

The background features a white space with several colorful circles and dashed lines. In the top left, there is a large teal circle with a white center, a smaller teal circle, and a dashed teal circle. In the top right, there is a large lime green circle, a smaller green circle, and a dashed green circle. In the bottom left, there is a large green circle with a white center, a smaller yellow circle, and a dashed yellow circle. In the bottom right, there is a large orange circle, a smaller pink circle, and a dashed yellow circle. A large dashed blue circle is also present, partially enclosing the text.

# Zhorai:

Designing a Conversational Agent for Children  
to Explore Machine Learning Concepts

**Phoebe Lin, GSD, Harvard**

**Jessica Van Brummelen, CSAIL, MIT**

**Galit Lukin, ORC, MIT**

# Meet Zhorai!

- Interactive, intelligent conversational agent
- Workshop format
- **3rd to 5th graders**



# Motivation

Bring  
transparency to  
tools we  
engineer

Conversational  
AI becomes  
commonplace  
technology

Explore AI  
through natural  
interaction

# Motivation



Characterization  
and engagement

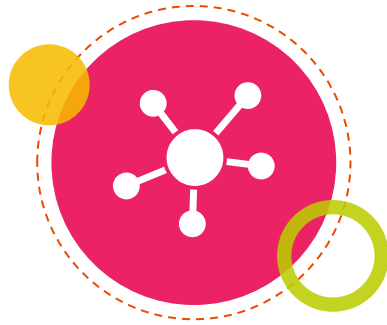
Learn by  
teaching

Visualize and  
observe  
reasoning

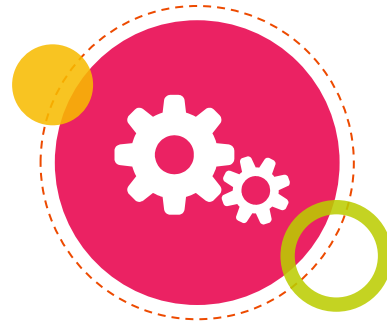
# Big AI Ideas



Natural  
Interaction



Learning



Representation  
& Reasoning



Societal Impact

Source: Touretzky, D.; Gardner-McCune, C.; Martin, F.; and Seehorn, D. 2019. Envisioning ai for k-12: What should every child know about ai? Proceedings of the AAAI Conference on Artificial Intelligence 33:9795–9799



# Activity Assessment












## Objectives

1. How does an agent learn new information?
2. How does the agent represent language?
3. How do machines classify concepts?
4. What are the limitations of ML and why?
5. What are the social implications?

## Assessment

1. Individual student worksheet
2. Testing understanding through discussion

# Activity Breakdown

Name	Description	Online/Unplugged/ Discussion
Warm Up	Pre-Assessments + Introduction to Zhorai	 + 
Module 1	Understanding Knowledge Representation in Machines	 
Module 2	Teaching New Knowledge to Machines	 
Module 3	Witnessing Machine Learning Classification	 
Module 4	AI and Ethics: Scaffolded Discussion	 
Cool Down	Post-Assessments	



Video



## MODULE 3: WITNESSING MACHINE LEARNING

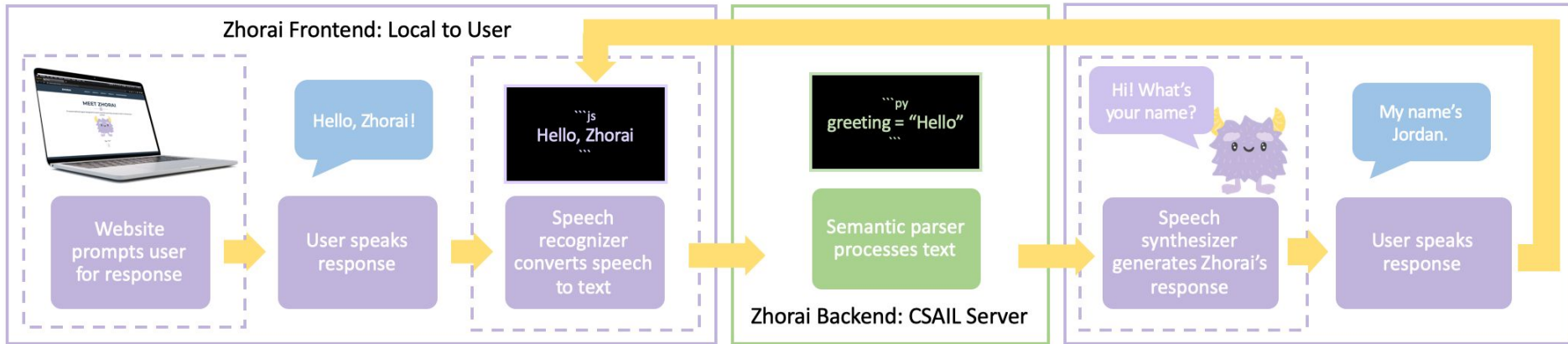


Ask Zhoraï to guess where animals live.

where do they live?



