

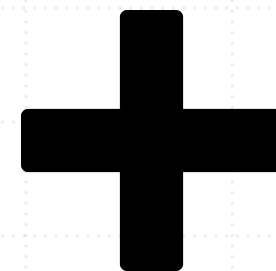


Voice Recognition Escape Room

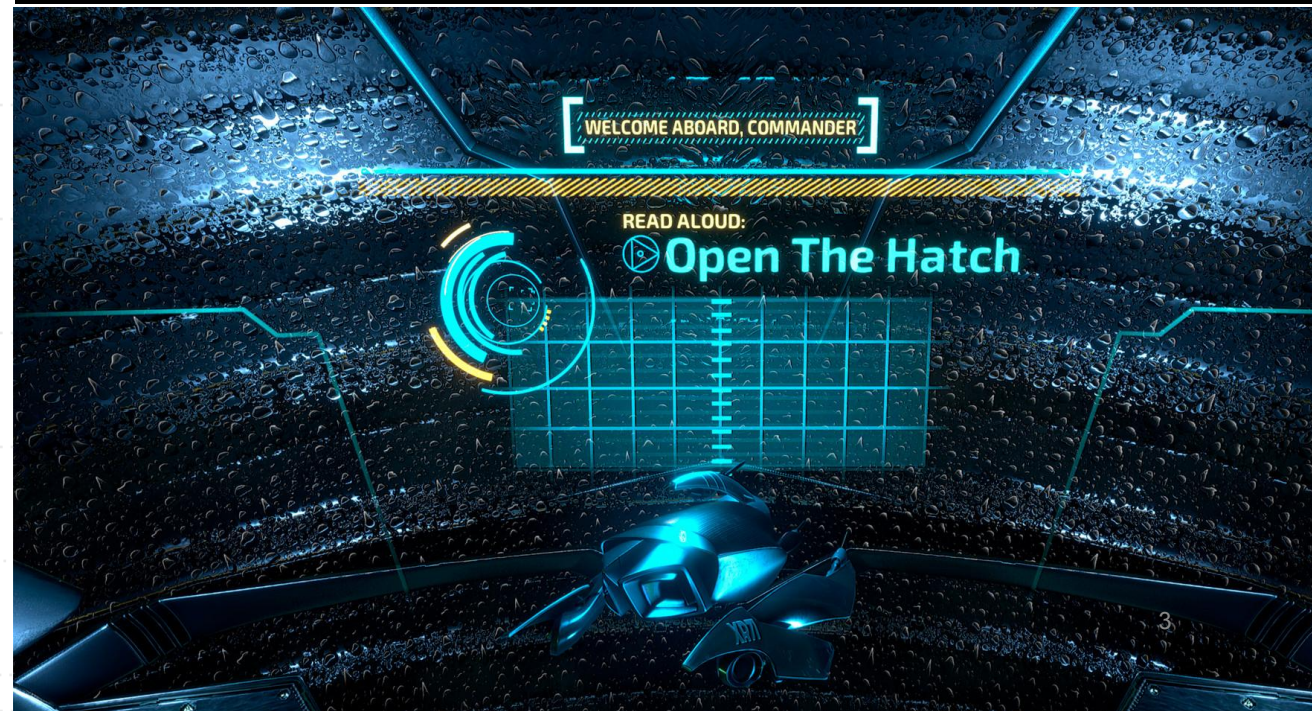
Syretta Man Nga Yin

Supervisor: Dr. Mark Wheelhouse

Second Marker: Dr. Arthur Gervais



Require exact pattern
or wordings





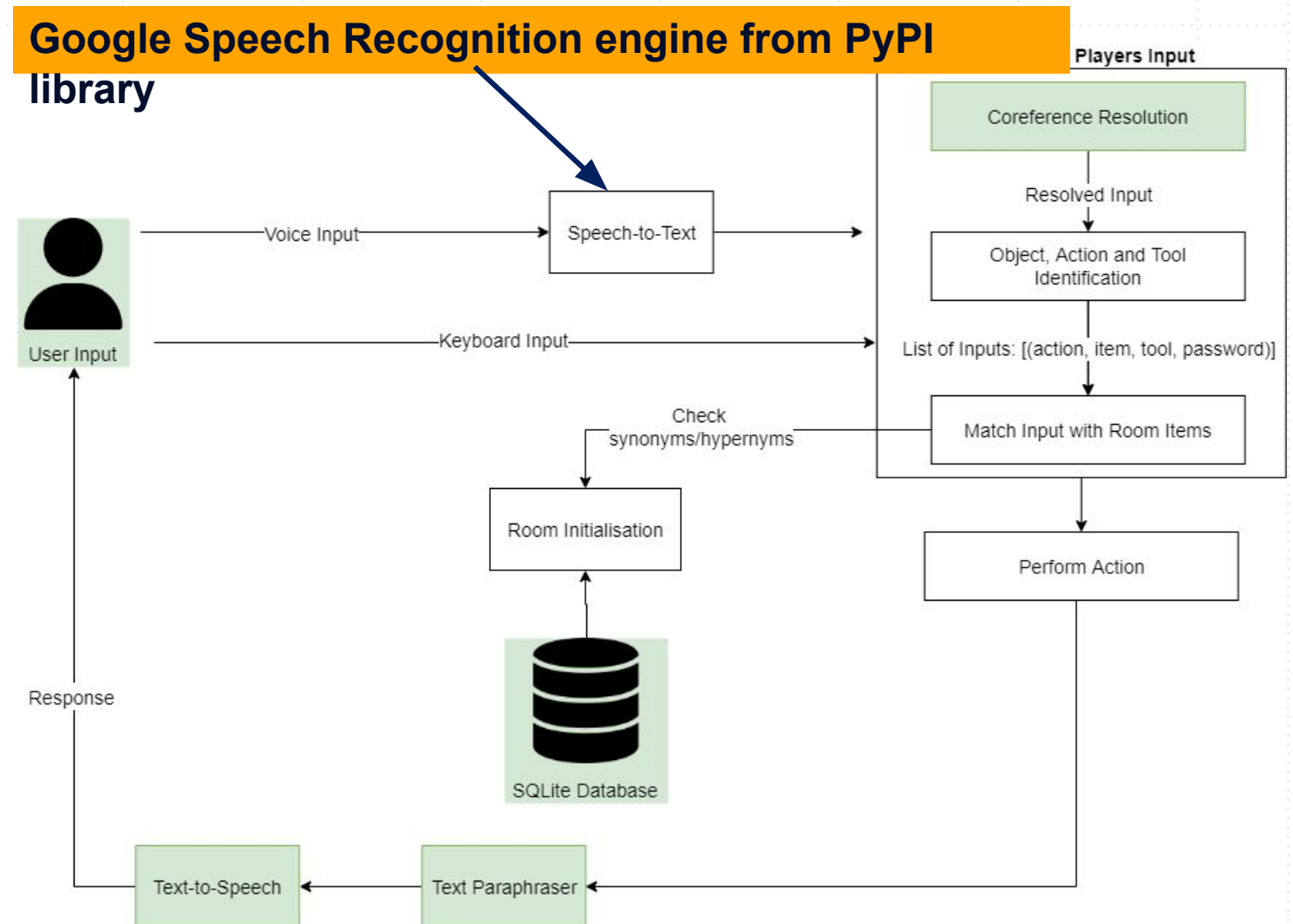
Objectives

- **Building of Intention Extraction Engine**
 - NLP interface that comprehend users' intent
- **Game Processor**
 - Processor users input during gameplay using intention extraction engine
- **Room Generator**
 - Extract Relevant Information from Input to Generate Room



