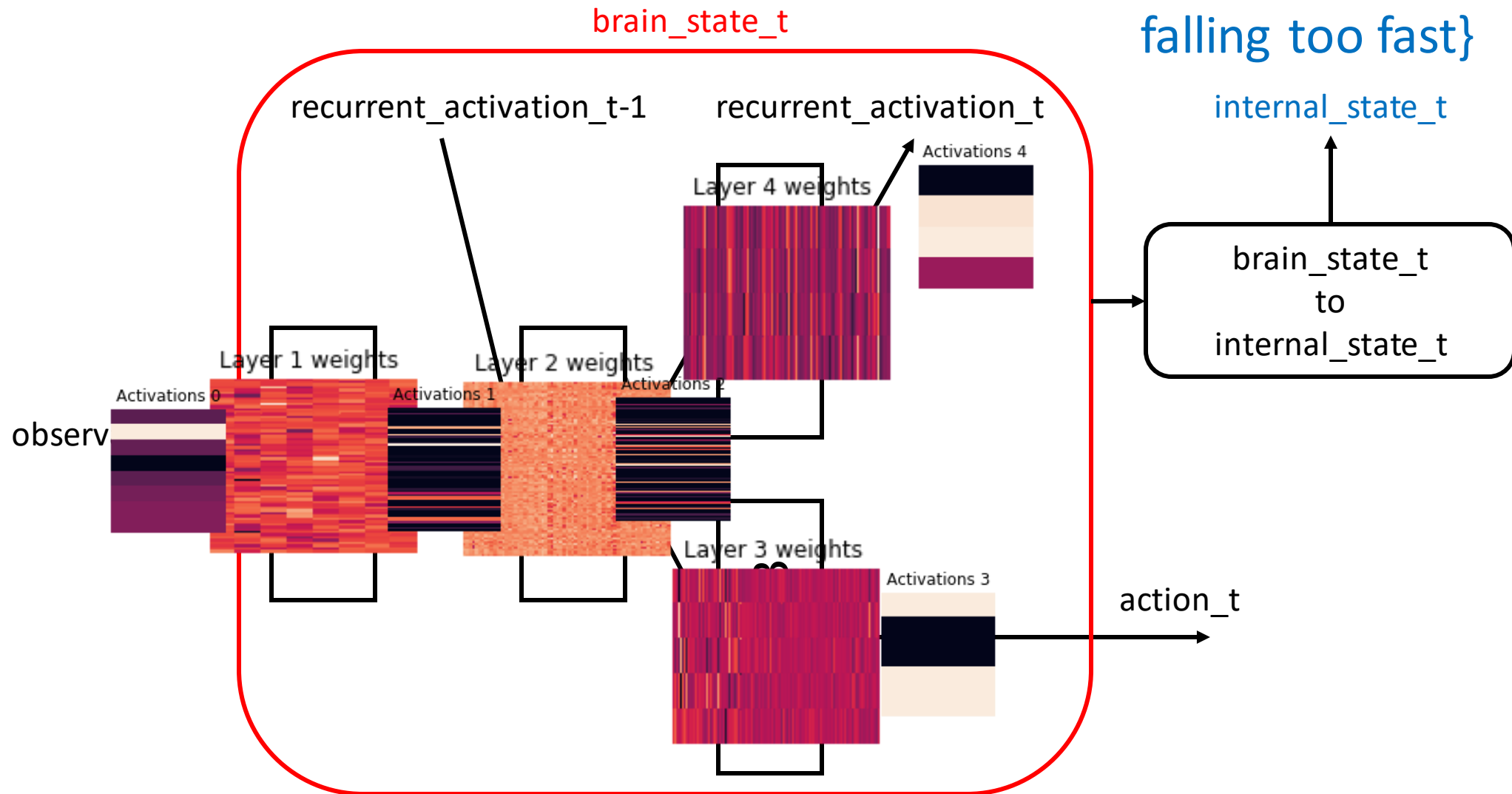
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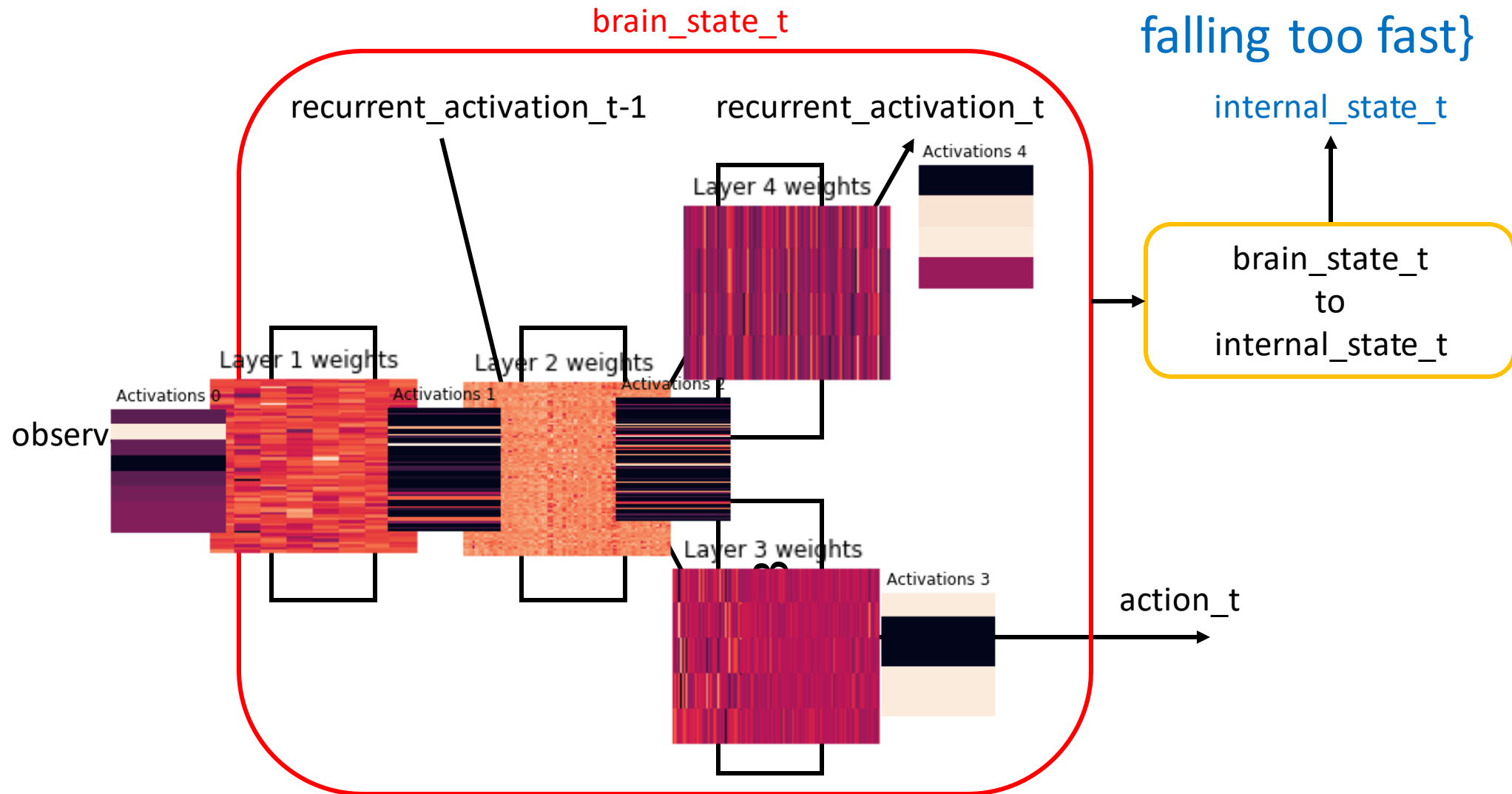
