Designing a Teachable Agent for Novice Programmers

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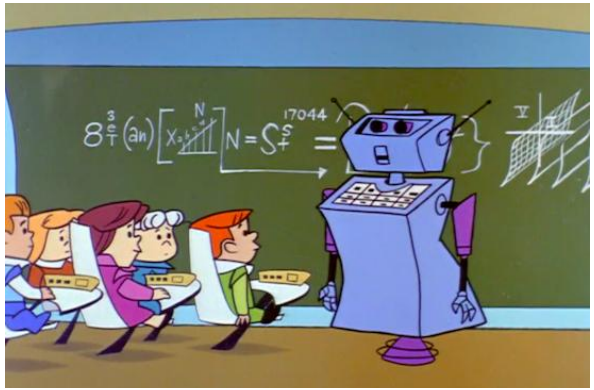
Final Project Presentation for CIS 4930/6930

Fall 2021



Motivation: Novice Programmers

- Novice students in introductory computing class struggle with
  - Development of computational thinking (CT)
  - Language-specific challenges
- Spoken dialogue system might help
- Learning by teaching
- Teachable agents influence self-efficacy, motivation and learning (Jacq et al., 2016)

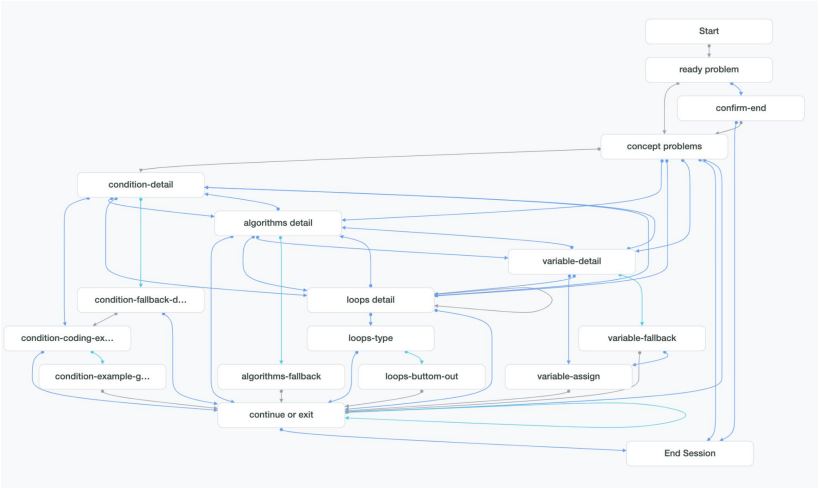
Overview: Teachable Agent

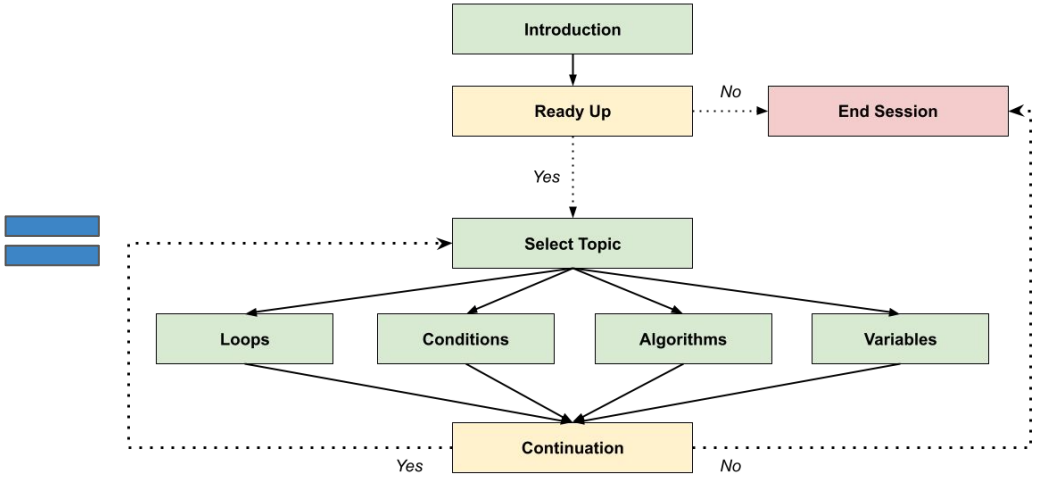
- English-based teachable agent: *Nova*
- Students can teach the agent four specific programming topics
  - Algorithms, Conditions, Loops, Variables
- Presents conceptual problems, combined with coding examples
- *Nova* persona:
  - Young, robotic-voiced alligator
  - Active-listening, positive attitude