Demonstration

System Diagram of Game Processor



Coreference Resolution

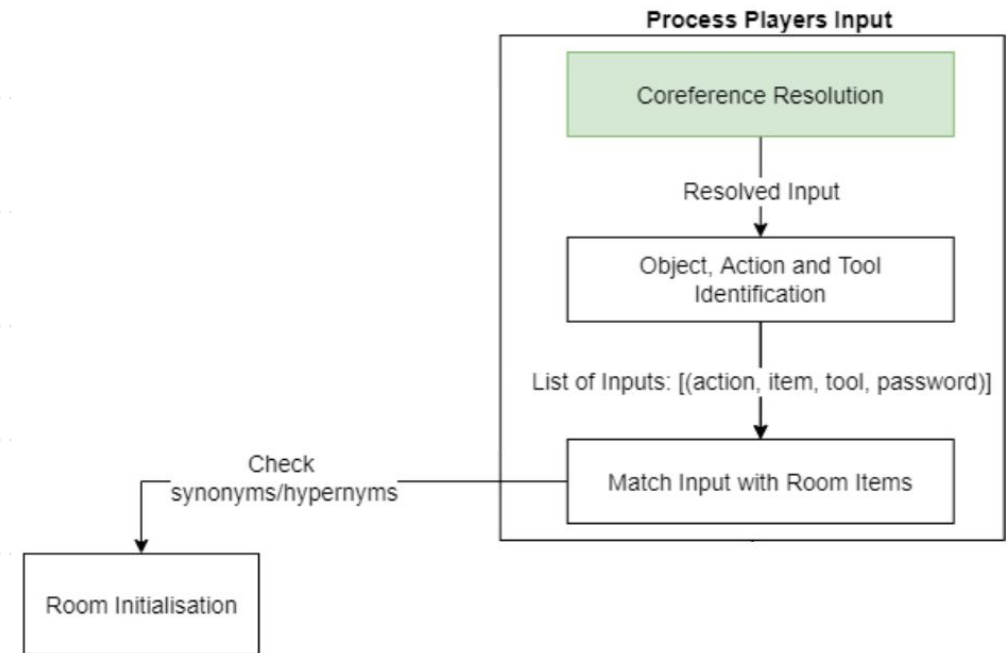


Check the door.

The door is locked.



Unlock it with a key.



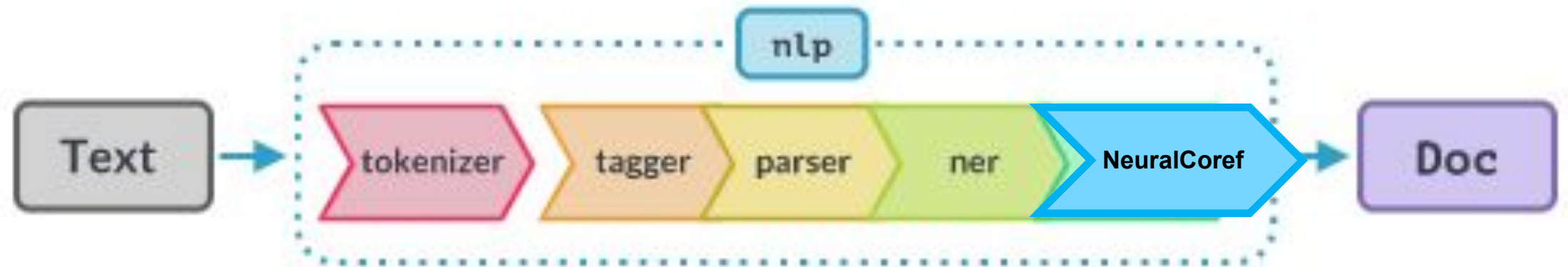
user_input_log.txt

Check the door.

Unlock it with a key.

Coreference Resolution – NeuralCoref

- Added to spaCy pipeline



user_input_log.txt

Check the door.

Unlock it with a key.



Resolved:

Check the door.

Unlock the door with a key.

Object, Action, Tool Identification

	open	the	door	with	a	key
POS	VERB	DET	NOUN	ADP	DET	NOUN
DEP	ROOT	det	dobj	prep	det	pobj

Action

Object

Tool

Match Input with Room Items

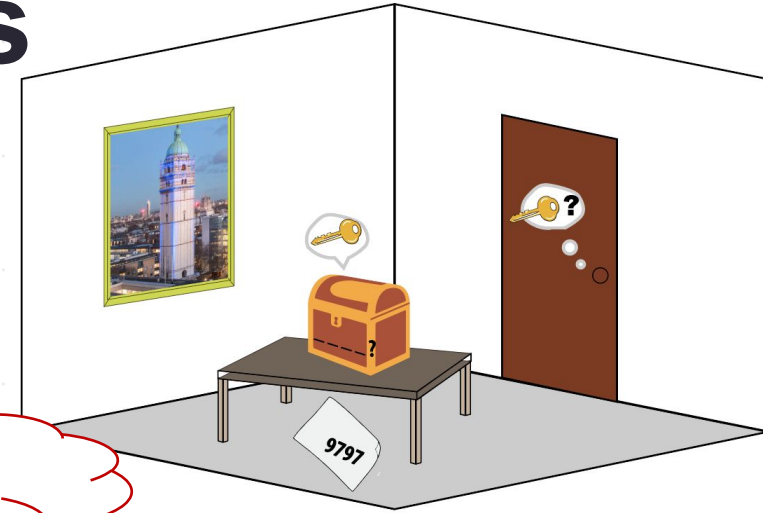


Examine the art.