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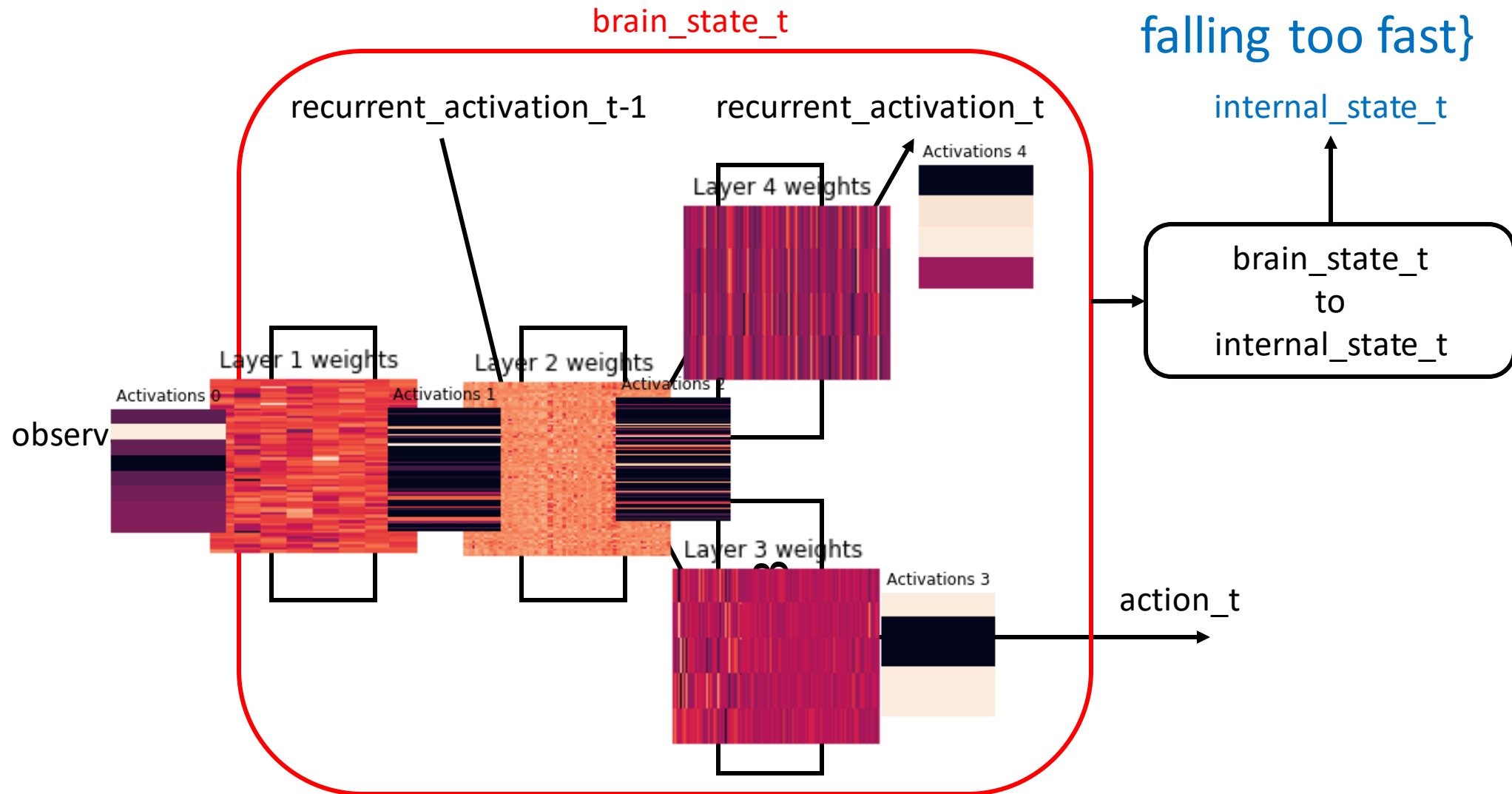
