

# LLM-Based Hint Generation for Serious Games

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# Problem & Motivation

- Learning programmers for beginners can be frustrating alone
  - Common issues like syntax errors and finding what to do to make progress can lead to being stuck

Research question:

- Can an LLM-based hint helper generate context-aware hints for players in a serious game?

# Gidget

- Serious game for beginner programmers
- Originally made to gather data for the efficiency of pedagogical design elements
- Player gives a set of commands and can watch them play out step-by-step to aid with debugging

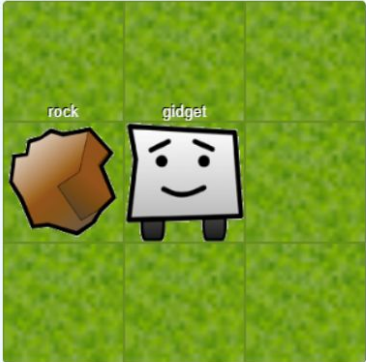
Level 1. Testing Gidget's Scanner

**instructions**  ?

```
scan rock
```

**scanned** rock

**world**



**gidget's memory**

**20 units**

scanned

analyzed

grabbed

focus

results

Tell Gidget to execute:

**hint helper**

According to the goal box for this level, my mission is to make sure my scanner is working by scanning a rock. I tried to add instructions, but it's not working! Please click on the instructions box to begin editing!


# Gidget

Level 2. Testing Gidget's Mobility

**instructions**  ?

1

**world**



**gidget's memory**

**20 units**

- scanned
- analyzed
- grabbed
- focus

**results**

**hint helper**

Tell Gidget to execute:

For some reason, I can't seem to get to the right place! This is so confusing...please help me!

# Methodology

## Main pipeline:

- Extract game state
- Extract current player attempt
  - Parse player attempt for syntax errors
- Define rules and available actions
- Create structured prompt
- Send the prompt to the model
  - gpt-4o
- Get hint

Level 2. Testing Gidget's Mobility

**instructions**  ?

```
scan rock
goto bucket
```

**world**

**gidget's memory**

**20 units**

scanned

analyzed

grabbed

focus

results

Tell Gidget to execute:

**hint helper**

Hint: Remember to scan the bucket if you want to move Gidget to it. This will allow you to use the 'goto' command with the bucket as your target.

For some reason, I can't seem to get to the right place! This is so confusing...please help me!

# Demo


Level 2. Testing Gidget's Mobility

**instructions** restore original instructions ?

```
scan bucket  
goto bucket
```

gidget on bucket

**world**



**gidget's memory**

20 units

scanned

analyzed

grabbed

focus

results

Tell Gidget to execute:

**hint helper**  
Get Hint

I accomplished all of my goals! I never could have done it without you!

# Evaluation

- Efficiency of hints were tracked based on correctness and helpfulness

Category	Definition
Correct advice, correct direction	Hint given was correct and player successfully used it to make progress towards win condition
Correct advice, not immediately helpful	Hint given was correct, but player did not successfully use it to make progress towards win condition
Incorrect advice	Hint given would not make progress towards win condition if followed

# Evaluation

- Example: Correct advice, correct direction
  - Hint addressed the step that was causing failure
  - The suggestion makes progress towards the win condition
  - Player clearly recognized what to do from the hint

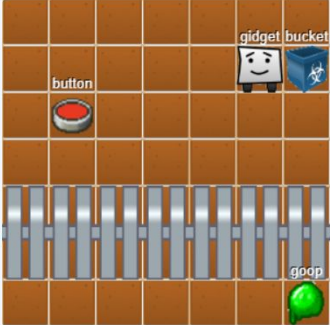
Level 11. Entering the Factory with Gidget

**instructions**  ?

```
scan goop
goto goop
grab goop
scan bucket
goto bucket
drop goop
```

goop on bucket.

**world**



**gidget's memory**

**50 units**

scanned

analyzed

grabbed

focus

results

Tell Gidget to execute:

**hint helper**

Hint: Try analyzing the button to see if it can help open a path to the goop. Then consider using "ask" with the button to interact with it.

I failed some of my goals so I didn't complete this mission. I won't be able to figure this out without your help! Can you help me try again?

# Evaluation

- Example: Correct advice, not immediately helpful
  - Hint addressed the step that was causing failure
  - Suggestion does make progress towards win condition
  - Player did not clearly recognize where the error was from the hint

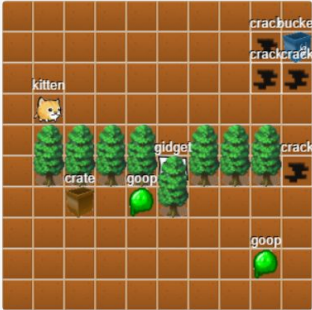
Level 8. Avoiding Obstacles with Gidget

**instructions**  ?

```
scan kitten
scan crate
scan goop
scan bucket
scan crack
scan goop
goto goop, grab it
goto bucket avoid crack
goto kitten
grab kitten
goto crate
drop kitten
```

kitten on crate  
goop on bucket is glowing

**world**



**gidget's memory**

110 units

scanned

analyzed

grabbed

focus

results

Tell Gidget to execute:

Oh no... I ran out of energy... Can we try again? I know with your help, I can succeed!