Action: examine

Object: art

Which item is it referring to?



door

painting

box

key

paper

table

Synonyms: {'painting'}

Hypernyms: {'application', 'graphic_art', 'art', 'trade', 'fine_arts'}

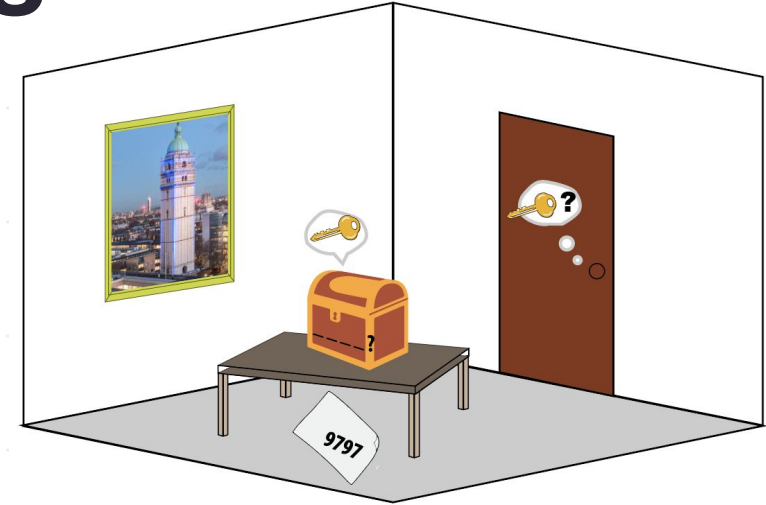
Match Input with Room Items



Examine the picture.

Action: examine

Object: picture



door

painting

box

key

paper

table

Not Found!

Synonyms: {'painting'}

Hyperyms: {'application', 'graphic_art', 'art', 'trade', 'fine_arts'}

$$\text{Leacock Chordorow (LCH) Similarity} = -\log \frac{\text{shortest_path}(\text{synset1}, \text{synset2})}{2 * D} > \text{threshold}$$

- Add to cache if found a match

Match Input with Room Object

- Repeat the same for the actions of that object

- Result

- Identified object: **painting**
- Identified action: **investigate**



Examine the picture.

It is a painting of Imperial



⇒ Perform action



Text Paraphrasing

- Result from Pegasus Paraphraser

It is written 9797 on the painting.

The painting has a writing on it.

It is written on the painting.

There is a writing on the painting.

It is written on a painting.

On the painting is written 9797.



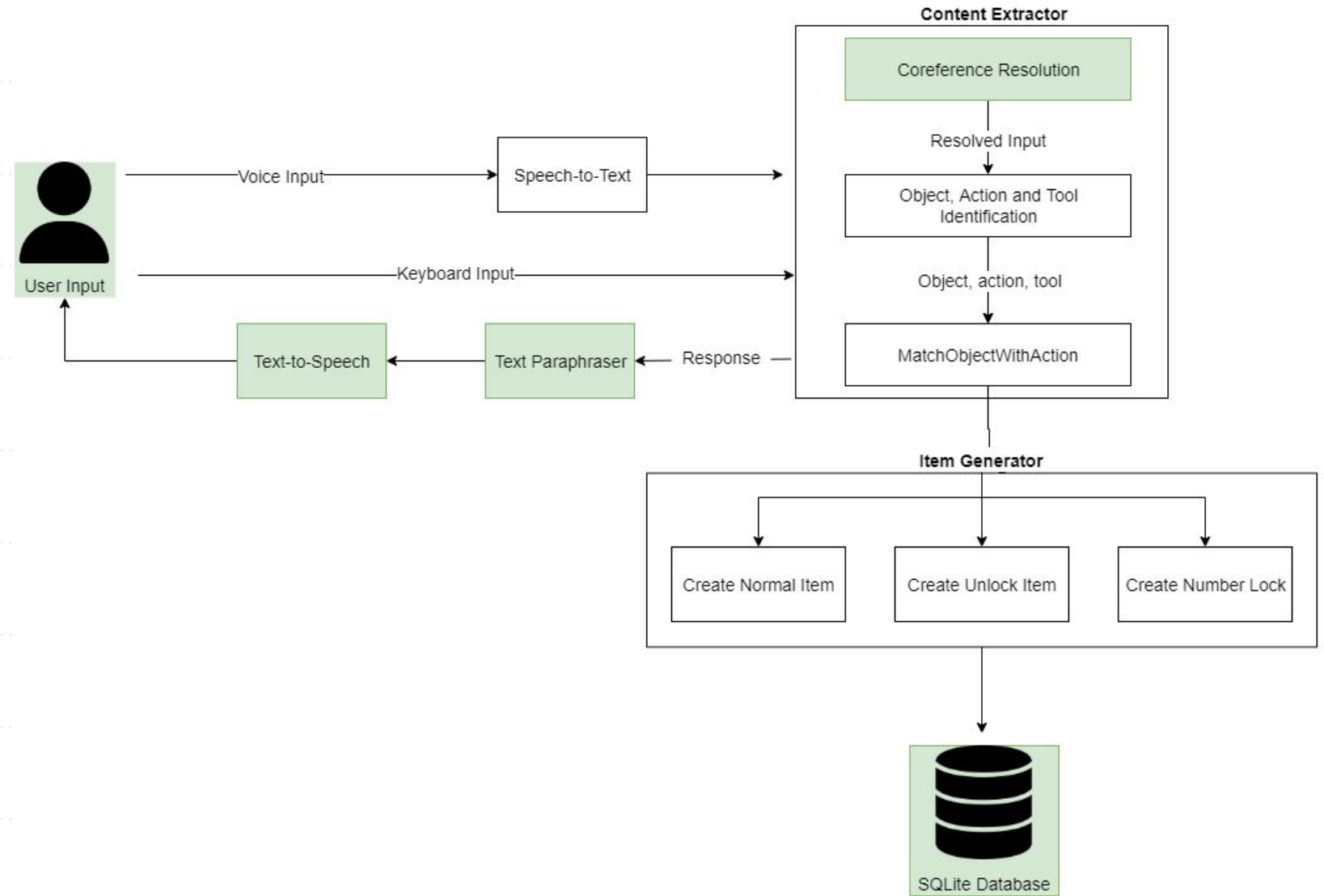
Objectives

- **Building of Intention Extraction Engine**
 - NLP interface that comprehend users' intent
- **Game Processor**
 - Processor users input during gameplay using intention extraction engine
- **Room Generator**
 - Extract Relevant Information from Input to Generate Room



Demonstration

System Diagram of Room Generator



Object, Action and Tool Identification

- **Matchers**, spaCy library
 - extract information using pattern matching
- *Noun phrase extracting rules*

```
pattern1 = [{"POS": "PROPN"}]  
pattern2 = [{"POS": "NOUN"}, {"POS": "NOUN", "OP": "?"}]  
pattern3 = [{"POS": "NOUN"}, {"LOWER": "of"}, {"POS": "DET", "OP": "?"}, {"POS": "NOUN"}]
```

- *Verb phrases extracting rules*

```
pattern1 = [{"POS": "VERB"}, {"POS": "PART", "OP": "*"}, {"POS": "ADV", "OP": "*"}]
```

Object, Action and Tool Identification

- *Noun phrase extracting rules*

```
pattern1 = [{"POS": "PROPN"} ]  
pattern2 = [{"POS": "NOUN"}, {"POS": "NOUN", "OP": "?"}]  
pattern3 = [{"POS": "NOUN"}, {"LOWER": "of"}, {"POS": "DET", "OP": "?"}, {"POS": "NOUN"}]
```



Take the key and open the door with the key.