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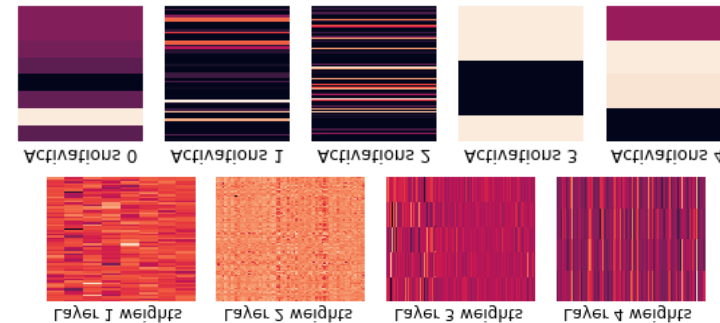
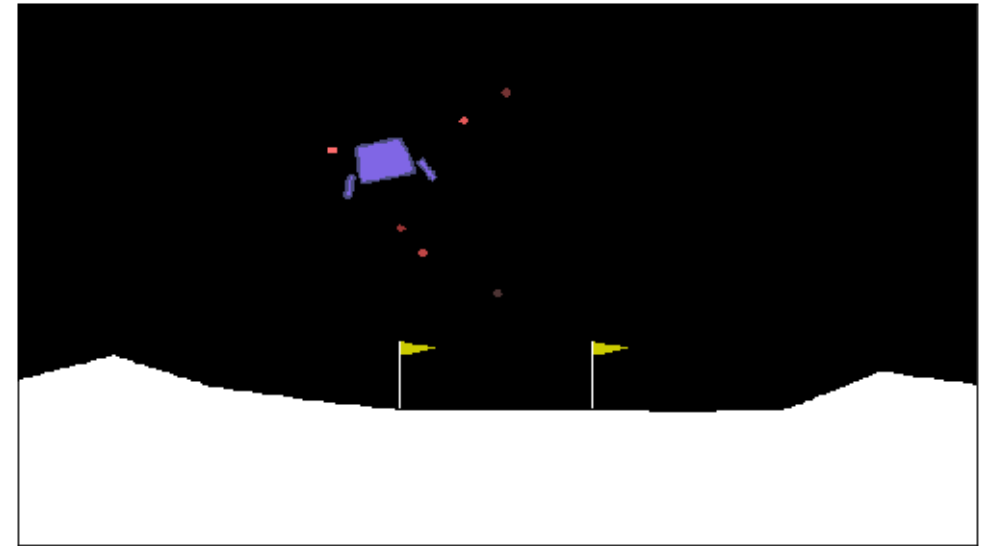
Design, V0