**hint helper**

Hint: After grabbing the glowing goop, ensure you place it on the bucket to complete part of the win condition. Remember to use "avoid crack" when moving around the cracks to prevent from dropping any held items.

# Evaluation

- Example: Incorrect Advice
  - Did not address the step that was causing failure
  - Suggestion does not make progress towards win condition
  - Player did not get closer to win condition from hint


Level 9. Avoiding Active Obstacles with Gidget

**instructions**

```
scan rat
scan bird
goto rat avoid bird
scan goop
goto goop
grab goop
scan bucket
goto bucket
drop goop
scan crate
goto crate
drop rat
```

bird on crate  
goop on bucket

**world**



**gidget's memory**

**90 units**

scanned

analyzed

grabbed

focus

results

Tell Gidget to execute:

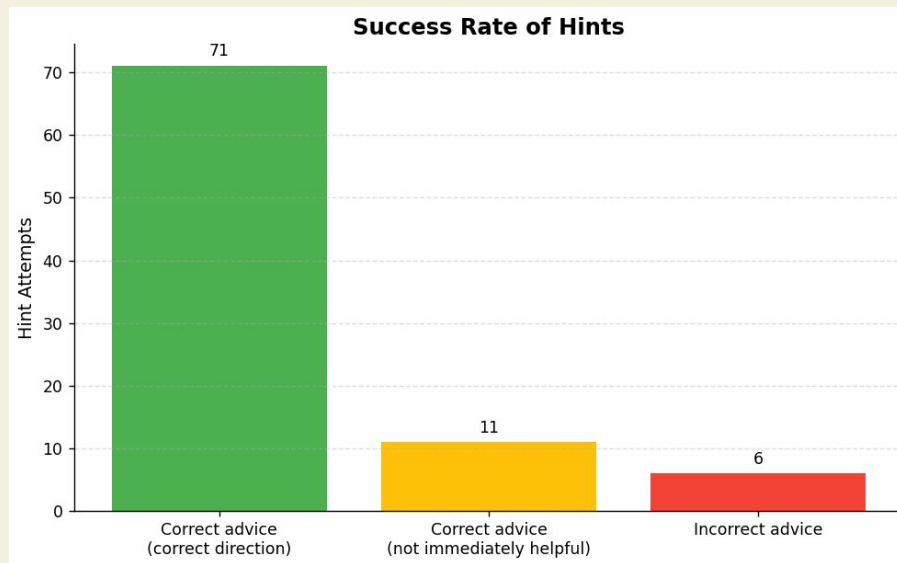
**hint helper**

Hint: Try focusing on scanning and analyzing the bird and goop to discover any special abilities they might have that can help you complete the level's objectives.

Oh no... I ran out of energy... Can we try again? I know with your help, I can succeed!

# Evaluation

- 12 Players tested
- 88 hints tested with players
- ~81% of hints given immediately helped the player
- All players gave feedback that the hint helper was at least considered for future levels after use
- Incorrect advice was often clearly incorrect and players knew to ignore instead of following bad advice



# Limitations

- Most common error – Room for improvement:
  - Player attempts that do not align with the intended solution often caused an incorrect hint
- Larger test group size could provide more insight for errors

Level 10. Gidget's Low on Energy

**instructions**  ?

```
scan dog, goto it, analyze it
scan goop
scan bucket
ask dog to carry gidget goop
ask dog to carry gidget bucket
ask dog to carry gidget goop
ask dog to carry gidget bucket
ask dog to carry gidget goop
ask dog to carry gidget bucket
```

three goops on bucket

**world**

**gidget's memory**

**30 units**

scanned

analyzed

grabbed

focus

results

Tell Gidget to execute:

**hint helper**

Hint: Consider asking the dog to carry Gidget to one of the goop locations first. This can help conserve energy by moving directly to each goop before using commands to interact with them further.

I failed some of my goals so I didn't complete this mission. I won't be able to figure this out without your help! Can you help me try again?

# Conclusions

- The results show that LLMs are able to generate context-aware hints given a structured game environment
- The project successfully demonstrated a pipeline that takes a game state and player code to generate a hint for the player
- Future work:
  - Improve hint quality
  - Test with a larger-scale group
  - Test with other models to see how they compare

# Q&A