PURDUE UNIVERSITY | Department of Computer Science

Interactive Debugging and Testing Support for Deep Learning

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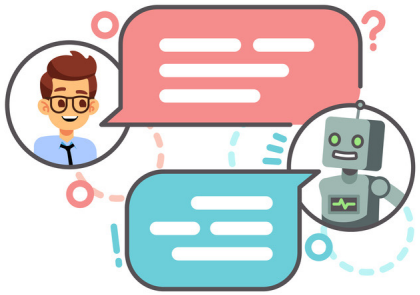
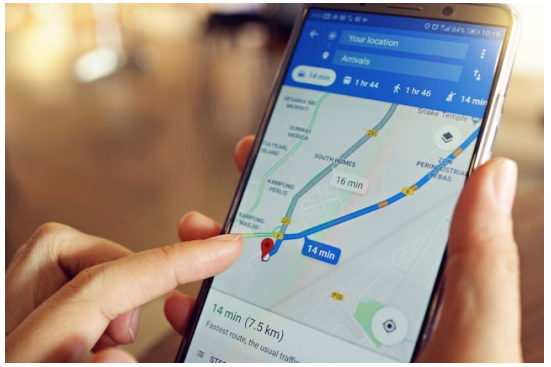
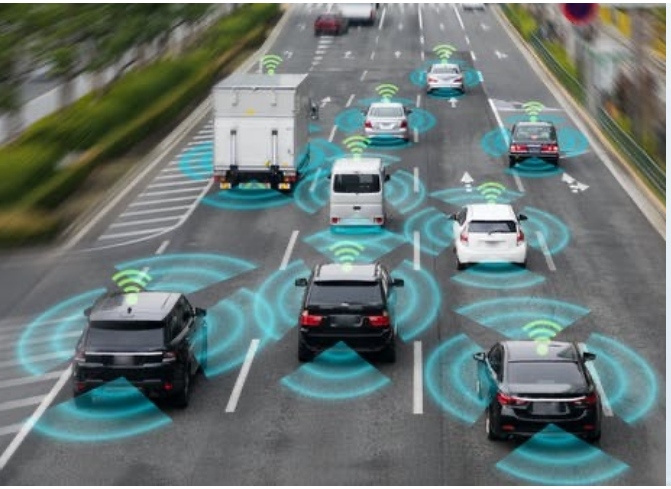
Purdue University