# Technical Implementation



<https://github.com/jessvb/zhorai>

## Zhorai Frontend: Local to User



Website prompts user for response

Hello, Zhorai!

User speaks response

```
```js  
Hello, Zhorai  
```
```

Speech recognizer converts speech to text

```
```js
Hello, Zhorai
```
```

Speech recognizer  
converts speech  
to text

```
```py
greeting = "Hello"
```
```

Semantic parser  
processes text

Zhorai Backend: CSAIL Server

Hi! What's  
your name?

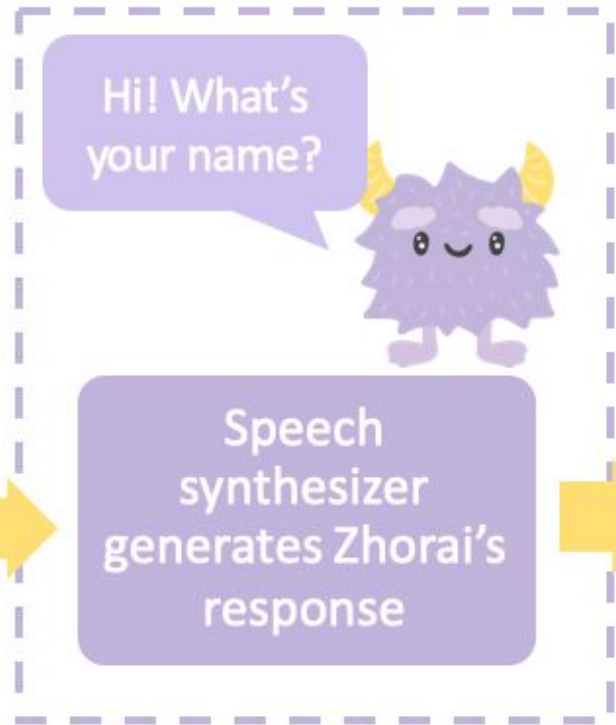


Speech synthesizer  
generates Zhorai's  
response

```
"""py
g = "Hello"
"""
```

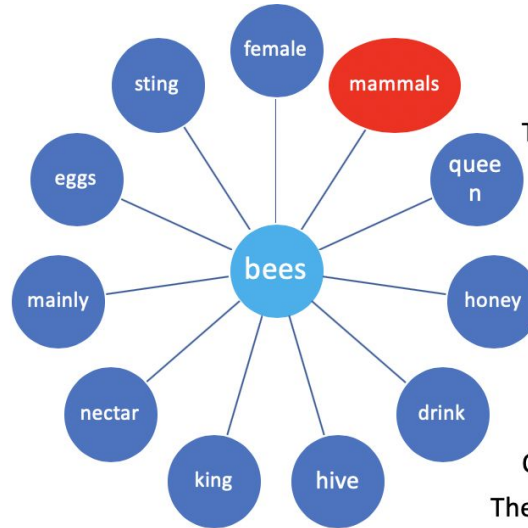
atic parser  
sses text

ad: CSAIL Server



# Semantic Parser

- Sentence Parser and Part of Speech Tagger to extract words that describe the animal.
- Words receive a correlation sign
- Displayed as a Mind Map - a familiar structure for children



(a)

Mainly female bees sting  X

If they sting they die  X

The Stingers stay on its victim  X

Bees live in a hive  X

Spiders eat bees  X

Bees drink nectar  X

Bees make honey  X

Bees are not mammals  X

There are no King bees  X

There are only queen bees  X

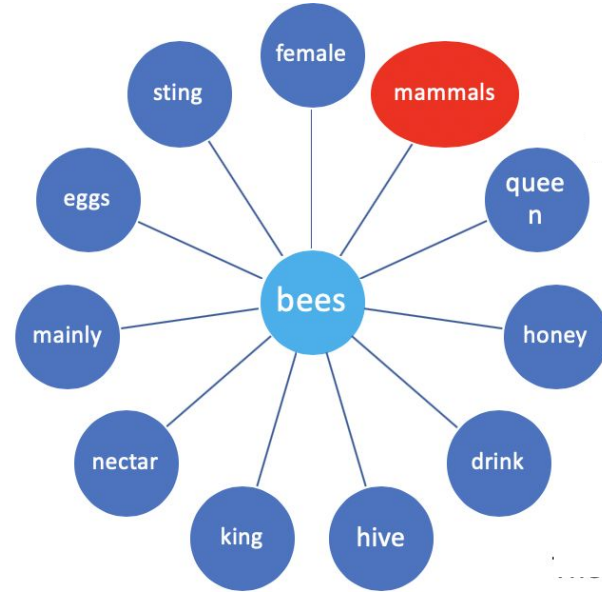
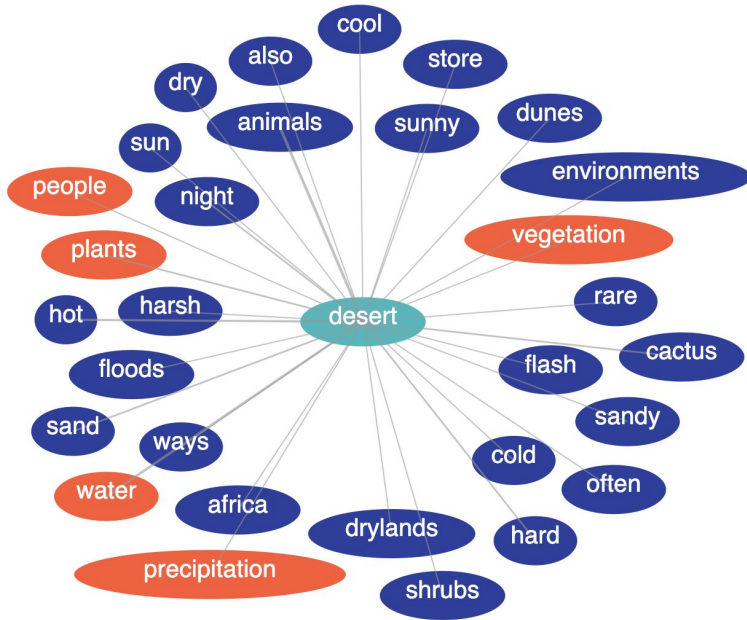
Only the queen bee lays eggs  X

Their hive is made from beeswax  X

(b)

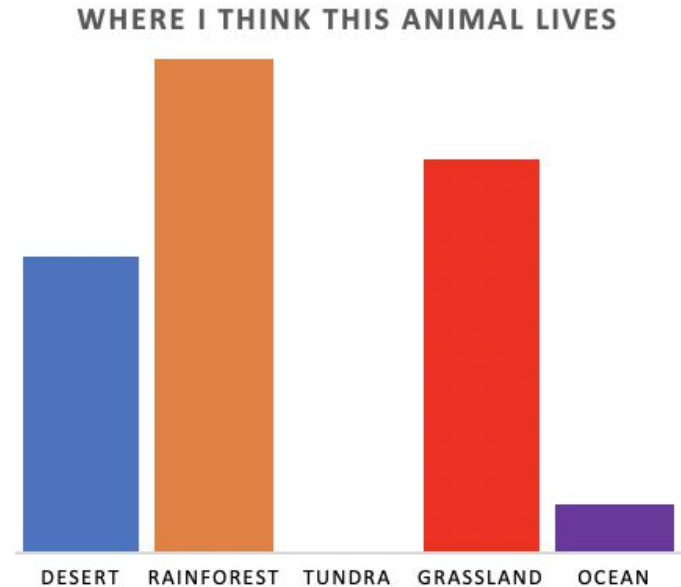
# Calculating Similarity

- Wu-Palmer Similarity between all pairs of words with the same correlation sign.



# Classification

- Classifying animals to an ecosystem
- Input: Semantic parser output from:
  - User provided animal sentences
  - Precompiled ecosystem sentences
- Output: Similarity Score based on the words and correlations
- Displayed as a Bar Graph - a familiar structure for children





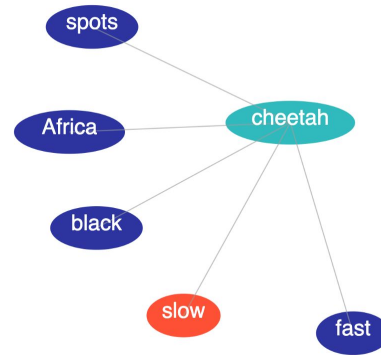


# User Study

- 14 children in groups led by a facilitator
- Pre- and Post-assessments and a worksheet designed to test understanding

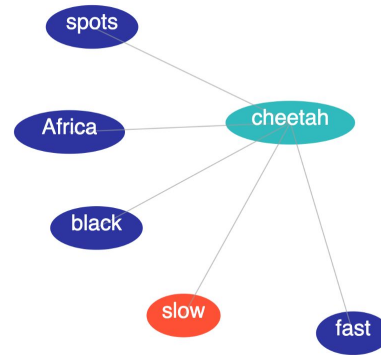
# User Study

- Which sentences could you say to Zhorai to create the following mind map?