Functionality Expansion and Refinement

- Dialogflow ES -> Dialogflow CX
  - Reason: better state management
- Changes to the agent’s conversation
  - Adding coding examples
  - More scaffolding
  - More variations on the problem-specific fallback
- Survey Changes
  - Dropped few ambiguous questions
- Interface Changes
  - Expanding the purpose and defining it more clearly
  - Exit/Ending changes

Dialogue Workflow

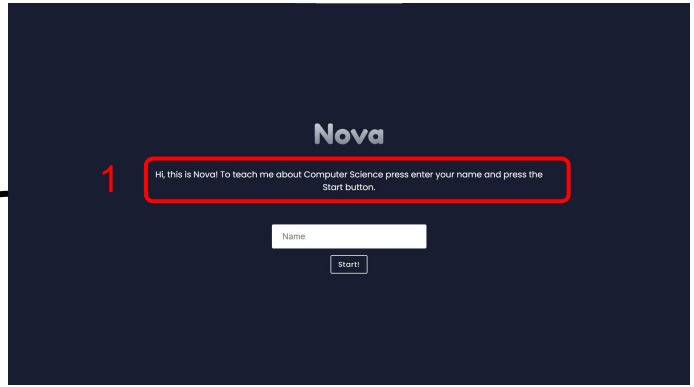


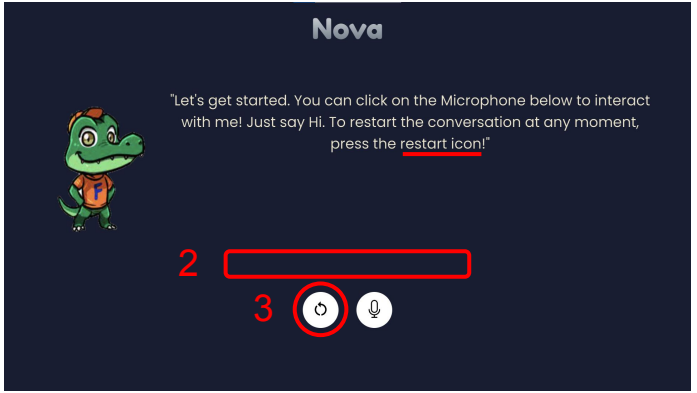


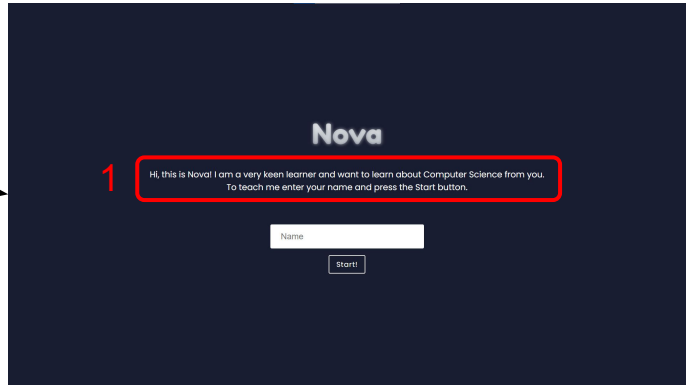
Interface Design (and Modifications)

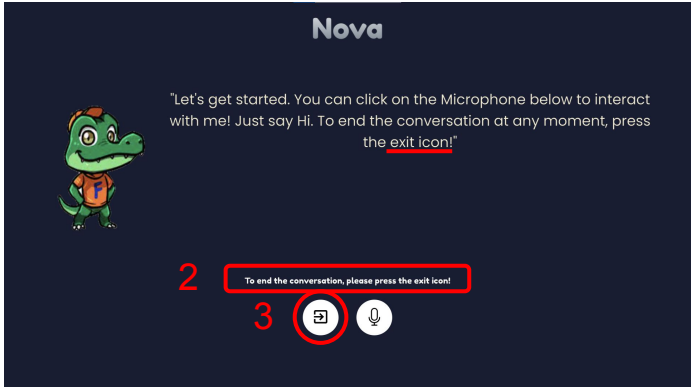
Initial

Final









System Development Goals:

Minimal	Basic	Stretch
✅ Create knowledge database (1)	✅ Expand knowledge database (2)	✅ Expand knowledge database (3+)
✅ Program conceptual agent via DialogFlow	✅ Implement visual interface (coding)	❌ Customized agent
✅ Test for concept task completion	✅ Improve system flexibility (more training phrases, responses)	✅ Host system publicly
	✅ Test for all task completion (+feedback request)	❌ Implementation on common platforms