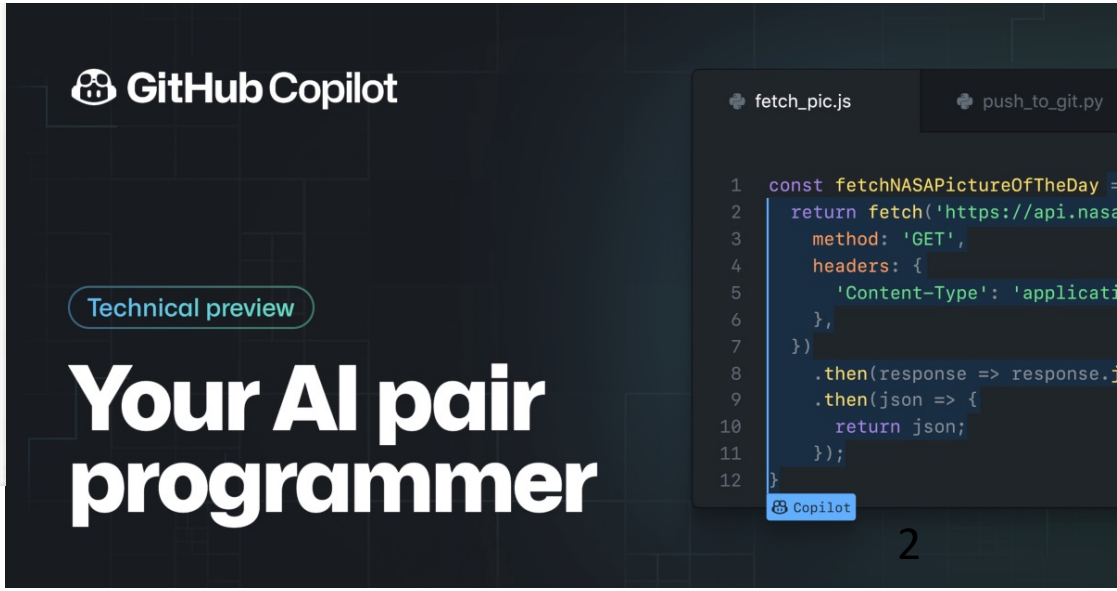
AI is eating software



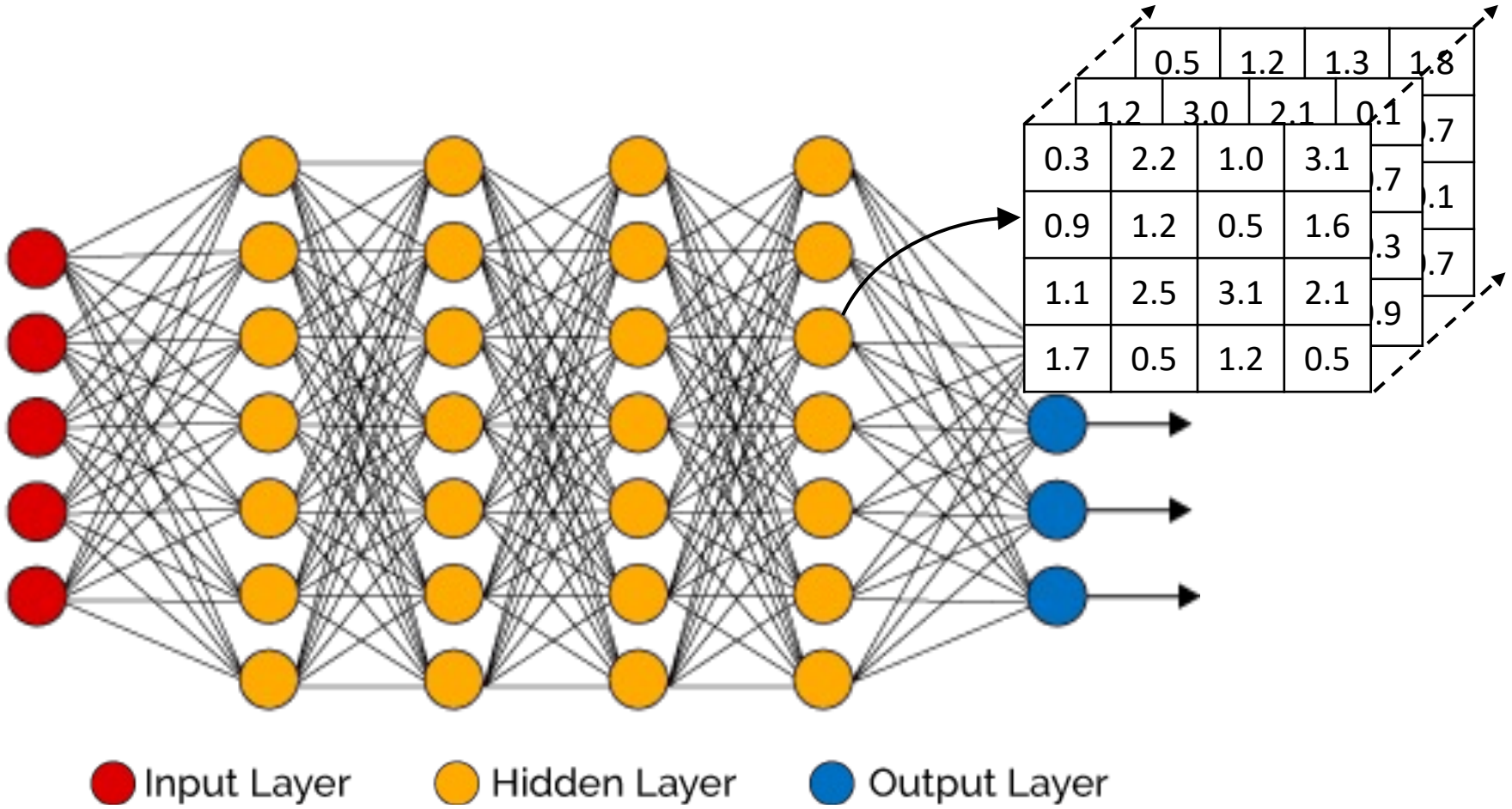
Google Ads







The Key Enabler: Deep Learning



DNNs are hard to debug

Set a breakpoint & step through

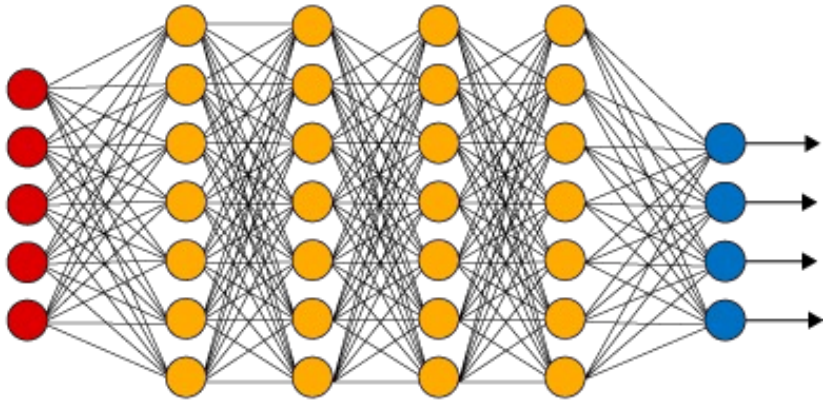
```
static void Main(string[] args)
{
    int testInt = 1;

    for (int i = 0; i < 10; i++)
    {
        testInt += i;
    }

}
```

traditional software

How to set a break point?



???

0.3	2.2	1.0	3.1
0.9	1.2	0.5	1.6
1.1	2.5	3.1	2.1
1.7	0.5	1.2	0.5

neural network

Motivating Example:
An RNN model for sentiment analysis

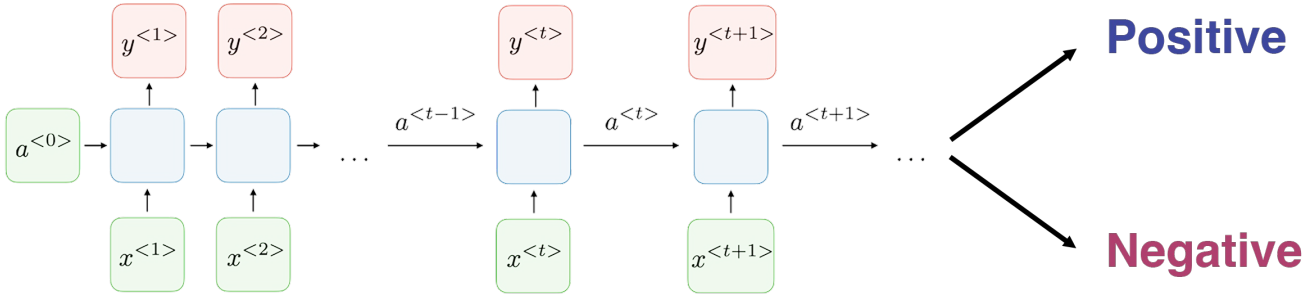
100, 000 comments
from an online forum

His ruling makes perfect sense. Especially when you read the citations of law.

Positive

So John Kelly is just a more useful idiot than the Mooch.