Pattern 2

Pattern 2

Noun phrases: [key, door]

Object, Action and Tool Identification

- *Verb phrases extracting rules*

```
pattern1 = [{"POS": "VERB"}, {"POS": "PART", "OP": "*"}, {"POS": "ADV", "OP": "*"}]
```



Take the key and open the door with the key.

Noun phrases: [key, door]

Verb phrases: [take, open]

Object, Action and Tool Identification

- *Tools extracting rules*

```
pattern1 = [{"DEP": "pobj"}]
```



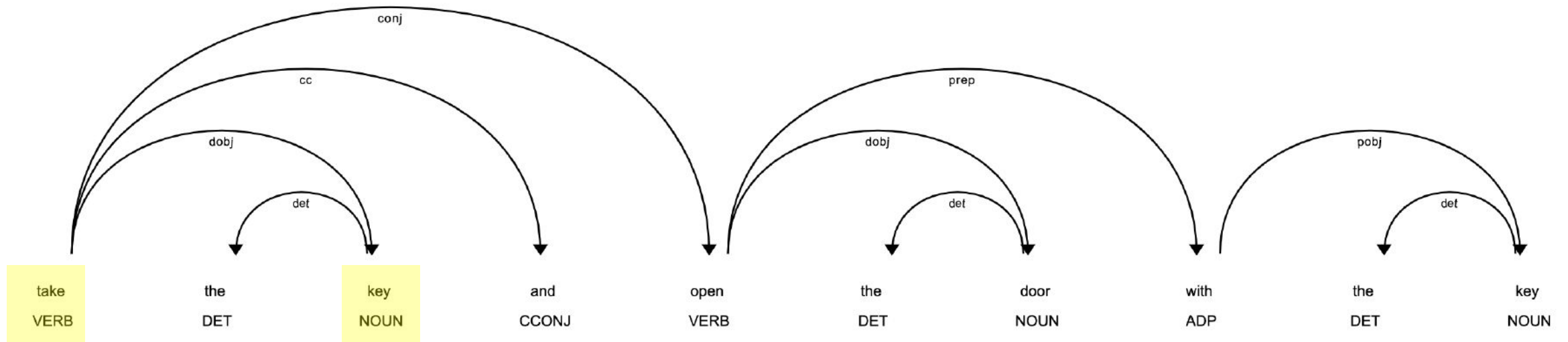
Take the key and open the door with the key.

Noun phrases: [key, door]

Verb phrases: [take, open]

Tool: [key]

Match Object with Action



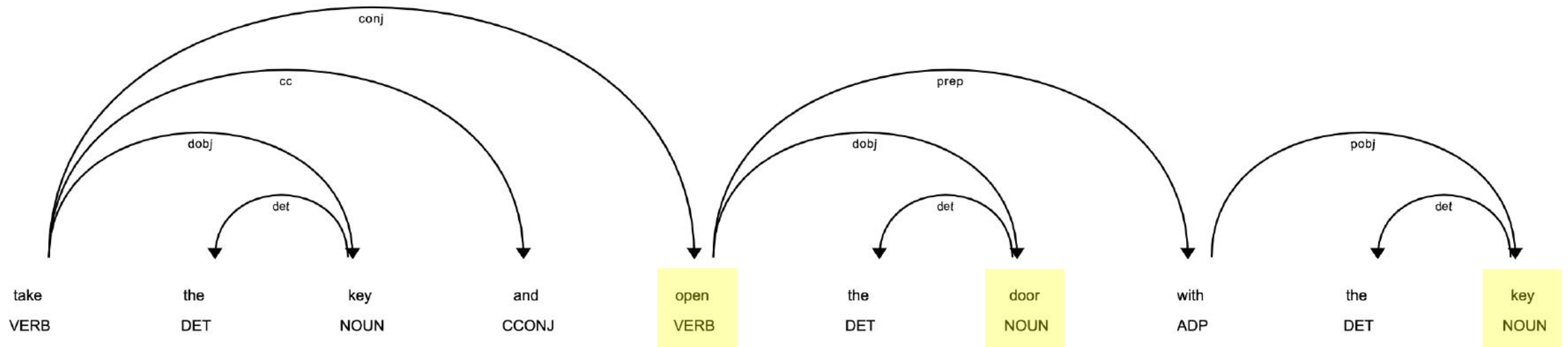
Noun phrases: [key, door]

Verb phrases: [take, open]

Tool: [key]

Queue: {key: (take, None)}

Match Object with Action



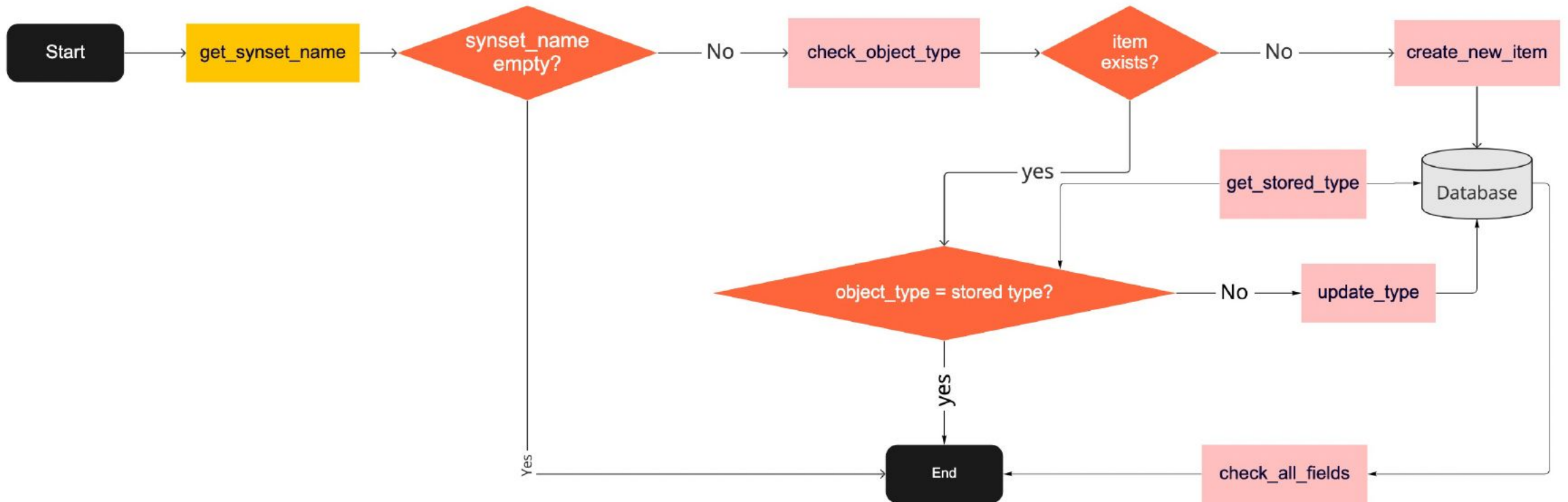
Noun phrases: [key, door]