{High above the ground,
right of the center
falling too fast}

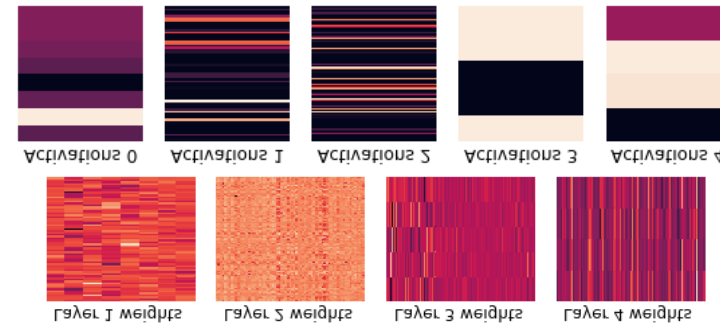
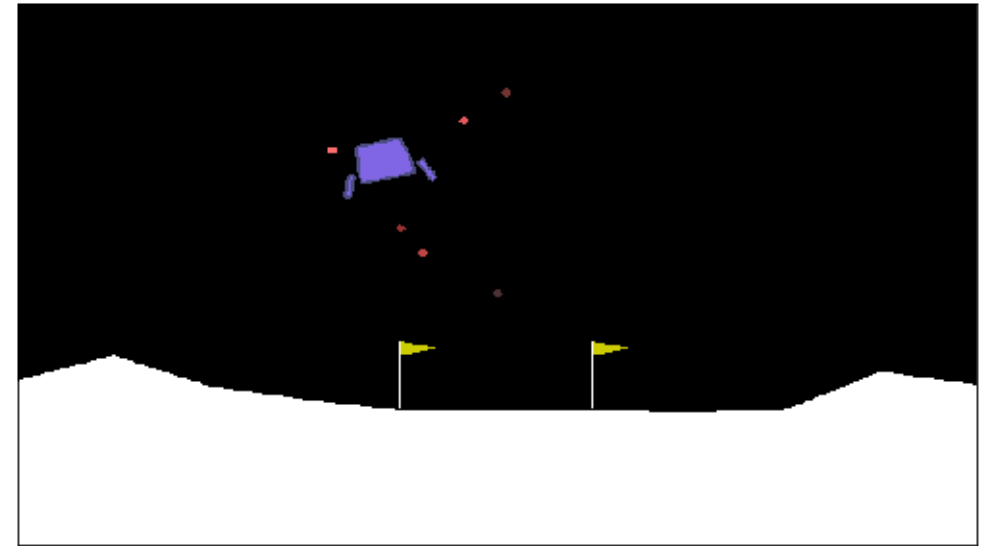
Design, V0

- Design decisions
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 - Internal state of the agent
 - Beliefs about itself relative to semantically important regions
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- Brain state of the agent



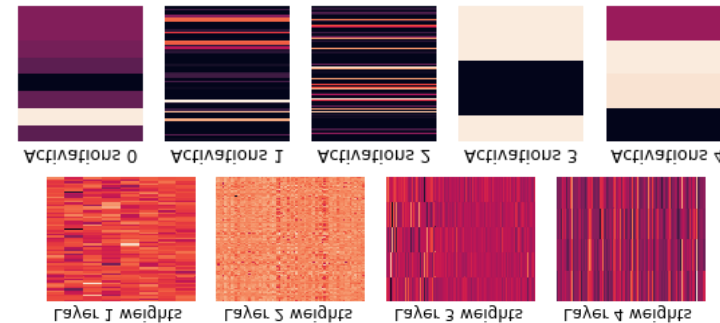
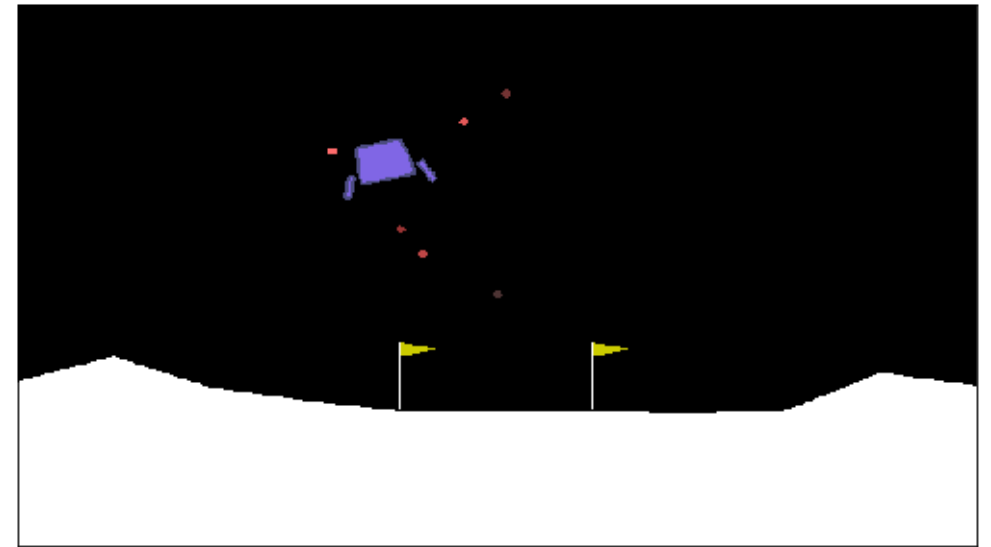
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- Our ontology



Design, V0

- Design decisions
 - Environment and the agent's "physical" form
 - Internal state of the agent
 - Beliefs about itself relative to semantically important regions
 - Left of the flags, right of the flags, high above the ground, close to the ground, falling too fast
- Brain state of the agent
- Our ontology
 - Layer weights of the neural network
 - Connectivity of the neural network
 - Activations of the neural network at time t
 - The agent's observation at time t
 - The agent's action at time t
 - The position and velocity of the agent at time t
 - A region the agent believes it's in
 - Brain state at time t (set of layer weights, activations, and connectivity)
 - Internal state at time t (set of regions the agent believes it's in)



