Expanding the Scope of Tasks that Rosie can Learn

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Interactive Task Learning

Design agents that can learn new tasks from scratch through natural forms of interaction

Situated Interactive Instruction

Situated

Instruction happens in a shared environment

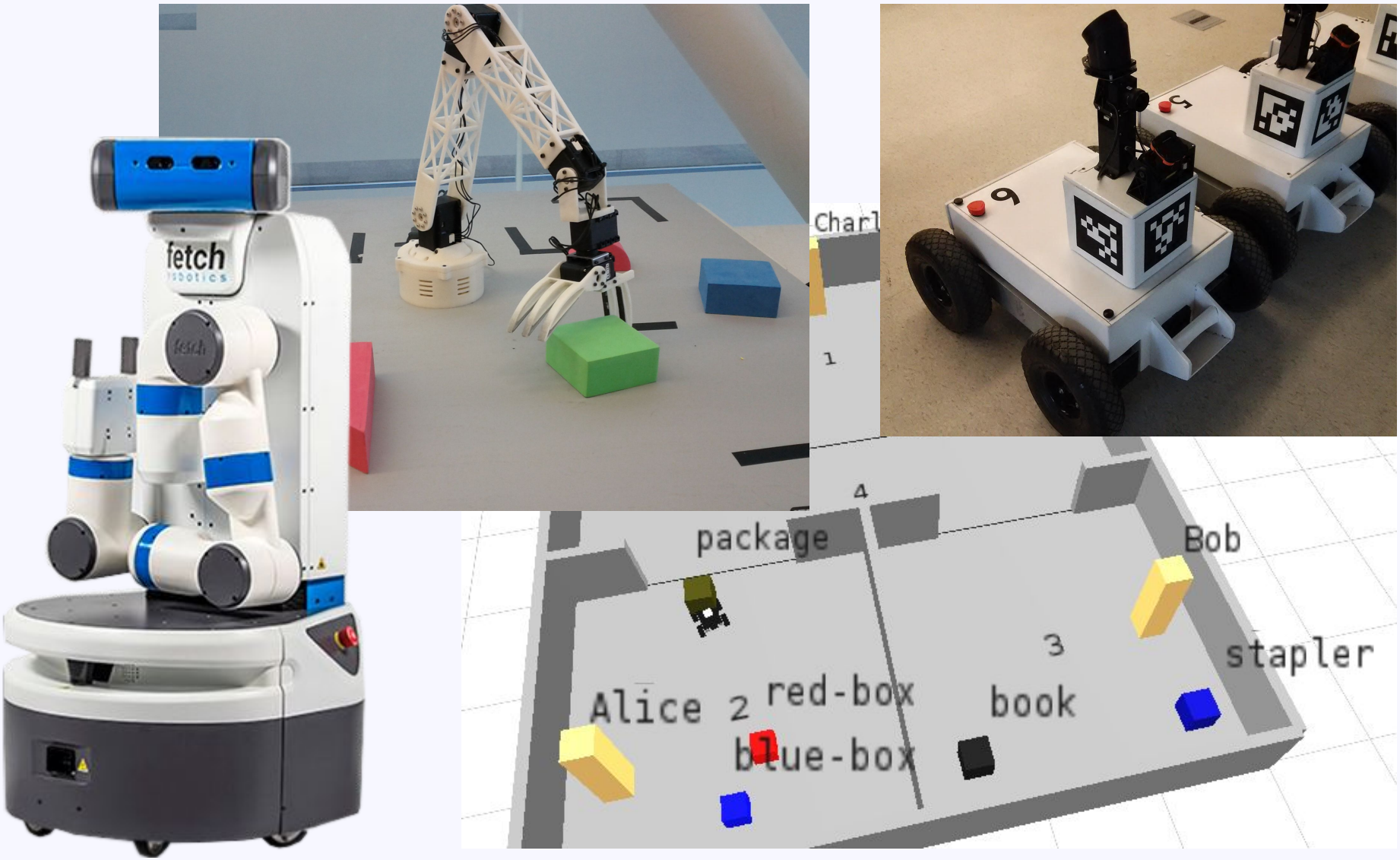
Interactive

Both the instructor and agent engage in dialog

Instruction

Agent learns primarily through natural language

Task Domains



Learning Tasks

Move the cup to the table.