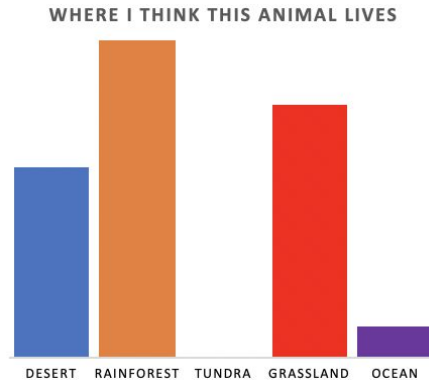
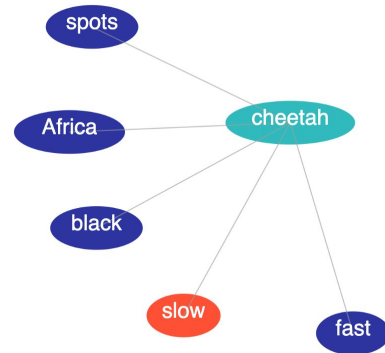
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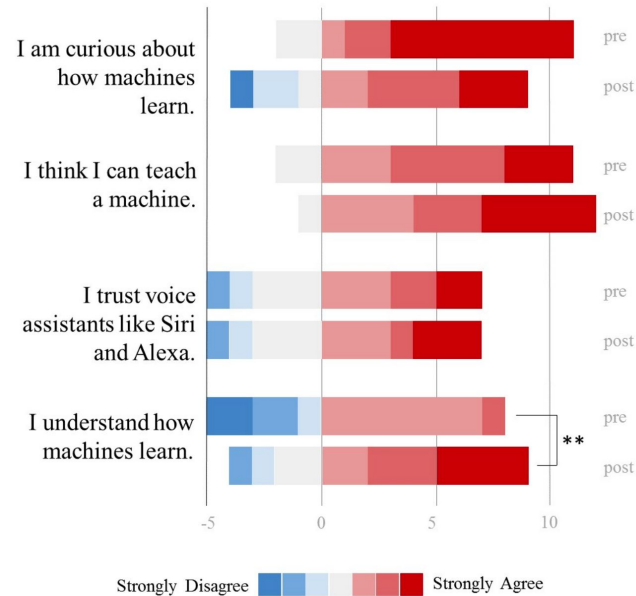
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- Based on this histogram, which ecosystem would Zhorai think a toucan lives in?



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Pre vs. Post-Assessment Responses to Questions



# Results

- **Perception of conversational agents**
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- **AI Ethics**
  - On over-reliance of AI: *“in the future, humans will start depending and relying on AI a lot more, then they could easily make a mistake and not realize that the person they’re trying to help is not getting helped”*
  - On how to reduce harm: *“I think if we gave Zhorai more knowledge, like things we would have in a conversation about Earth, about people, about cultures, about math”*



# Design Implications

**Allow AI to  
make mistakes**

**Visualize the  
system model**

**Learn by  
teaching and  
discussion**

# Future Work

- Larger follow up study
- Voice vs text
- Diversify curriculum and topics
- Collect more data to improve model

A decorative graphic consisting of a large, light blue dashed circle that frames the central text. Various colored circles (solid and hollow) in shades of teal, green, yellow, orange, and pink are scattered around the perimeter of the dashed circle.

# Acknowledgements

We would like to acknowledge Randi Williams and Cynthia Breazeal, our co-authors who helped make this work a reality. We also thank Hal Abelson for his guidance and feedback.



# Thank you!

<https://zhorai.csail.mit.edu>

<https://github.com/jessvb/zhorai>

## Conversational agents and AI education

Potential for conversational agents to be used as a tool for engagement in programming and AI education.

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[@aigelicwings](https://twitter.com/aigelicwings)

## Visualizing system model to children

Children should understand how machines learn, and we can do that by visualizing what's going on underneath the hood.

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[@JessVanBrum](https://twitter.com/JessVanBrum)

## Perspective towards AI

Children are curious about AI and their attitudes influenced their perspectives on AI.

**Galit Lukin**

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