Reinforcement learning

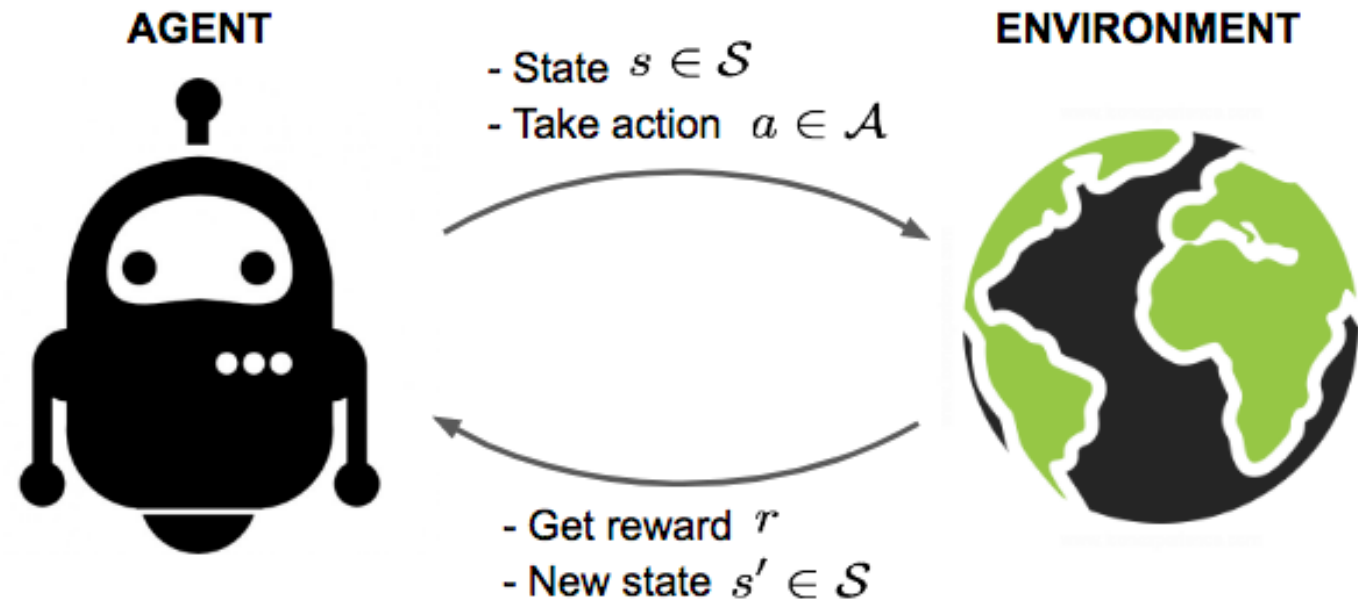


Image from:

<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?

- V0
 - Internal states are causally reducible to brain states
 - Internal states are ontologically irreducible to brain states

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Phenomena of type A are causally reducible to phenomena of type B if and only if:

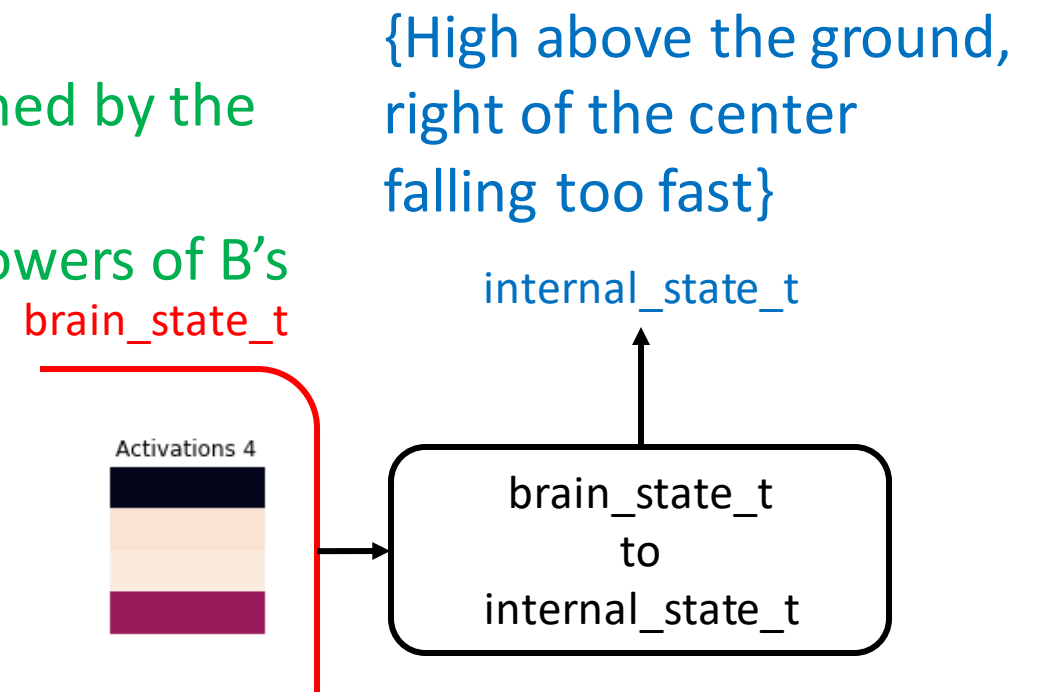
- the behavior of A's are entirely causally explained by the behavior of B's
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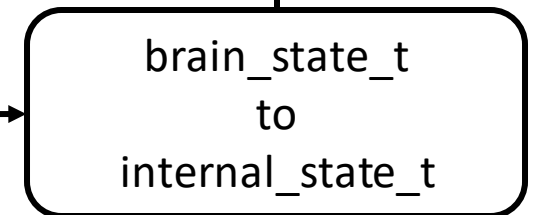
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brain_state_t

Activations 4

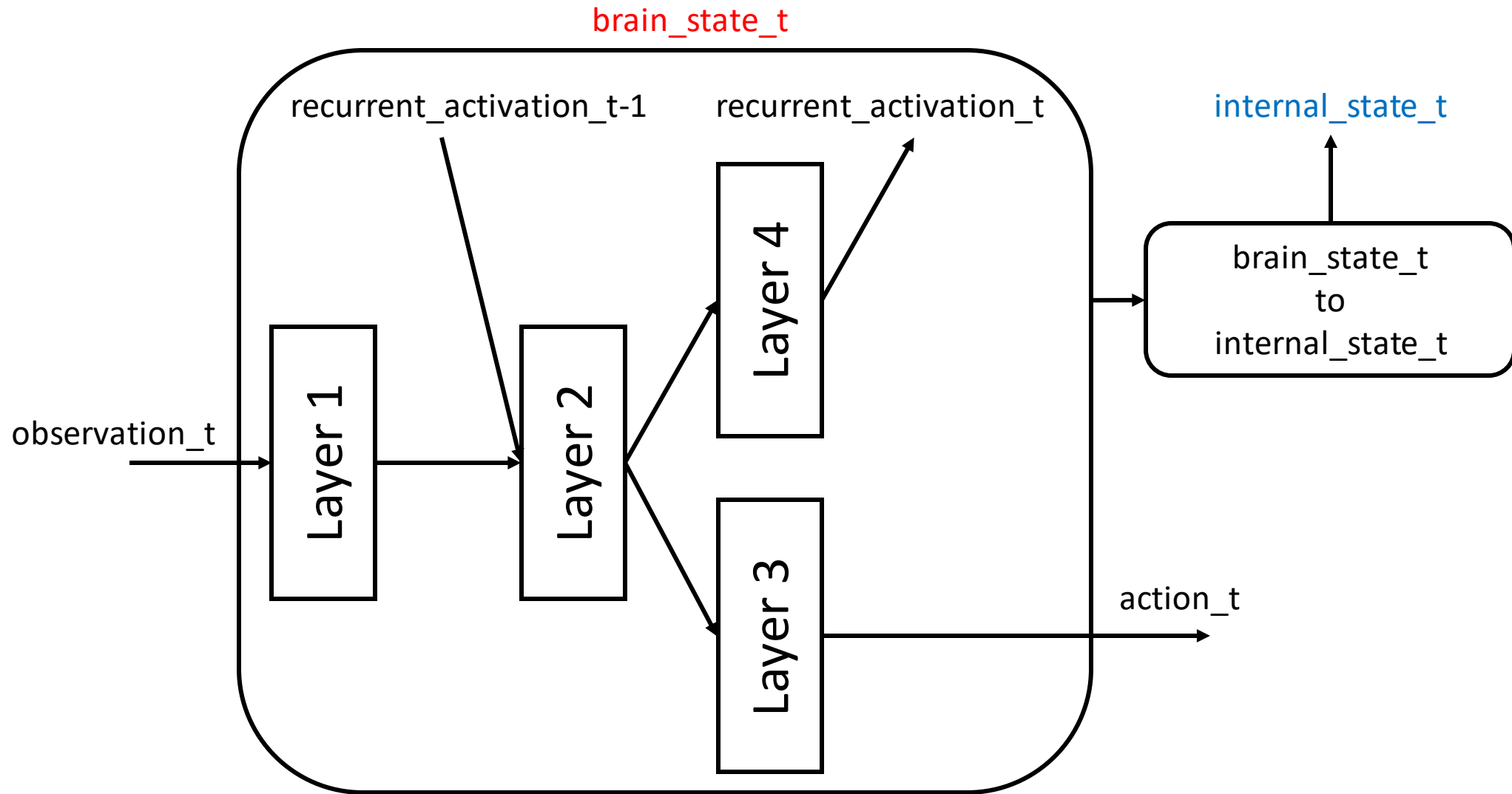


internal_state_t



{High above the ground,
right of the center
falling too fast}

Design, V0



Did we satisfy our requirements?