Verb phrases: [take, open]

Tool: [key]

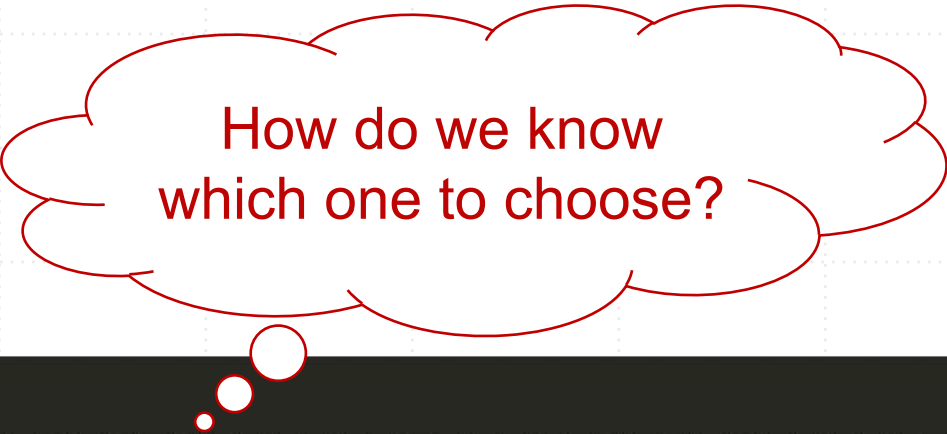
Queue: {key: (take, None), door: (open, key)}

Item Generator



Item Generator - Selecting Synsets

- Synsets from Wordnet



How do we know
which one to choose?

Name	Definition
table.n.01	a set of data arranged in rows and columns
table.n.02	a piece of furniture having a smooth flat top that is usually supported by one or more vertical legs
table.n.03	a piece of furniture with tableware for a meal laid out on it
mesa.n.01	flat tableland with steep edges
table.n.05	a company of people assembled at a table for a meal or game
board.n.04	food or meals in general

Item Generator - Selecting Synsets

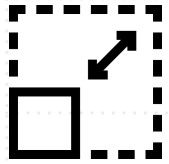
- **WordNet Domains**
 - Check if synsets is in domain ["furniture"]
- Compute list of hypernyms
 - Check if contains the synset of "Physical Object"

Name	Definition
table.n.01	a set of data arranged in rows and columns
table.n.02	a piece of furniture having a smooth flat top that is usually supported by one or more vertical legs
table.n.03	a piece of furniture with tableware for a meal laid out on it
mesa.n.01	flat tableland with steep edges
table.n.05	a company of people assembled at a table for a meal or game
board.n.04	food or meals in general

Evaluation



Areas of Evaluation



Scaling Input

Evaluate how well the intent extraction engine react with a scaling input



Inefficient Component

Find out the most inefficient component that slows down the intent extraction engine



Possible Improvement

Explore ways of improvement after taking user feedback

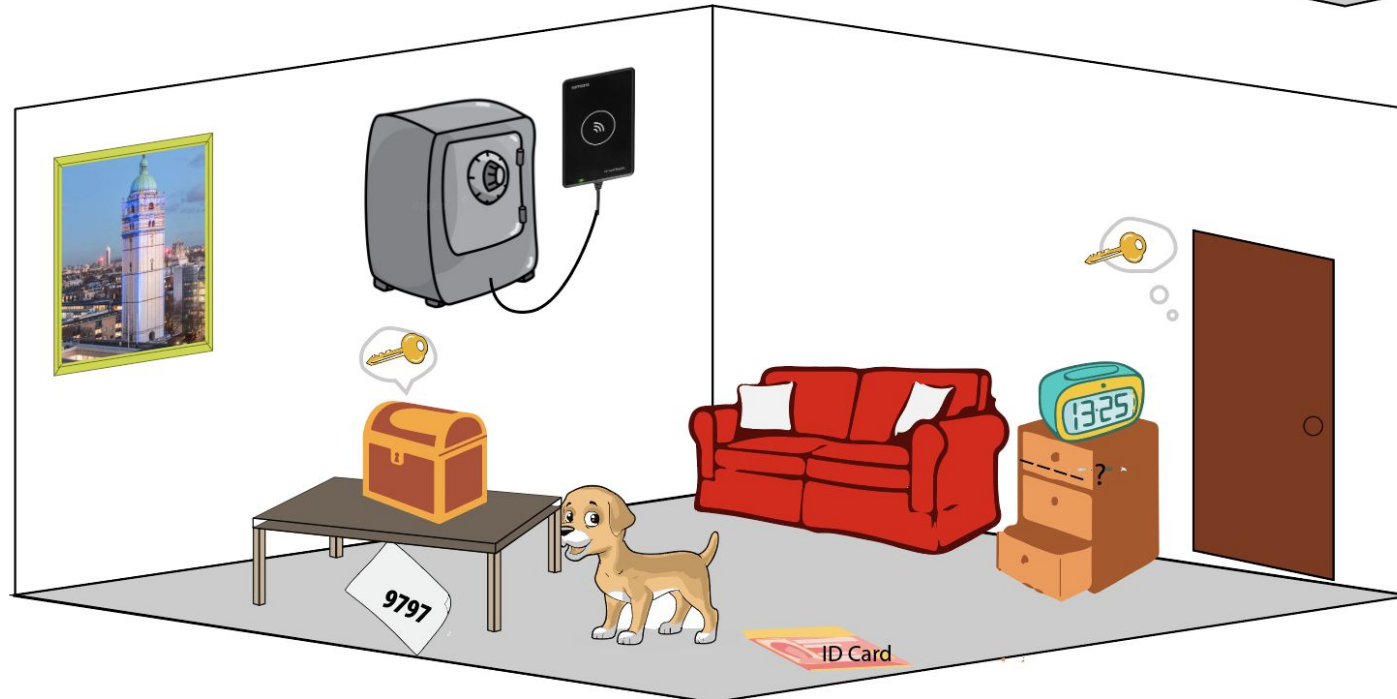
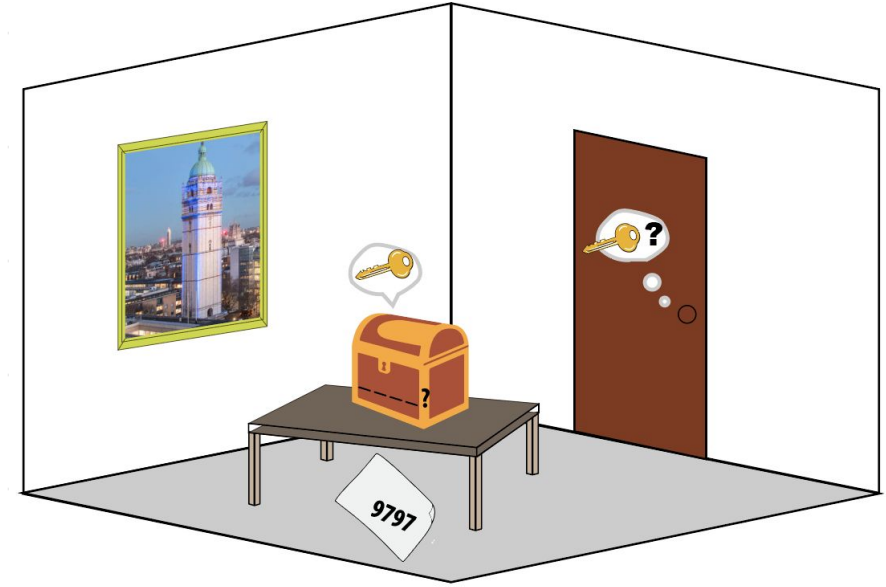
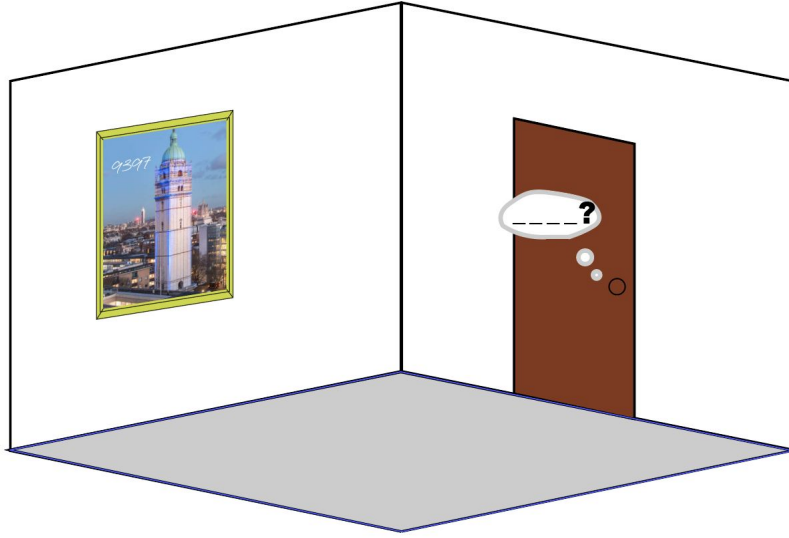
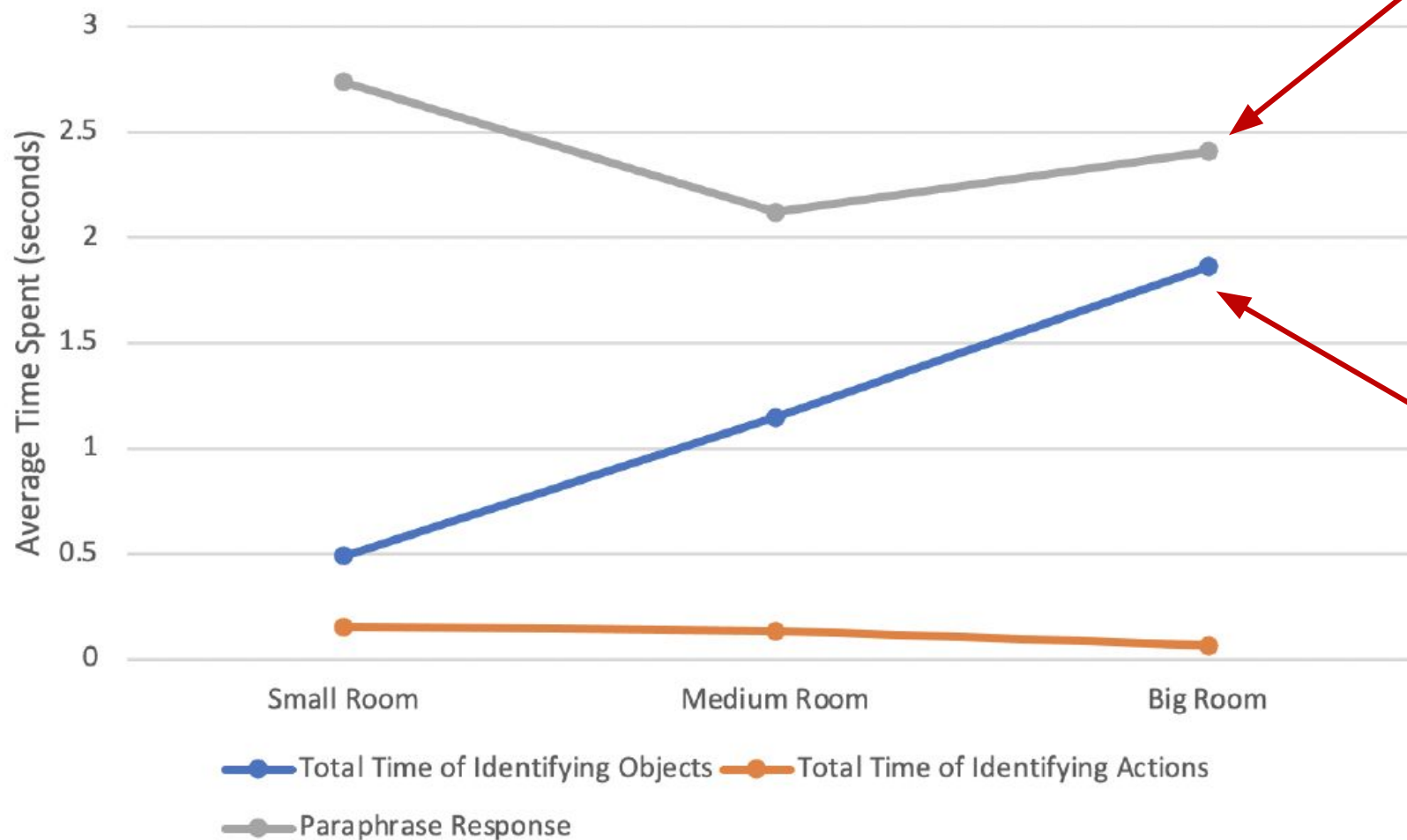


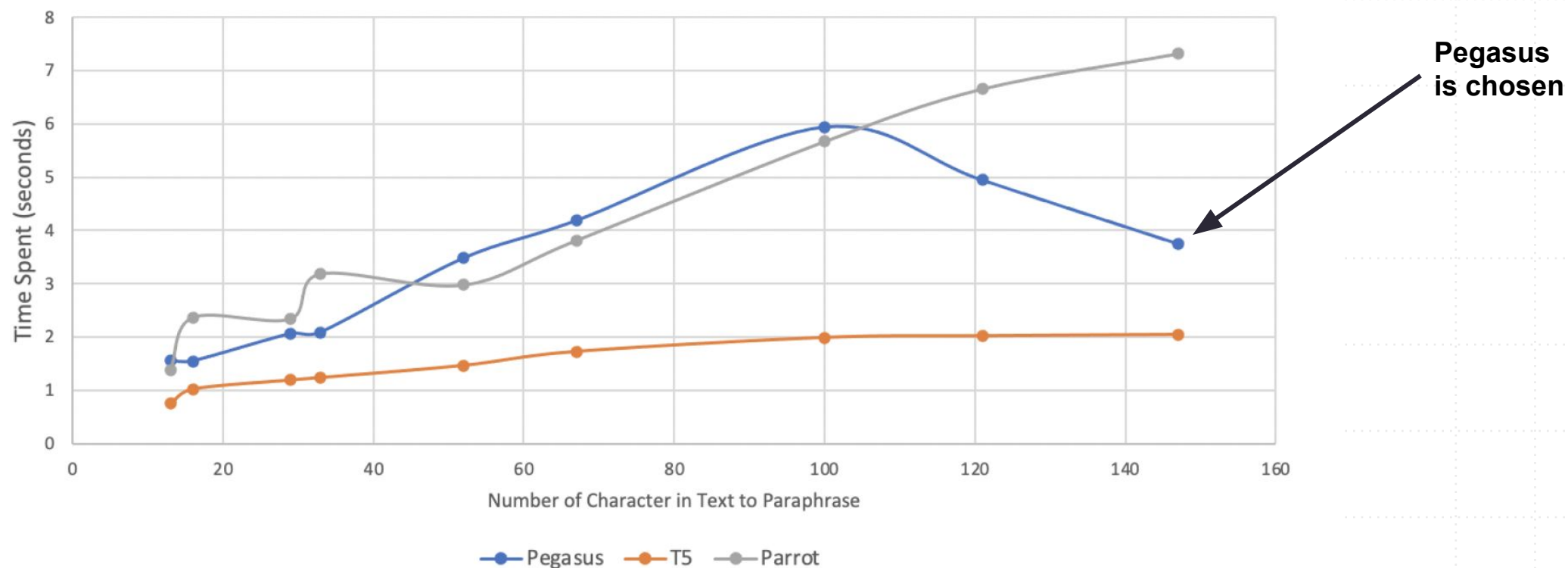
Diagram showing time spent in each components



Most time-consuming component

Drastic increase when size of room increase

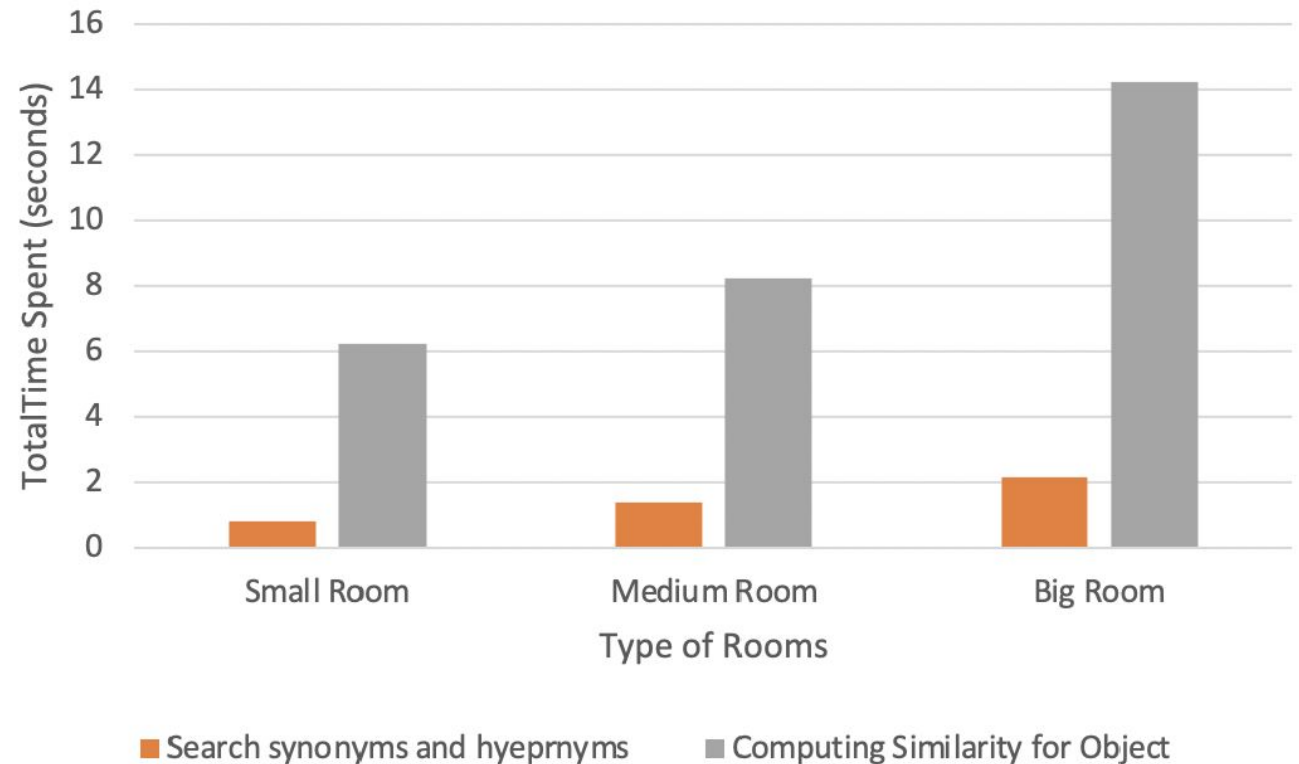
Efficiency Issue of Text Paraphrasing



Efficiency Issue of Object Identification

- Time complexity of computing synonyms and hypernyms: $O(k \times h)$
 - where k is number of synsets, h is number of hypernyms of that synset
- Time complexity of similarity score computation: $O(m \times k)$
 - where m is number of room items, k is number of synsets

⇒ Struggle with scaling



User Feedback



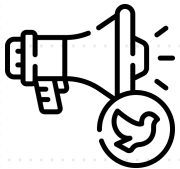
Accuracy

“...There are **only a few times** where it **misunderstood** my speech, such as when it mistook “dog” for “dock”...”



Room Creation Experience

“The experience on the small and medium room was nice. It was **quick and easy**. It starts to **get repetitive and boring** when creating the big room.”



Freedom of Expression

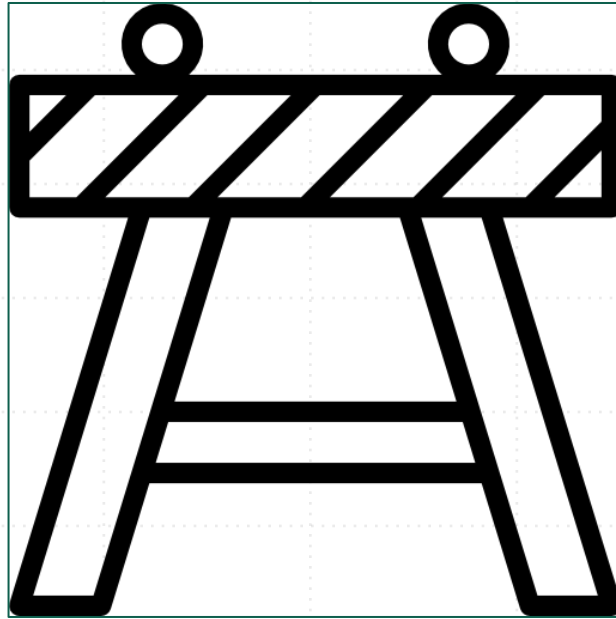
“The engine understood what I meant even though I did not refer to the object by its exact name... I was attempting to **perform insane things...**”



User Interface

“The user interface is **simple and easy to use** but I was **confused** sometimes because I didn’t know if I had picked up the thing successfully.”

Limitation



Limitations



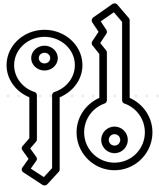
Manual Input in Room Creation

The Room Generator might sometimes require user to **answer a series of questions** to create an object, which could affect the UX



Fixed response from Engines

The engines are only able to respond with **predefined responses** whenever triggered



No Duplicated Objects

Objects of **different characteristics (e.g. red / blue)** will **not be distinguished**, and be treated as a single entity

Conclusion

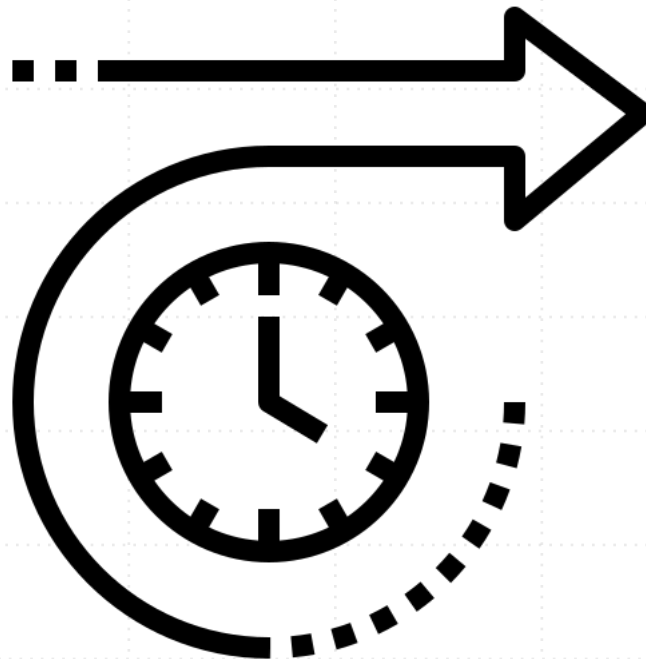




Conclusion

- ✓ Successfully established intent extraction
- ✓ Provide high level of freedom in user input
- ✓ Incorporating speech technology into escape room games

Future Work



Automatic Room Content Extraction

From...

Manual item creation based on answers to a series of prompts



I need a locked box

How is it locked?



Lock it with password

What is the password?



1234



Automatic item creation based on full paragraph description



I need a locked box.
Lock it with 1234.
Put it next to the flowers.

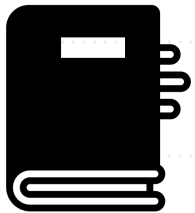
Done.



Extend Object Types

From...

Handle 3 types of objects



Normal



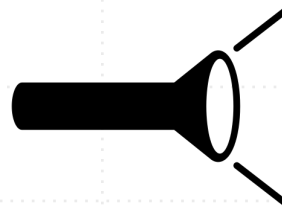
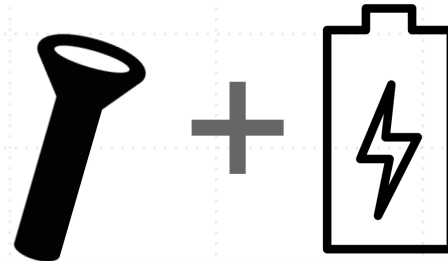
Lock

Unlock

...To

Diverse object types

Merging items



Object properties

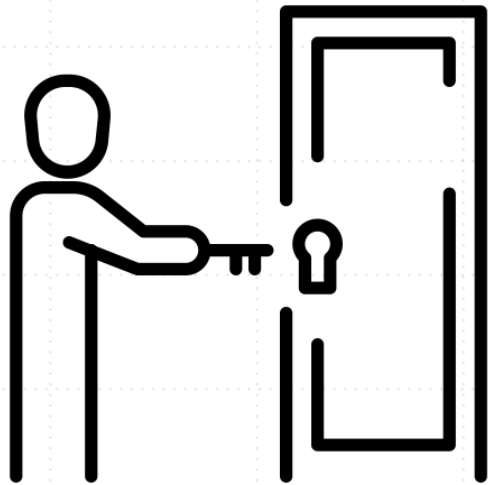


Sizes, colours

Learning User Inputs for Room Improvements

From...

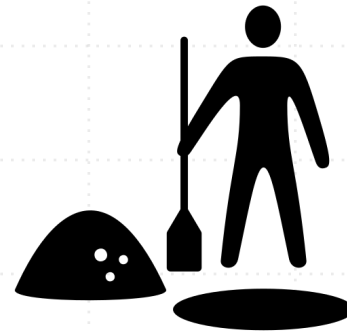
Only a single way of escaping



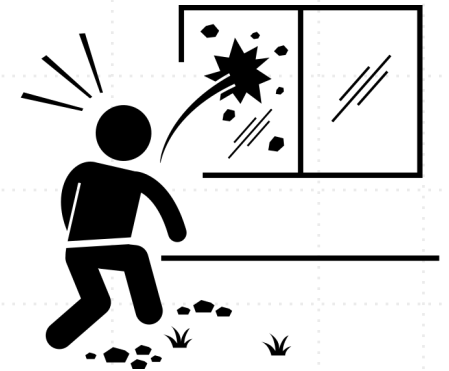
Can only escape by unlocking the escape object

...To

Allow for creative ways of escaping



Digging a tunnel



Smashing the window

Improvement in User Interaction

From...

Error if either Noun or Verb is missing



Door. 1234

Sorry, what do you mean?



Open the door with the password 1234.

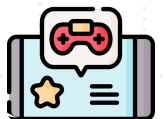
...To

Interactive responses and sentiment analysis



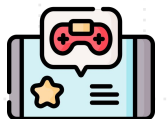
Stupid game... Just end now

Don't give up yet. You were very close! Do you want some tips?



Sure

Your last guess had 2 numbers right



Application in Non-text-based Game

From...

Text-based escape game



Open the door.

The door is locked.



Open the drawer.



...To

Visual escape game



*VR Escape Room,
Laser City*



Crimson Room

Questions