What is the goal?

The goal is that the cup is on the table.

Pick up the cup.

Put the cup on the table.

Task Learning Characteristics

- **Fast and Efficient**

  Learn quickly from few examples

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- **Fast and Efficient**

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- **Effective Generalization**

  Generalize from one example to many variations

- **Compositional**

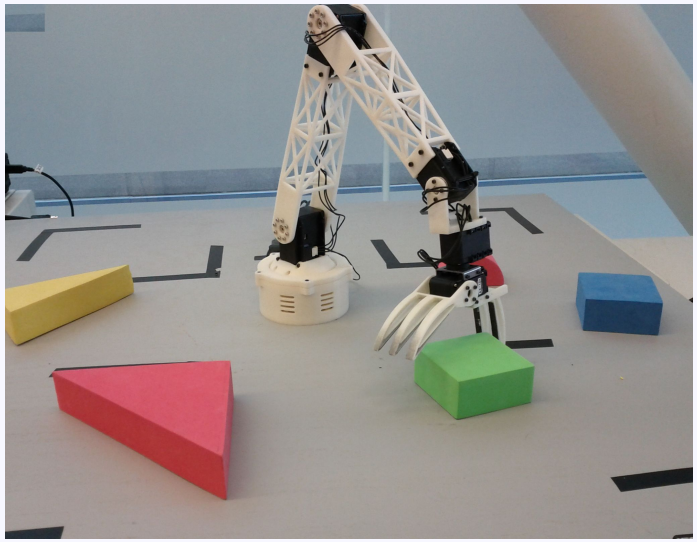
  Build upon previously learned knowledge

- **Diverse**

  Use range of techniques to cover huge task variation

Previous Work on Rosie

- **Goal-Based Formulation**
- **Singular Actions**
- **Sufficient Action Modeling**



Shiwali Mohan. From Verbs to Tasks: An Integrated Account of Learning Tasks from Situated Interactive Instruction. Ph.D. Thesis, 2015.

Expanding Learning Diversity

- **Diverse Action Types**

  Physical, Communicative, Mental, Perceptive

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- **Diverse Task Formulations**

  Goal-Based, Procedural, Optimization, RL

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- **Diverse Task Formulations**

  Goal-Based, Procedural, Optimization, RL

- **Diverse Action Modifiers**

  Control Structures, Collections, Temporal

Diverse Action Types

20 Most Common Verbs

be	take	tell
have	see	work
do	come	call
say	want	try
go	look	ask
get	use	need
make	find	feel
know	give	become
think		

Expanding Learning Diversity

- **Acting**

  do, go, get, make, take, come, use, give, work

- **Mental**

  think, know

- **Communicative**

  say, tell, call, ask

- **Perceptive**

  see, look

Diverse Action Types

Want a rich and varied set of initial actions

Each action requires:

- Proposal Knowledge
- Execution Knowledge
- Modeling Knowledge

Perceptual Actions

Deliver the package to Alice

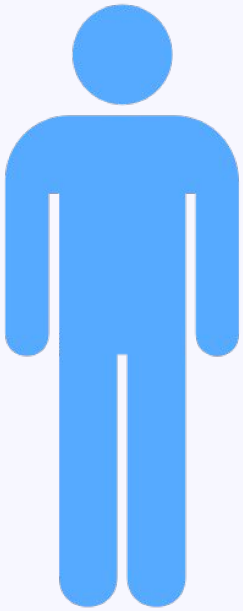
What is the goal?

The goal is that Alice is holding the package

Pick up the package

Find Alice

Give the package to Alice



Mininger, A., and Laird, J. E. (2016). Interactively Learning Strategies for Handling References to Unseen or Unknown Objects. In Proceedings of the Fourth Annual Conference on Advances in Cognitive Systems.