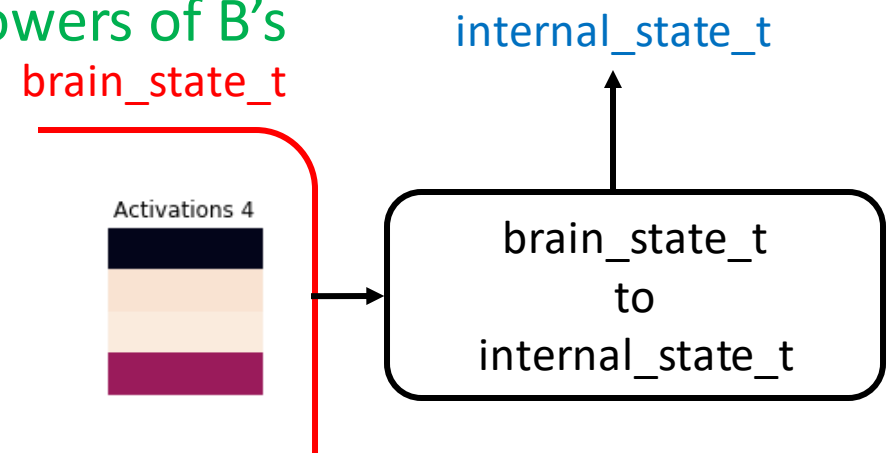
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Phenomena of type A are ontologically reducible to phenomena of type B if and only if A's are nothing but B's

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Our ontology

- Layer weights of the neural network
- Connectivity of the neural network
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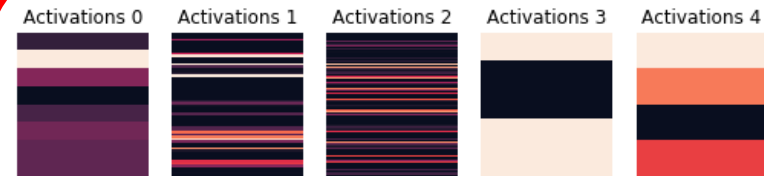
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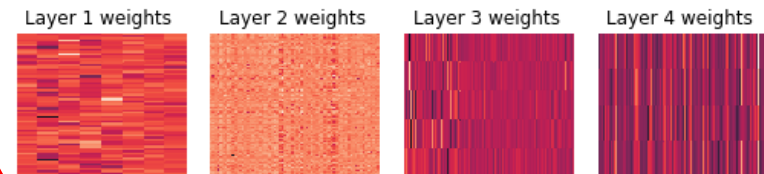
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{ 'I_am_high_above_the_ground', 'I_am_to_the_right_of_the_center', 'I_am_falling_too_fast' }

network activations at time t



network layer weights



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layer 4 weights



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

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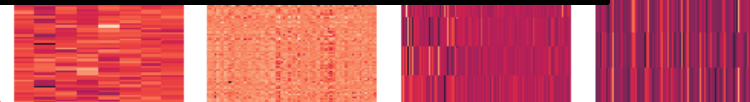
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Is that the “real” ontology though?

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- Bits
- Python objects
- Electrons
- Quarks
- ...

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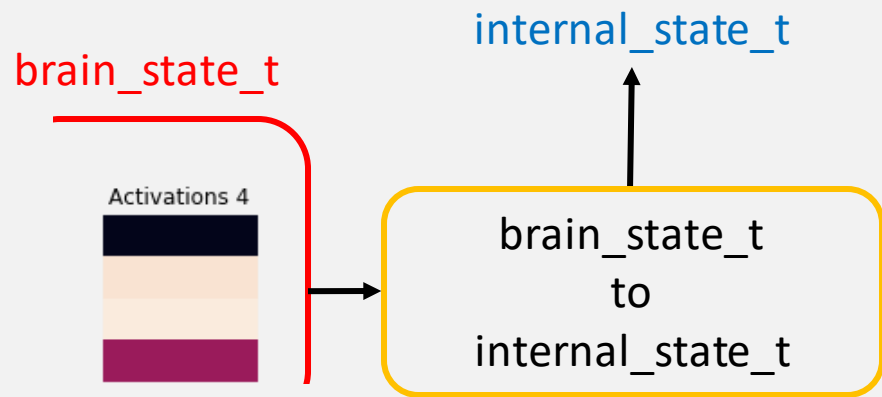
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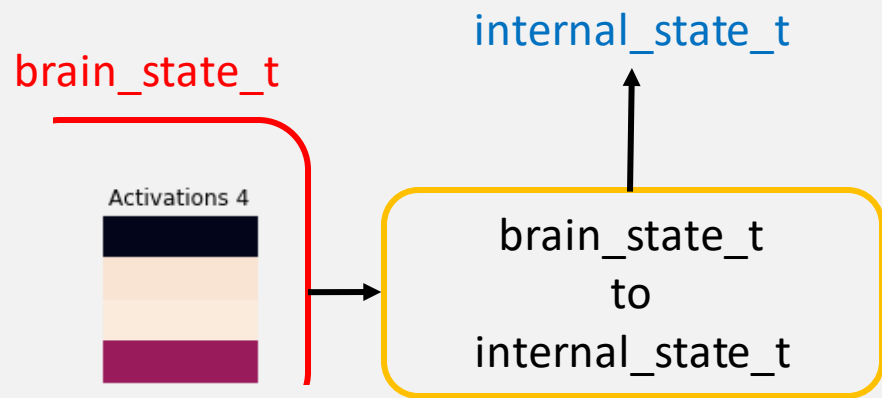
What's the deal with that function?

{High above the ground,
right of the center
falling too fast}



What's the deal with that function?

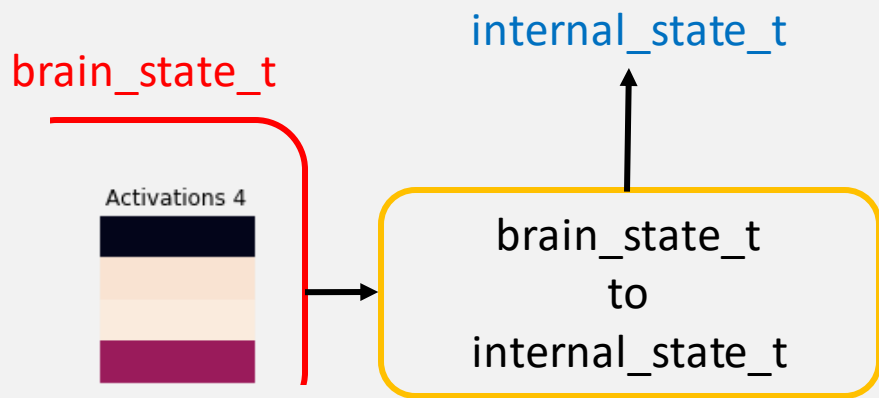
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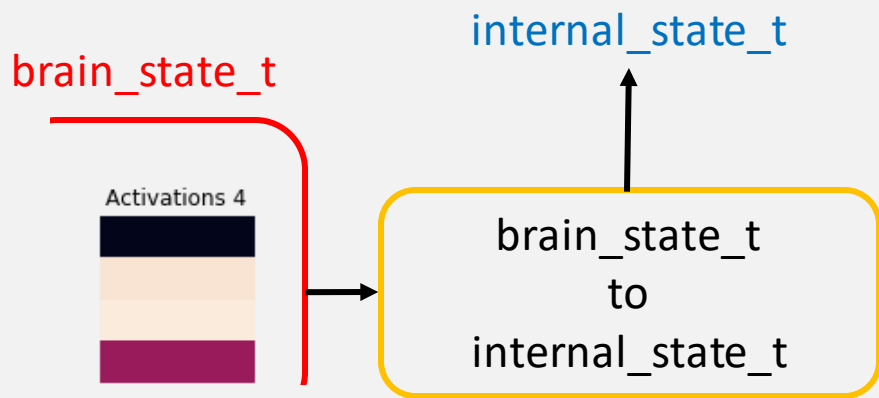


- Is this just some representation of "data flow"?

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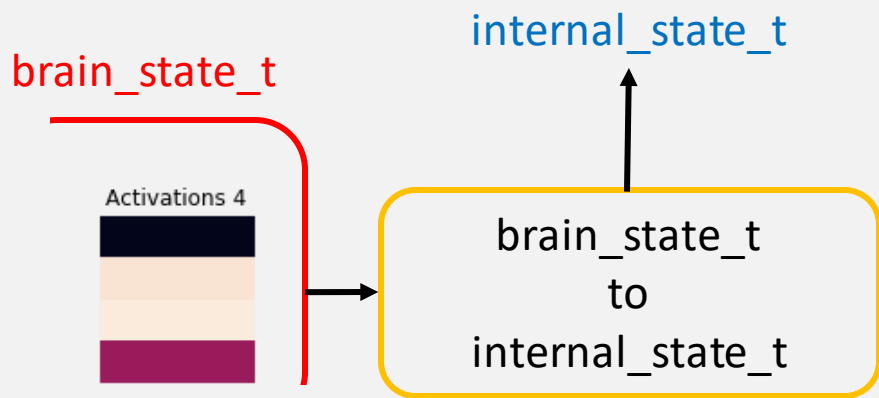


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"[...] consciousness is a state the brain can be in, in the way that liquidity and solidity are states that water can be in."

- *Why I'm Not a Property Dualist*, John Searle

brain_state_t

Activations 4



brain_state_t
to
internal_state_t

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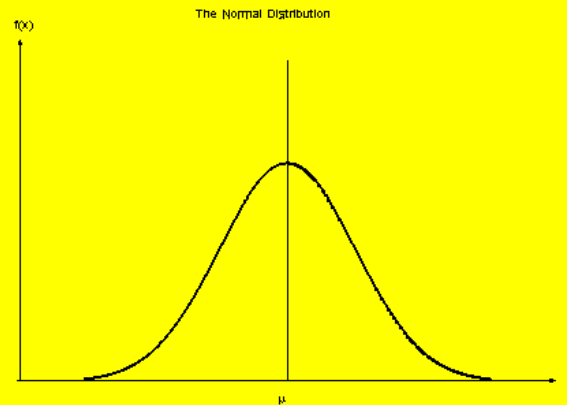
Just like a gaussian and its parameters...

brain_state_t

Activations 4



- Is this just some
- Is this something
- (or both?)



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

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

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34
35     return i_am_high_above_the_ground, i_am_low_to_the_ground, i_am_in_the_middle
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Conclusion

- Software engineer style philosophy reifying seemed to work well
- Created a V0 software agent who's
 - Internal states are causally reducible to brain states
 - Internal states are ontologically irreducible to brain states
- Download and play with the code yourself
 - <https://github.com/Josh-Joseph/tsc-2019>
- Disagree with us?
 - 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?