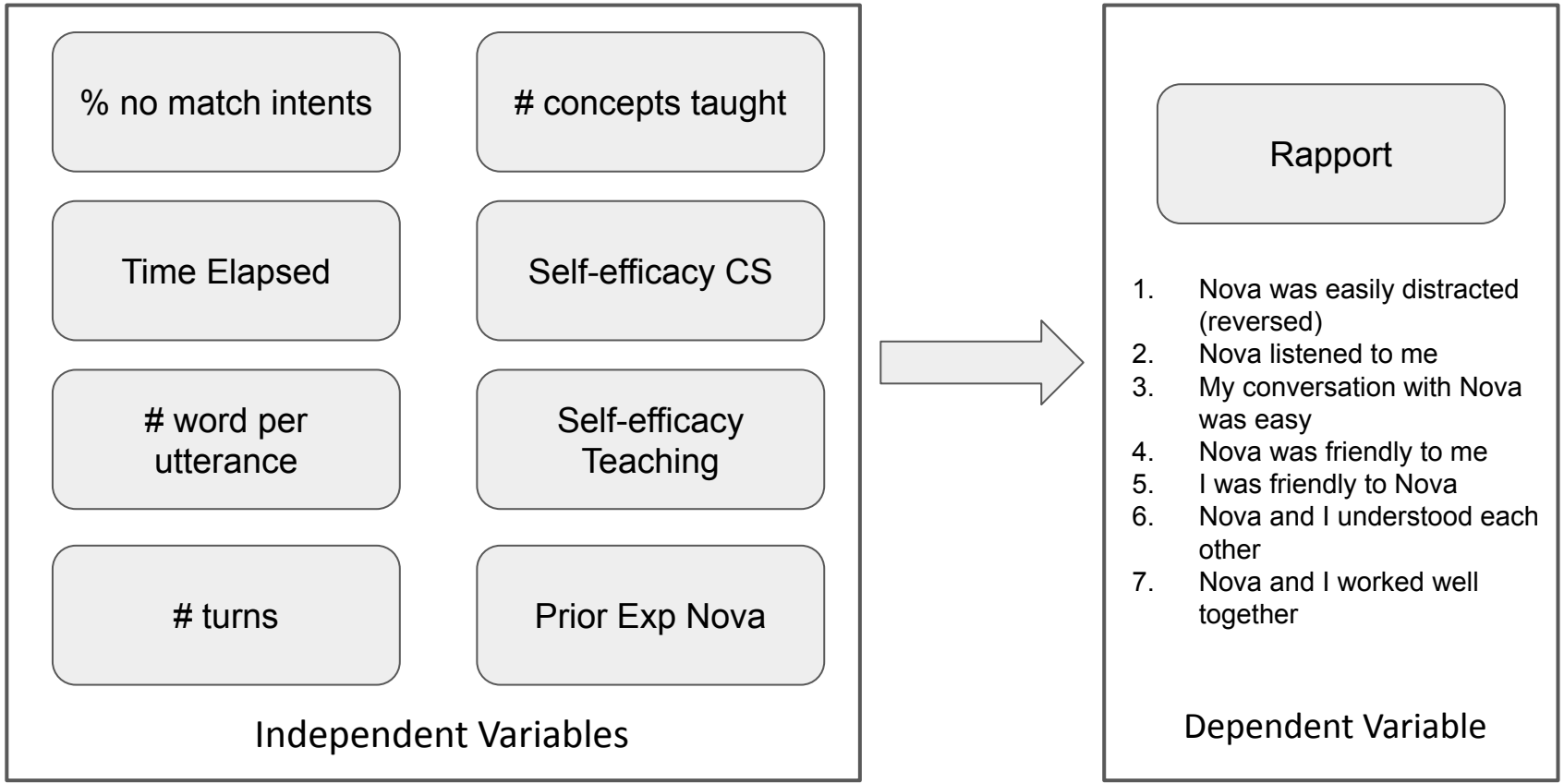
Final Evaluation Round Robin

- 24 users tested the system
  - High self-efficacy on computer science (3.92 out of 5) and teaching (3.85 out of 5)
  - 38% reported having prior experience interacting with Nova
- Users spent on average 3.5 minutes (201.75 seconds) interacting with Nova
- On average, users initiated 13.96 dialogue turns, each turn contains 4.88 words
- User reported generally high rapport level (29.13 out of 35) after interacting with Nova

	Independent Variables								Dependent Var
	no-matched intent (%)	TimeElapsed (in sec)	# turns	# word per utterance	# concepts taught	SE-CS	SE-teaching	Prior exp with Nova (0/1)	Rapport
Mean	0.38	201.75	13.96	4.88	2.04	3.92	3.85	0.38	29.13
Std	0.11	60.24	3.51	1.51	0.86	0.56	0.51	0.49	3.87
Median	0.39	198.00	13.00	4.50	2.00	4.00	3.88	-	30.00
Min	0.17	96.00	9.00	2.00	1.00	2.67	3.00	-	22.00
Max	0.53	334.00	21.00	9.00	3.00	4.67	4.75	-	35.00