Mental Actions

- **Modifying Working Memory**

  Remember the current location as the starting location.

- **Accessing Semantic Memory**

  Think of an office of Alice.

- **Accessing Episodic Memory**

  Recall Alice in a location.

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Communicative Actions

Tell Alice a message

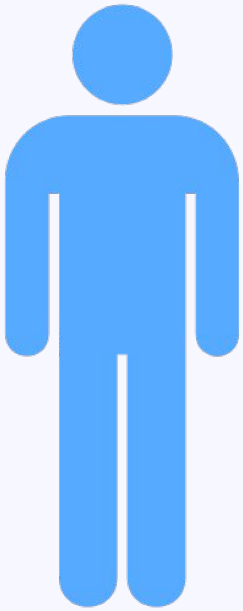
The goal is that Alice heard the message

Ask "What is the message?"

Remember the answer as the message

Find Alice

Say the message.



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Diverse Action Types

pick up
put down
give

open
close
turn on/off

orient
turn
face
approach
go to
find
scan
explore
lead

think
recall
remember

ask
say

Diverse Task Formulations

Diverse Task Formulations

How is the task represented?
What learning mechanisms are used?

May depend on:

- How the task is taught
- What capabilities the agent has
- Characteristics of the task

Goal-Based Formulation

Formulate the task as achieving a goal

Use planning and search to select actions

Discard the soda.

What is the goal?

The goal is that the soda is in the garbage

Procedural Formulation

Formulate the task as following a procedure

Rely on the procedure to execute the task in the future

Lead a tour.

Go to the copy room.

Say ‘Here is where you can make copies.’

Go to the kitchen.

Say ‘Here is where you can eat lunch.’

Compositional Formulation

Formulate the task as performing a set of subtasks

Prepare the conference room.

Perform the following:

Turn on the lights.

Lower the screen.

Put 10 water bottles on the table.

Optimization Formulation

Formulate the task as optimizing some measure

Stock the fridge with sodas.

What is the goal?

Put as many sodas in the fridge as you can.

Reinforcement Formulation

Formulate the task as an RL problem

Stock the fridge with sodas.

What is the goal?

Maximize your reward

When you put a soda in the fridge, you get a positive reward

If you take a soda out of the fridge, you get a negative reward

Diverse Action Modifiers

Diverse Action Modifiers

Modify the actions to allow more complexity

Modifiers Include:

- Groups of Objects
- Control Structures
- Temporal Modifiers

Object Groups

Handle multiple objects in a goal/task

- **Numerical Quantities**
  - Deliver 2 packages to the soar office.
  - The goal is that there are at least 4 sodas in the fridge.

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  - The goal is that all cans are in the trash.
  - Stack all the blocks on the table.

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- **Universal Quantifiers**
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  - Stack all the blocks on the table.
- **Enumeration**
  - Store each object on the table.
  - Maintain each location on this floor.

Conditional Statement

Conditionally execute a subtask

- **If Statement**
  - Example: teaching a maintenance task
  - If you are in the kitchen, stock the fridge.
  - If you are in an empty conference room, turn the lights off

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- **If Statement**
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- **Whenever Statement**
  - Independent task performed when appropriate
  - Whenever you see trash, throw it away

Looping Statements

Execute a subtask multiple times

- **Until Clause**
  - The condition can be used as the action model
  - Wait until *the steak is cooked*.

Looping Statements

Execute a subtask multiple times

- **Until Clause**
  - The condition can be used as the action model
  - Wait until *the steak is cooked*.
- **While Clause**
  - Defines a 'negative' goal, which is harder to learn
  - While the table is not clear, store an object on the table.
  - Wait while the steak is uncooked.

Nuggets and Coal

Nuggets

- Allows a much larger space of tasks to be learned
- Integrated approach allows interesting combinations
- Gives more options to the instructor

Coal

- Task complexity and diversity dwarfs even these extensions
- Multiplication of buggy interactions
- Instruction is still predicted to be precise

Questions?