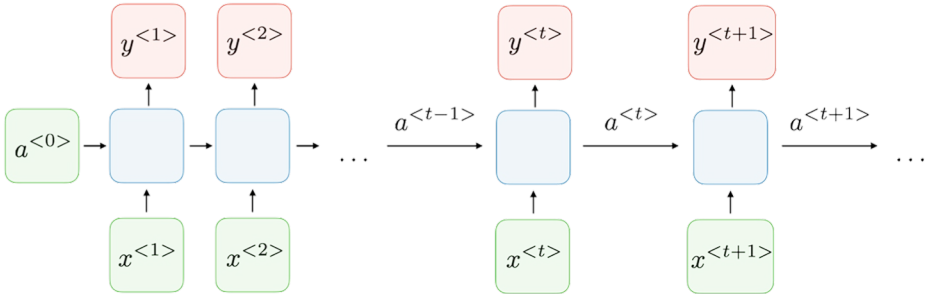
Negative



Motivating Example:
An RNN model for sentiment analysis

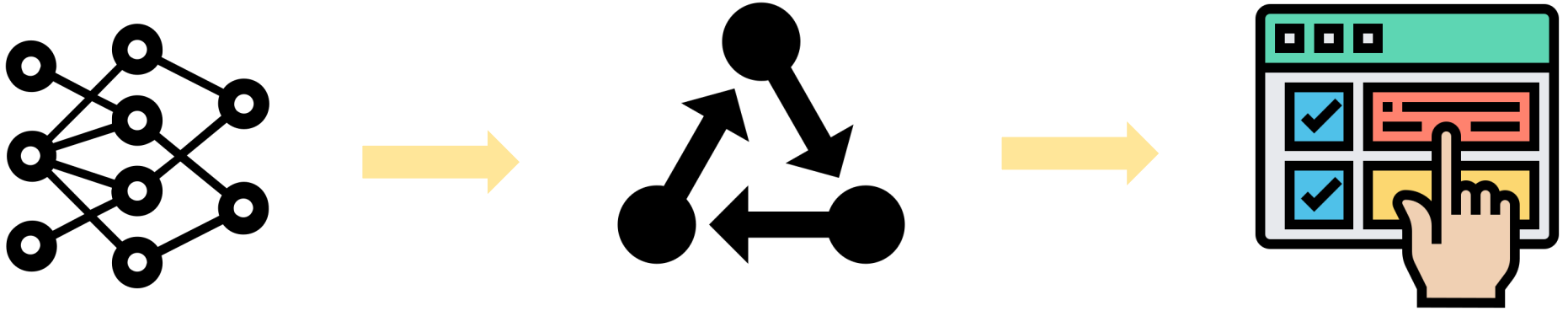
How naïve is Justin. How disingenuous of himself. It's not the money silly. It's being able to plant the seeds of ideas, concepts in the Minister's so that he or she will think favourably on your behalf the next time a related issue raises its ugly head.

- A comment from Reddit



Positive

Our Solution:
Abstracting DNNs to Finite State Machines

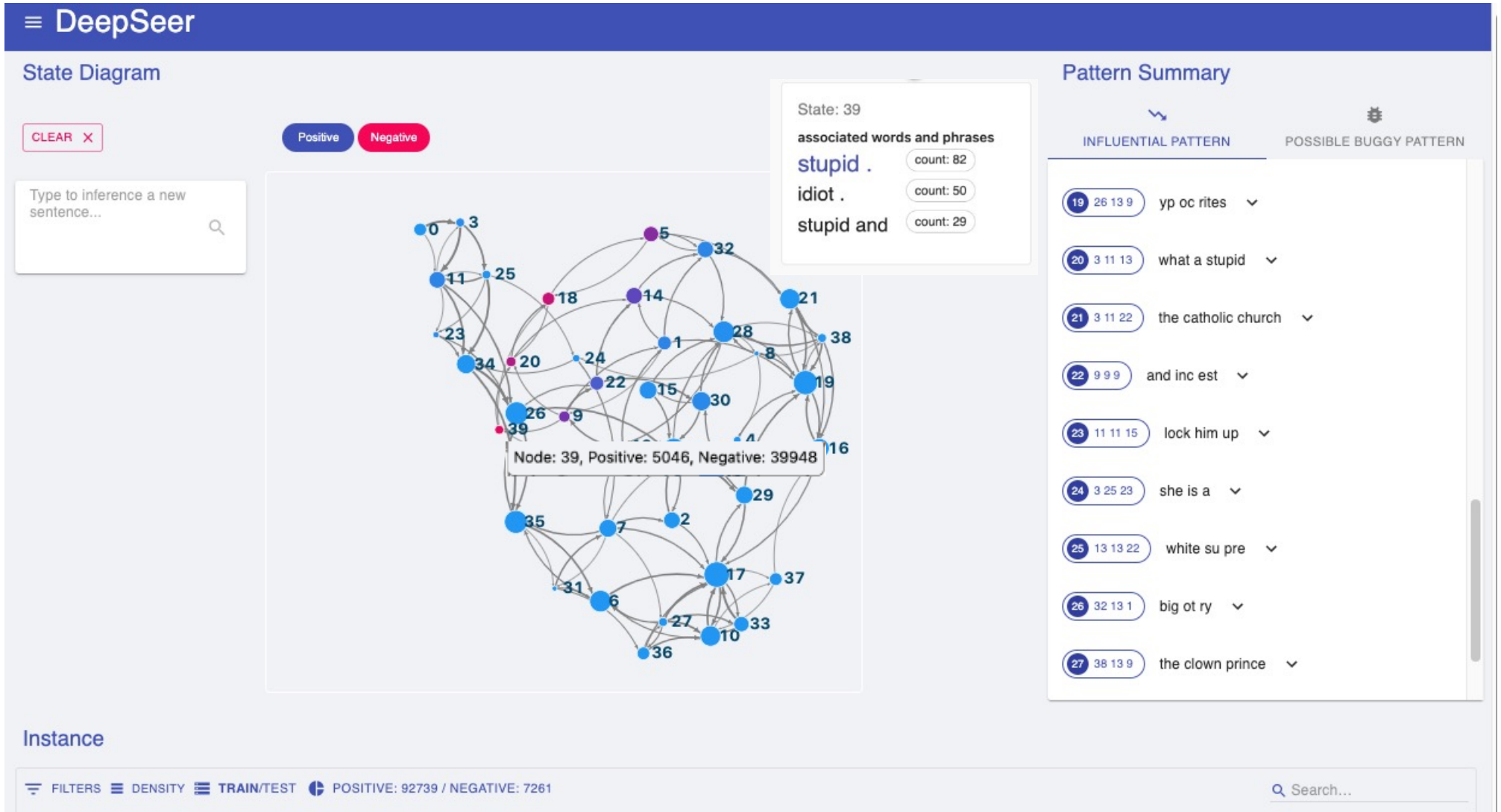


Complex DNN

Finite State Machine

Interaction Support

DeepSeer:
An Interactive System for Debugging and Testing RNN Models



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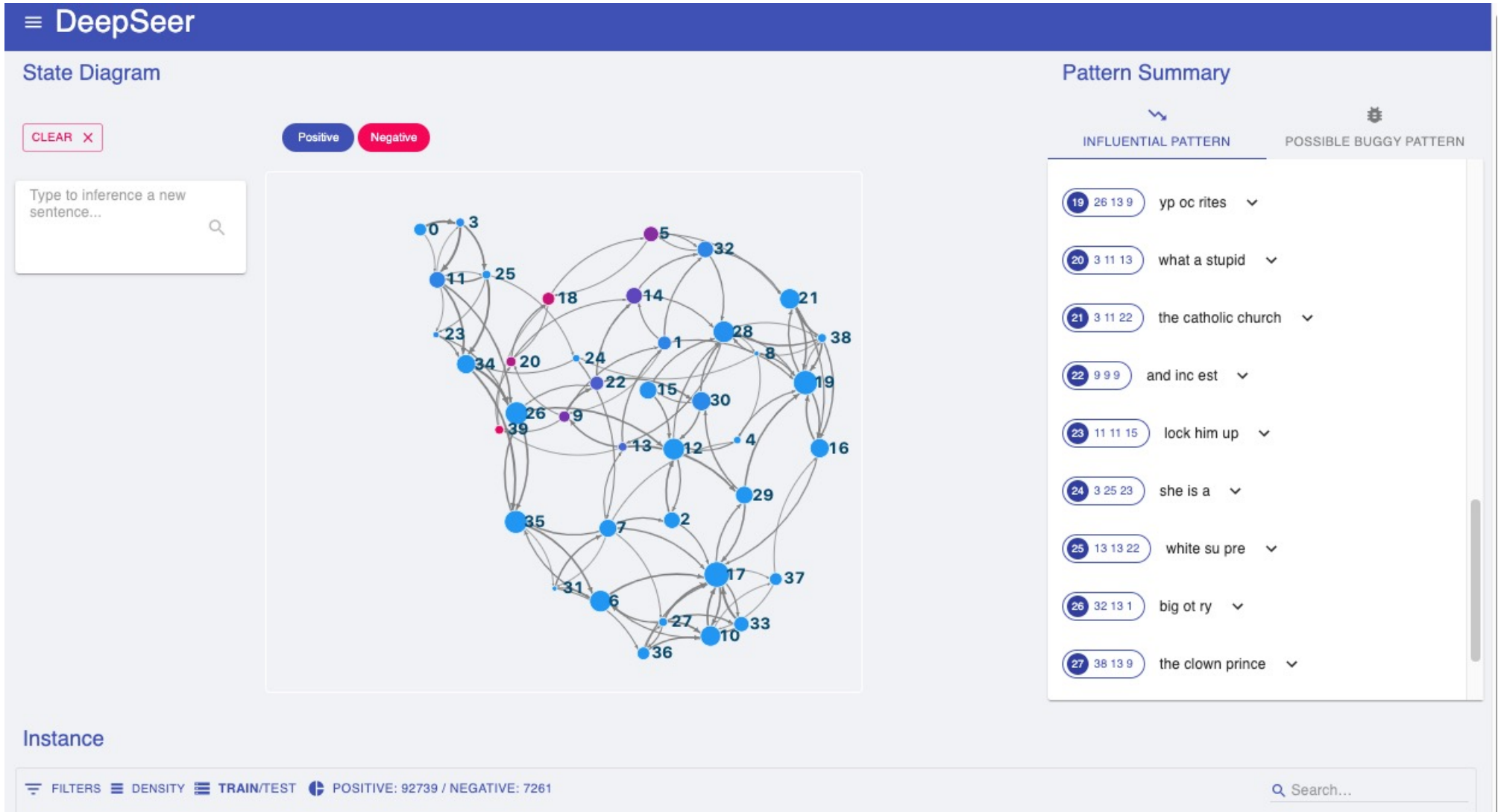