Log data | Pre-survey | Post-survey

PARADISE Model



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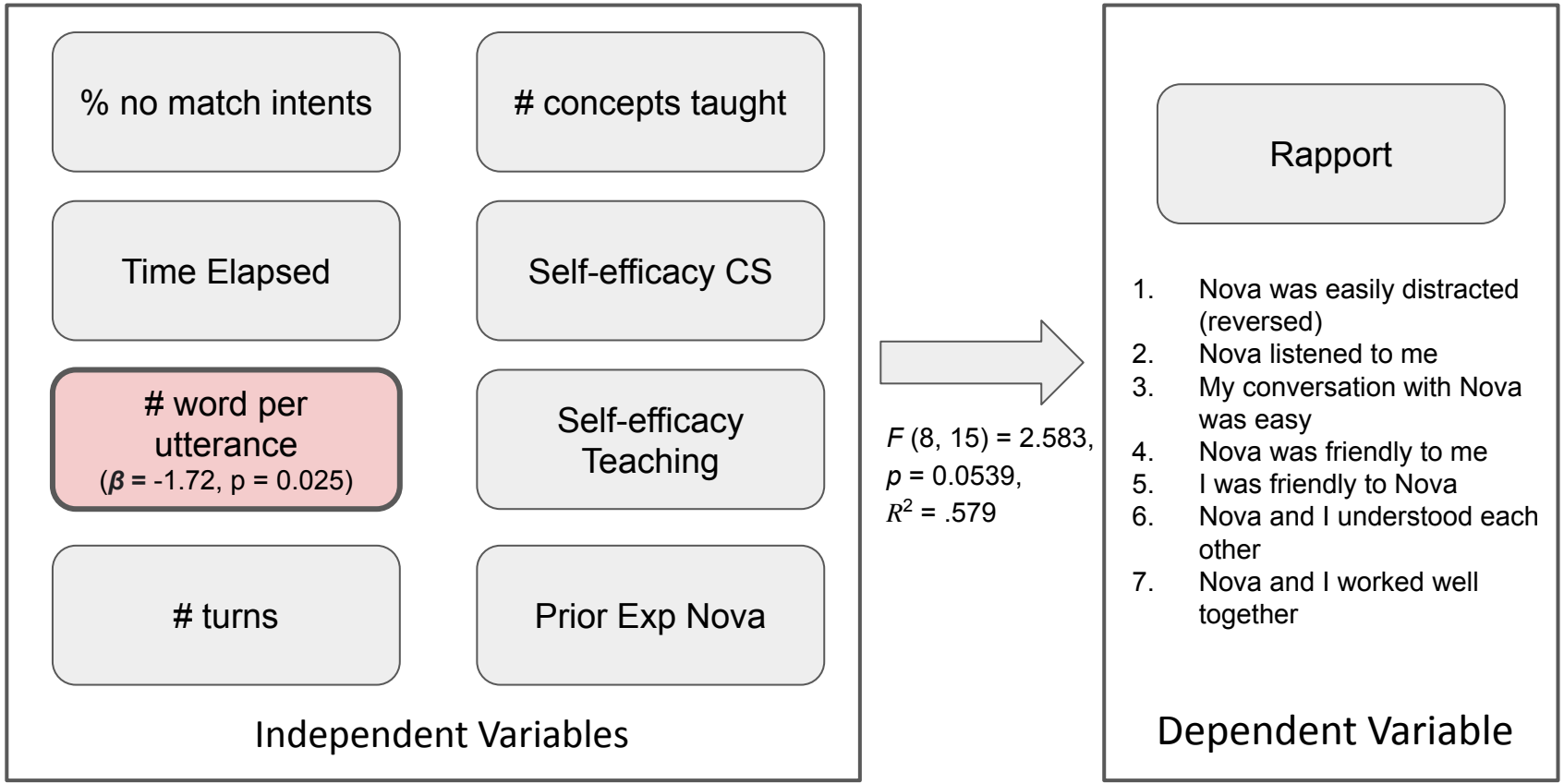

User Feedback

SO CUTE! GOOD JOB GUYS! ^_^

....the interface was the best one I've seen so far in this class.

Great job! This system is awesome

I like how the speech recognition updates in real time on the bottom of the screen, showing what words are being captured well or improperly.

It did a good job at responding properly to what I said. It had a hard time understanding when I said "loops" but it did a good job at self-correcting when it did understand.

I liked the overall interaction and I think it's a very cool system. Thanks for letting me try it out!

Q&A: