Learning Instructor Expectations in ITL Agent Interaction

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Motivation


Non-Expert

Special coffee

Robot
Interactive Task Learning

- Learns new task through instruction from humans
  - Through language and demonstration
  - Learning is online, one shot, and in real time.
Interactive Task Learning - Rosie

- Rosie
  - Interactive Task Learning (ITL) agent built on Soar
  - Learn all aspects of tasks: concepts, goals, constraints, failure conditions
  - Knows 30+ games and puzzles, and mobile delivery tasks

Outline

- Current System
- Study design
- Results
• Expert Instructor

You can move a block onto an object that is larger than the block.

Ok, I’ve learned the action.

Expert

Rosie
Prototype - Tower of Hanoi

- Has constraints, actions and goal state
Mentor: The name of the puzzle is Tower-of-Hanoi.

Agent: Please setup the puzzle.

Mentor: Ok.
Agent: Can you describe the actions, goal states and failure conditions?

Mentor: The goal is that a blue block is on a green block and the green block is on a red block and the red block is on an orange location.

Agent: Please setup the goal.
Mentor: Ok.
Agent: Ok, I’ve learned the goal.
PR12  change box colors
Preeti Ramaraj, 5/3/2018

PR13  start with border.. once it is completed, fill color
Preeti Ramaraj, 5/3/2018
Agent: Can you describe the actions, goal states and failure conditions?

Mentor: You can move a clear block onto a clear object that is larger than the block.

Agent: I don’t know the concept clear.
Mentor: If a location is not below an object then it is clear.
Agent: Ok, I’ve learned the concept clear.
**Existing Expert ITL Interaction**

**Agent:** Can you describe the actions, goal states and failure conditions?

**Mentor:** You can move a clear block onto a clear object that is larger than the block.

**Agent:** I don’t know the concept larger.

Mentor: If the volume of a block is more than the volume of an object then the block is larger than the object.

**Agent:** Ok, I’ve learned the concept larger.
Agent: Can you describe the actions, goal states and failure conditions?

Mentor: You can move a clear block onto a clear object that is larger than the block.

Agent: Ok, I’ve learned the action.
Mentor: Done
Agent: Ok, I’ve learned the rules of Tower-of-Hanoi. Please setup the initial state so that I can try and solve the puzzle.
Mentor: Ok.
Mentor: Done
Agent: Ok, I’ve learned the rules of Tower-of-Hanoi. Please setup the initial state so that I can try and solve the puzzle.
Mentor: Ok.
Agent: (searches for solution)
Agent: I have found a solution.
Problem

- Non-expert Instructor

You can move a fox or a geese to the boat if there are less than 2 blocks on the boat already.

I don't understand.

Non-Expert

Rosie
(maybe show a small snippet of person failing)

Preeti Ramaraj, 5/7/2018
1. Can a non-expert instructor successfully teach our ITL agent?
Characteristics of ITL Agent Interaction

- Modularity

Diagram:
- Learn Concept
- Learn Concept
- Learn Action
- Learn Goal
- Name Setup puzzle
- Learn Concept
- Learn Goal
- Learn Action
- Learn Concept
- Finish Teaching
Characteristics of ITL Agent Interaction

- Domain-specific Language
- Agent Feedback

Mentor: You can move a clear block onto a clear object that is larger than the block.
Agent: I don't know the concept clear.
switch agent feedback and local correction
Preeti Ramaraj, 5/6/2018
Characteristics of ITL Agent Interaction

• Local Correction

Mentor: The goal is that a blue block is on a green block and the green block is on a red block and the red block is on an orange location.

Agent: Please setup the goal.
Mentor: Ok.
Agent: I cannot satisfy the goal. A blue block is not on a green block.
Mentor: Ok.
Agent: Ok, I’ve learned the goal.
Questions asked in the study

1. Can a non-expert instructor successfully teach our ITL agent?

2. How do the characteristics of modularity, local correction, agent feedback and domain-specific language affect the teaching process?
Outline

- Current System
- Study design
- Results
1. 10 participants
   - Ensured they already knew the puzzle Tower of Hanoi
2. Pre-experiment survey
3. Information provided to the instructor
Study Design: Between-Subjects Design

Condition 1

Condition 2

- **Name**: The name of the puzzle is sorting-puzzle.
- **Failure state**: If a red block is on a blue location then you lose.
- **Goal state**: The goal is that all the red blocks are on the red locations and all the blue blocks are on the blue locations and all the green blocks are on the green locations.
- **Action**: You can move a block onto a clear location.
- **Concept**: If a location is not below an object then it is clear.
5. Post-Experiment Survey

- Rate ease of teaching

- Rate helpfulness of
  - condition information (video/sample instructions)
  - agent knowledge
  - being able to ask questions of the agent
add images for condition info, agent knowledge, ??? for interaction better or worse, maybe thumbs up and thumbs down... and ease of teaching

Preeti Ramaraj, 5/5/2018
Study Design

• Wizard of Oz Design
• To accommodate free-form language
• Created a codebook

Move block from location 1 to location 2
You can move block onto a location.

“on top of” = “above” = “on”
“place” = “move”

I have learned the goal
I cannot satisfy the goal state

• Agent says “I don’t understand”
Outline

• Current System
• Study design
• Results
Can a non-expert instructor successfully teach our ITL agent?

9 out of 10 instructors successfully taught the puzzle of Tower of Hanoi.
Qualitative results from the study - Outline

• Failures in instruction
• Instructor responses to survey questions
• Effect of characteristics of ITL agent interaction

Failures in Instruction

• Instruction is not understood by agent
• Task Component is not successfully learned
• 80 total failures
Failures in Instruction

- Multiple Sentence: 3
- Typographical Error: 3
- Ungrammatical Structure: 7
- Complicated Structure: 15
- Unanticipated Structure: 16
- Demonstration Failure: 10
- Unable to find solution: 4
- Unable to execute instruction: 4
- Language+Demonstration: 18

Frequency
Failures in instruction

- Multiple sentences
- Typographical Error
- Ungrammatical Structure
- Complicated Structure
- Unanticipated Structure
- Unable to find solution
- Unable to execute instruction
- Demonstration Failure
- Language + Demonstration Failure

Mentor: You can move one block at a time. The goal is to move all the blocks to the orange location from the green location.
Failures in instruction

• Multiple sentences
• Typographical Error
• Ungrammatical Structure
• Complicated Structure
• Unanticipated Structure
• Unable to find solution
• Unable to execute instruction
• Demonstration Failure
• Language + Demonstration Failure

Mentor: AA valid location is when category is location or category is block with volume greater-than object.
Failures in instruction

- Multiple sentences
- Typographical Error
- Ungrammatical Structure
- Complicated Structure
- Unanticipated Structure
- Unable to find solution
- Unable to execute instruction
- Demonstration Failure
- Language + Demonstration Failure

Mentor: **Blocks that are greater-than other blocks cannot be on top of lesser-than blocks.**
Failures in instruction

- Multiple sentences
- Typographical Error
- Ungrammatical Structure
- **Complicated Structure**
- Unanticipated Structure
- Unable to find solution
- Unable to execute instruction
- Demonstration Failure
- Language + Demonstration Failure

Mentor: The goal of the game is to have the red, green, and blue blocks on top of each other with the same order as the initial state at a location different than the initial location.
Failures in instruction

- Multiple sentences
- Typographical Error
- Ungrammatical Structure
- Complicated Structure
- Unanticipated Structure
- Unable to find solution
- Unable to execute instruction
- Demonstration Failure
- Language + Demonstration Failure

Mentor: I will show you the goal state
Mentor: The location isn’t free anymore once the blocks are moved.
Failures in instruction

- Multiple sentences
- Typographical Error
- Ungrammatical Structure
- Complicated Structure
- Unanticipated Structure
- Unable to find solution
- Unable to execute instruction
- Demonstration Failure
- Language + Demonstration Failure

Agent: “I don’t understand”
Failures in instruction

- Multiple sentences
- Typographical Error
- Ungrammatical Structure
- Complicated Structure
- Unanticipated Structure
- Unable to find solution
- Unable to execute instruction
- Demonstration Failure
- Language + Demonstration Failure

Mentor: Done.
Agent: Setup initial state
Mentor: Ok.
Agent: I am unable to find a solution. I do not see any actions in the state.
Failures in instruction

- Multiple sentences
- Typographical Error
- Ungrammatical Structure
- Complicated Structure
- Unanticipated Structure
- Unable to find solution
- Unable to execute instruction
- Demonstration Failure
- Language + Demonstration Failure

Mentor: Please move the red block to the orange location
Agent: I cannot do this action.
Failures in instruction

- Multiple sentences
- Typographical Error
- Ungrammatical Structure
- Complicated Structure
- Unanticipated Structure
- Unable to find solution
- Unable to execute instruction
- Demonstration Failure
- Language + Demonstration Failure

Mentor: The goal state is that the red block is on the orange location, the green block is on the red block, and the blue block is on the green location.

Agent: Please setup the goal state
Mentor: Ok

Agent: I cannot satisfy the goal. The blue block is not on the green location.
Mentor: The goal is that all the blocks are on the orange location.

*Agent: Please setup the goal state.*

Mentor: Ok.