DeepSeer:
An Interactive System for Debugging and Testing RNN Models

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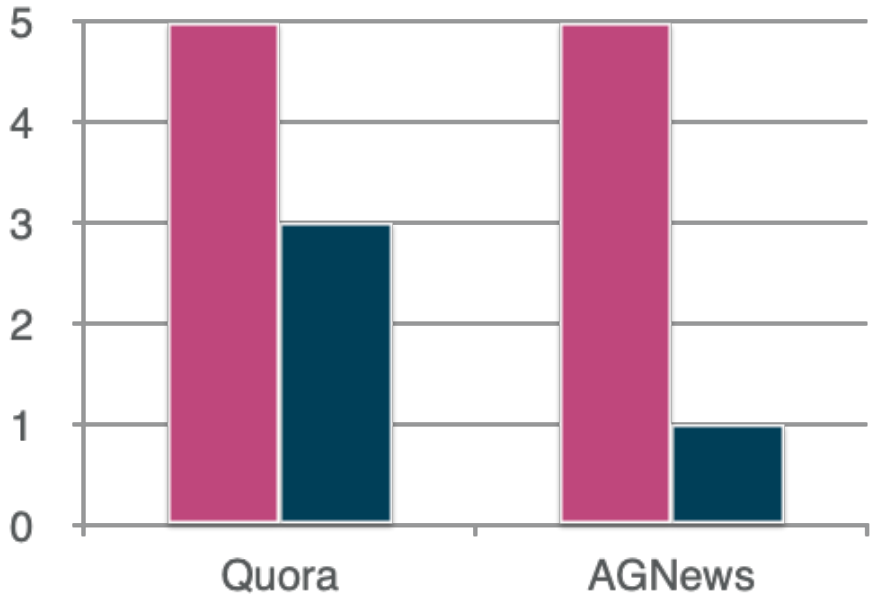
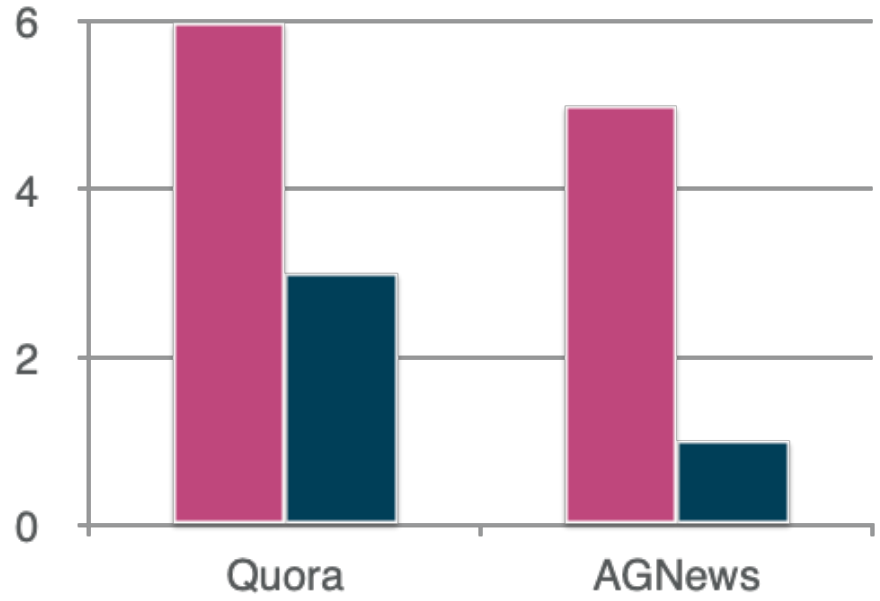
Further investigation reveals imbalanced training data with the word, “quarters”.

The medium number of reasonable explanations per user



The medium number of error-inducing keywords found by users

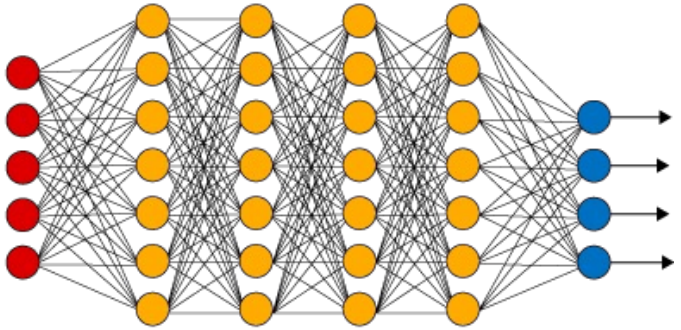


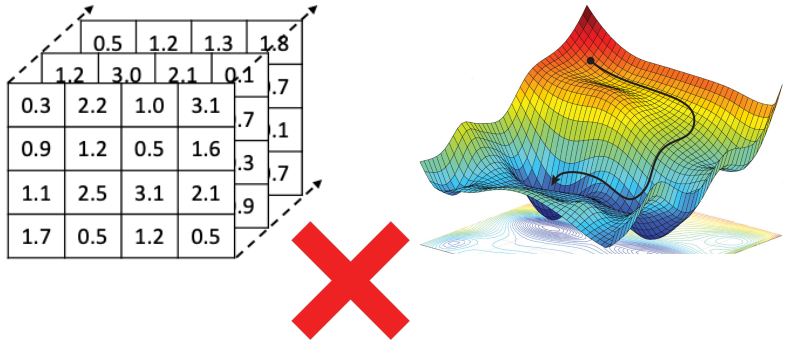
DeepSeer LIME

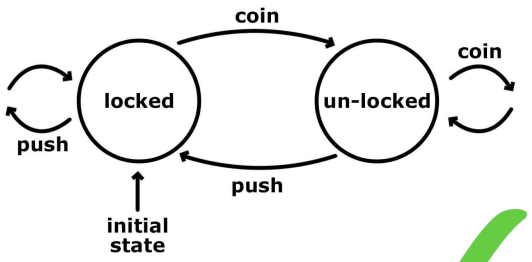
Key Takeaways

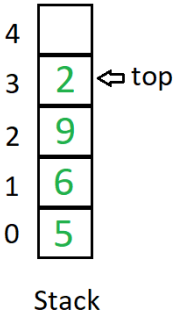
New debugging tools

Responsible AI



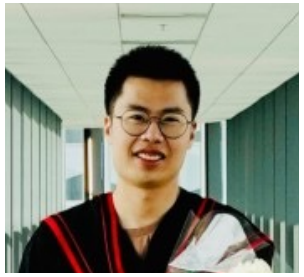






Collaborators:

Prof. Lei Ma



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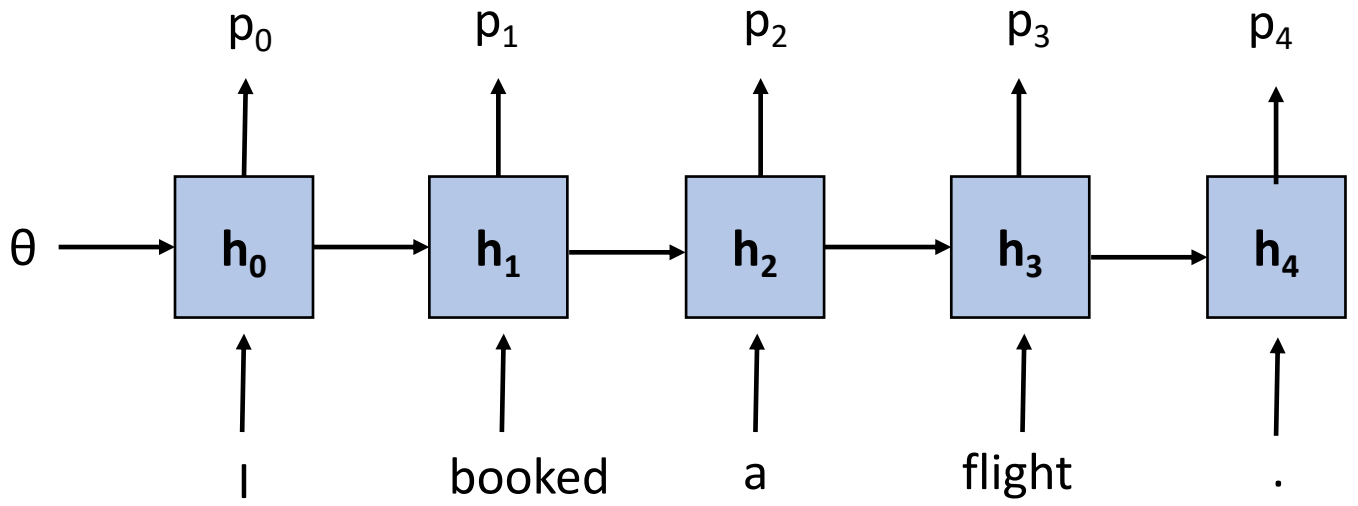
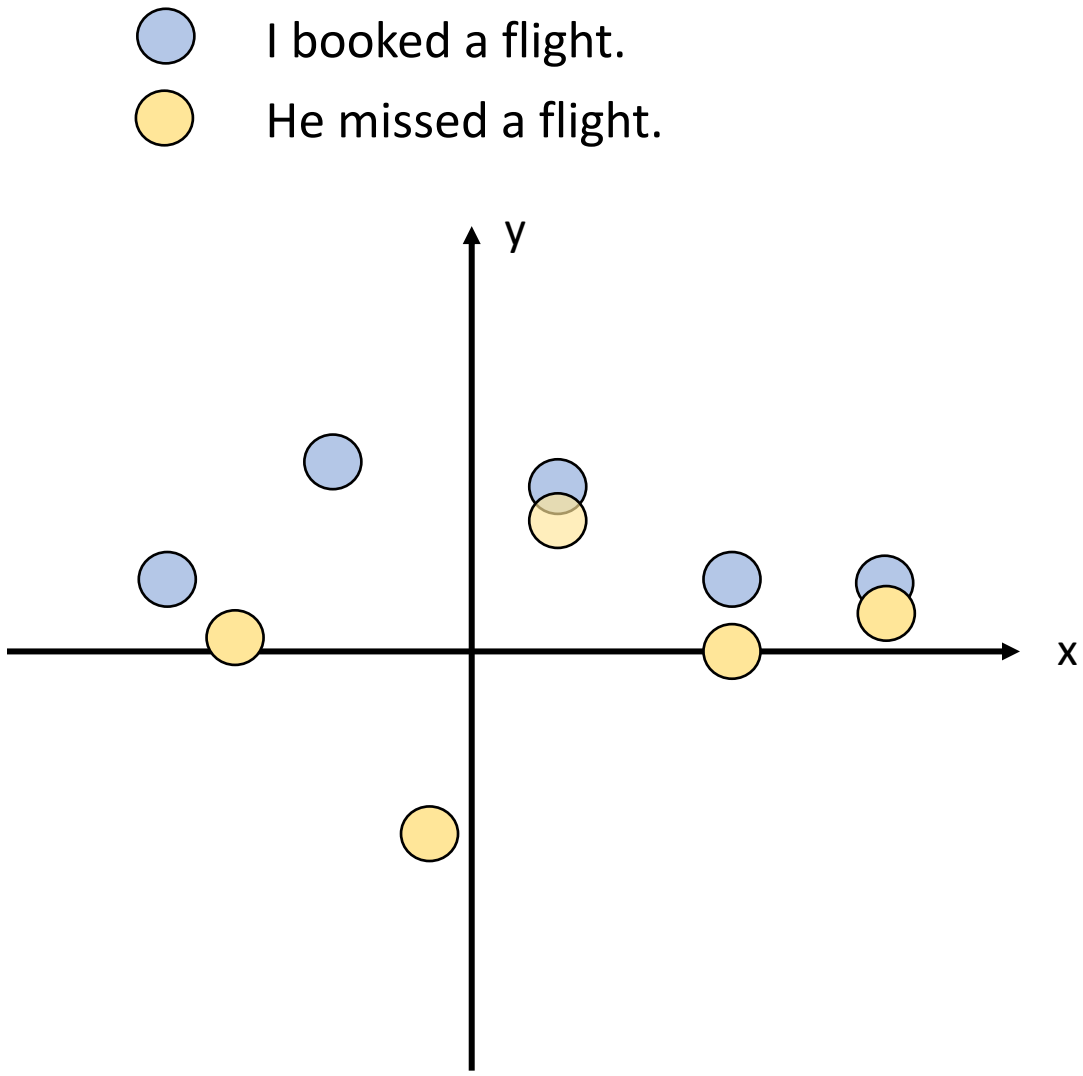
Approach Overview

- State profiling



Approach Overview

- State profiling
- Dimension reduction
  - Principal Component Analysis



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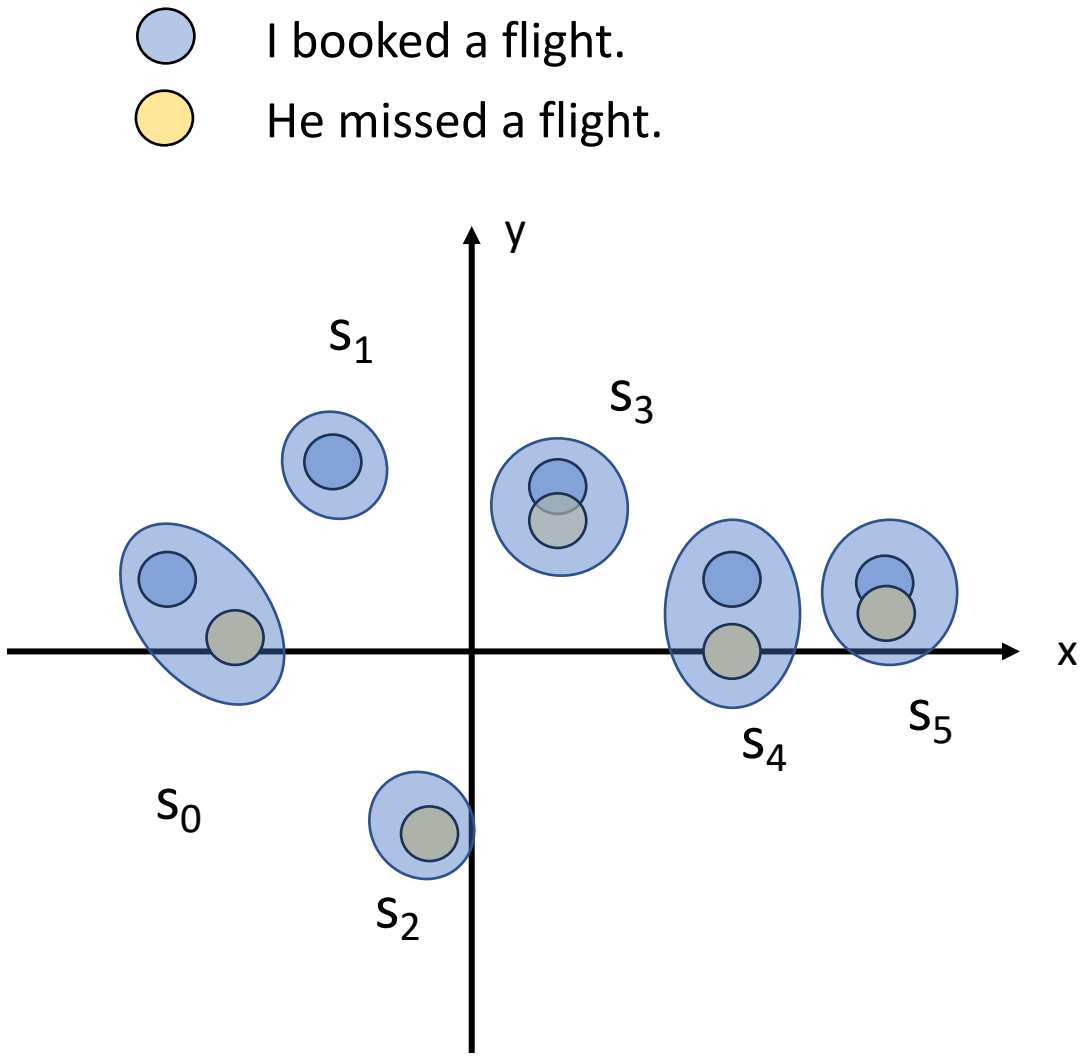
- State abstraction
  - Gaussian Mixture Models



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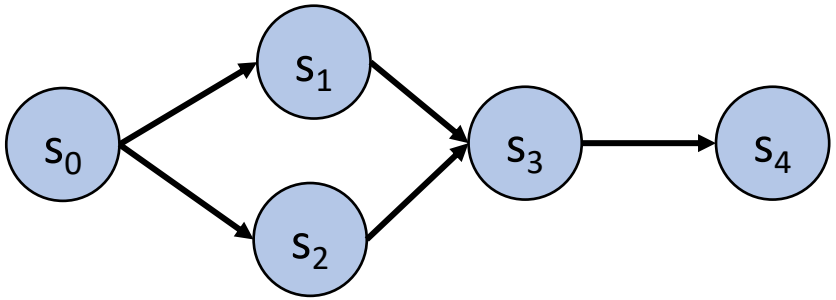
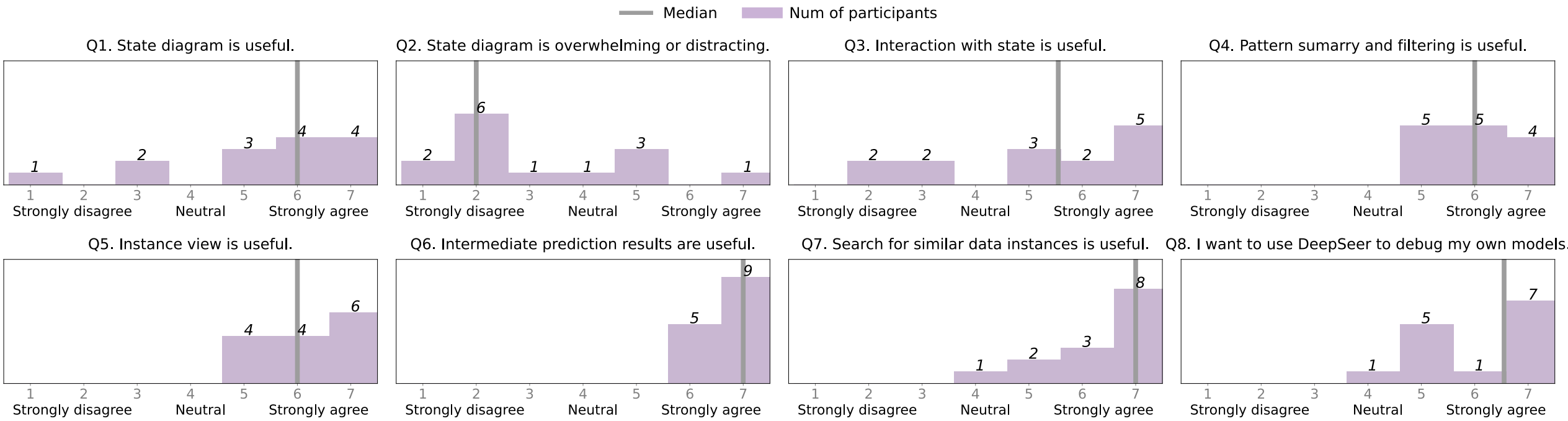


Evaluation
A User Study with 28 Participants



Evaluation
A User Study with 28 Participants

State Diagram

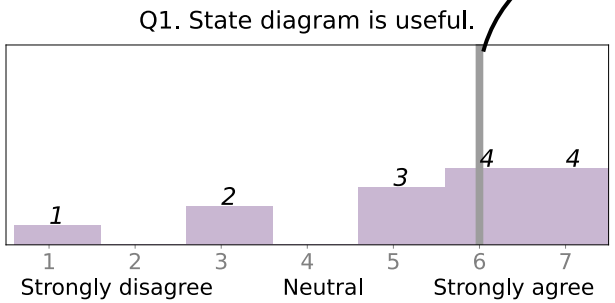
P10 said, "I think DeepSeer is in good design. The best feature I like the visualization of positive/negative states. "

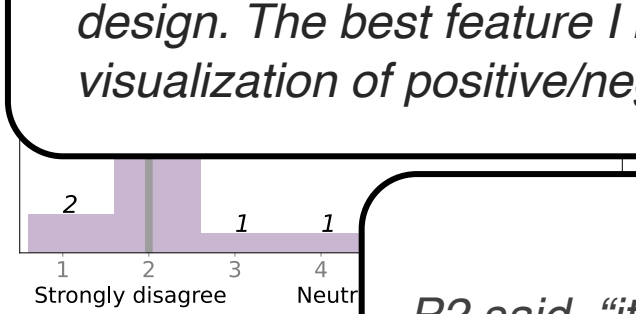
Pattern Summary

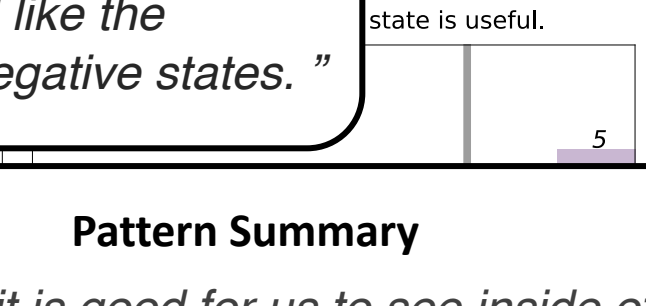
P2 said, "it is good for us to see inside of the model and find the bug with possibly buggy pattern."

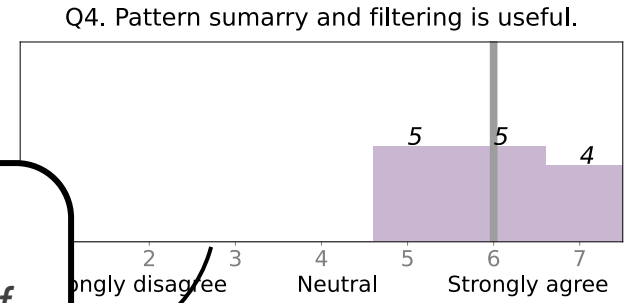
Intermediate Prediction Results

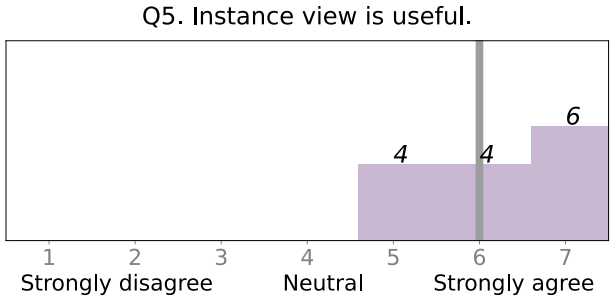
P5 said, "typing out my own example, and seeing the sequence of internal nodes that the RNN went through (and its prediction) was quite useful."

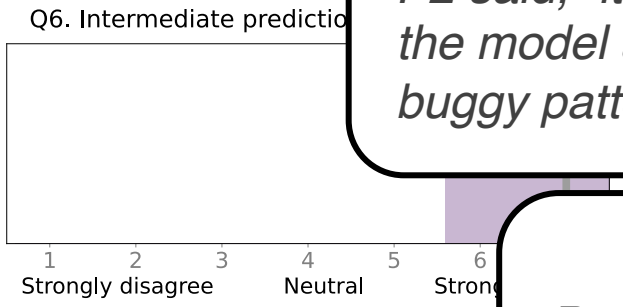


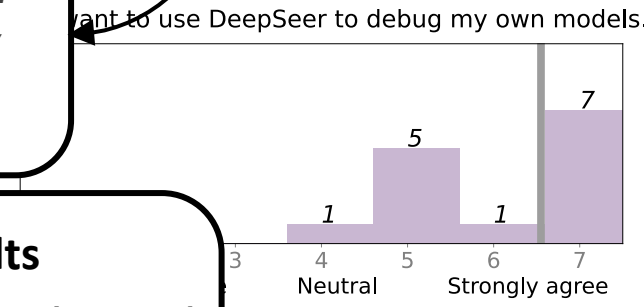












Design Implications

- Opening a black-box model is critical for debugging.
- Users wish to see the internal decision-making process of a model.
- Explanations should be interpretable to users.