*Agent: I cannot satisfy the goal. All the blocks are not on the orange location.*
Failures in Instruction

- Multiple sentences
- Typographical Error
- Ungrammatical Structure
- Complicated Structure
- Unanticipated Structure
- Unable to find solution
- Unable to execute instruction
- Demonstration Failure
- Language + Demonstration Failure

- Cannot anticipate all possible instructions
- Agent could provide example instruction
- More explicit feedback than “I don’t understand”
- Feedback completely dependent on instruction
- Transparency mechanisms to get access to agent’s view
Qualitative results from the study - Outline

- Failures in instruction
- Instructor responses to survey questions
- Effect of characteristics of ITL agent interaction
Helpfulness of Video/Sample Instructions

- Video
- Sample Instructions

Rating:
- Not at all helpful
- Very helpful

Frequency:
Instructor Responses to Survey Questions

Helpfulness of Video/Sample Instructions

• Video
  – P63: “It helped clarify the type of language needed to teach her and what information was necessary before she could solve the puzzle.” (Rating: 5)

• Sample Instructions
  – P13: “Provided some base terms to work with along with the framework that Rosie was building to solve the puzzle.” (Rating: 4)
Ease of Teaching

Frequency

Rating

Very Difficult

Very Easy

Video

Sample Instructions

Instructor Responses to Survey Questions

Sample Instructions
Ease of Teaching

• Video
  – P63: “I was unsure about some of the words and phrases I used and whether Rosie would understand them. However, after a few interactions with her it became more clear what kind of teaching style was necessary.” (Rating:5)

• Sample Instructions
  – P91: “The language processing abilities of the agent were very intuitive, but the feedback was very minimal.” (Rating:5)
Instructor Responses to Survey Questions

Helpfulness of knowing agent knowledge

- Video
- Sample Instructions

Frequency vs. Rating

- Not at all helpful
- Very helpful

Rating: 1, 2, 3, 4, 5

Frequency: 0, 1, 2, 3, 4, 5, 6
ake this one graph dont separate by condition
Preeti Ramaraj, 5/6/2018

knowledge was same for both conditions
Preeti Ramaraj, 5/6/2018
Helpfulness of knowing agent knowledge

P13: “It was very helpful to know whether or not she understood the instructions.” (Rating: 4)
Qualitative results from the study - Outline

- Failures in instruction
- Instructor responses to survey questions
- Effect of characteristics of ITL agent interaction
Effect of characteristics of ITL agent interaction

- Modularity
  - Instructors taught component in non-specific order
  - Agent response valuable
  - Can adapt to teaching style
Effect of characteristics of ITL agent interaction

• Agent Feedback
  – Confirming its knowledge
  – Indicating it is ready for a new instruction
  – Reassuring to get general and component-level feedback
  – Clearer feedback required

Valuable
Effect of characteristics of ITL agent interaction

• Local Correction
  – Used agent feedback to
    • Rephrase instruction
    • Verify demonstration
  – Unsure how to get out of instruction failure
  – Explicit instruction to reverse knowledge helpful
consider adding a video snippet of instructor constantly failing
Preeti Ramaraj, 5/7/2018

maybe in accompanying slide
Preeti Ramaraj, 5/7/2018
Effect of characteristics of ITL agent interaction

- Domain-specific Language
  - Instructor adapted to expected instruction set
  - Instructor used interchangeable words and synonyms
  - Top 3 failures were result of language
  - Expand language processing capabilities
Summary

Nuggets
• First step into understanding what an instructor’s expectations are
• Instructors were able to successfully teach the task

Coal
• Preliminary results
• Too specific to Rosie, need to generalize further
• Improvements are not implemented yet
References

Questions asked by instructors

- 6 out of 10 instructors asked questions
- about perception, long-term knowledge and what actions can it do at any given point of time

Helpfulness of being able to ask questions

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<thead>
<tr>
<th>Rating</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>1</td>
<td>Not at all helpful</td>
</tr>
<tr>
<td>2</td>
<td></td>
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<tr>
<td>3</td>
<td></td>
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<tr>
<td>4</td>
<td>Very helpful</td>
</tr>
<tr>
<td>5</td>
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Time taken across participants

Video (Total Teaching Duration)

Sample Instructions (Total Teaching Duration)
Variation across instructors

**Instructor Initiated Interactions (Video)**

- Participant ID 66: 50 interactions
- Participant ID 63: 20 interactions
- Participant ID 81: 10 interactions
- Participant ID 53: 25 interactions
- Participant ID 16: 40 interactions

**Instructor Initiated Instructions (Sample Instruction)**

- Participant ID 13: 20 interactions
- Participant ID 34: 15 interactions
- Participant ID 79: 30 interactions
- Participant ID 91: 25 interactions
- Participant ID 74: 20 interactions