

Text-based Adventures of the Golovin AI Agent

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Text adventure games

ZORK I: The Great Underground Empire
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ZORK is a registered trademark of Infocom, Inc.
Revision 88 / Serial number 840726

West of House

You are standing in an open field west of a white house, with a boarded front door.

There is a small mailbox here.

> *check mailbox*

I don't know the word "check".

> *look into mailbox*

The small mailbox is closed.

> *open mailbox*

Opening the small mailbox reveals a leaflet.

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Interactive fiction (IF)

Brief history

- 1975 – *Adventure*, Will Crowther
- 1979 – Infocom company founded
- 1979 – Zork Implementation Language (ZIL)
- 1980 – *Zork I*, Infocom
- 1989 – Infocom company closed
- 1993 – Inform language, Graham Nelson
- 1995 – first Interactive Fiction Competition

Z-machine

Virtual machine for simulating games (understanding commands, keeping locations, etc.). Instructions are compiled into Z-code.

Z-code interpreters: Frotz, Rezrov

The Text-Based Adventure AI Competition

- First edition during CIG 2016
- Organized by Tim Atkinson, Hendrik Baier, Tara Coplestone, Sam Devlin, Jerry Swan (University of York)
- One test game, prepared especially for the competition
- (The rules should be released this year)
- Competition won by BYU-Agent – David Wingate, Daniel Ricks, Nancy Fulda, Ben Murdoch (Brigham Young University)
- Winning agent score: 18/100

NATURAL LANGUAGE PROCESSING

Understanding natural language

Description

You are standing in an open field west of a white house, with a boarded front door.

Human



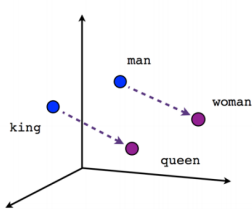
Computer



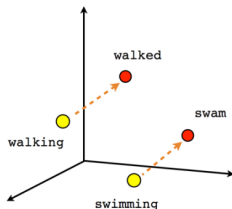
Natural Language Toolkit (NLTK)

- a suite of libraries and programs for symbolic and statistical natural language processing for English written in Python;
- supports classification, tokenization, stemming, tagging, parsing, and semantic reasoning functionalities.

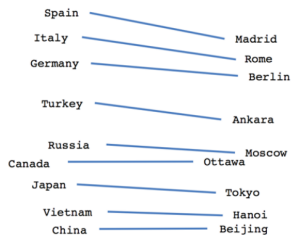
word2vec



Male-Female



Verb tense



Country-Capital

THE AGENT

Hey bot, what is your name?

> *Your name is Golovin.*

Hey bot, what is your name?
> *Your name is Golovin.*

Algorithm (sketch)

Generating commands

- Standard commands based on the nouns in the game state description and the agent's inventory
- Computing synonyms, finding similar commands in predefined set
- Scoring each command (synonym similarity, word uniqueness, command popularity, NN model's weight, ...)
- Roulette wheel command selection
- Blacklisting unsuccessful commands

Battle mode

- Introduced to increase surviving chances
- Triggered by the certain words in the descriptions
- Prevents using standard commands
- Forces to use multiple repetitions of the battle-labeled commands

Algorithm (sketch)

Inventory management

- Interesting objects identified in state descriptions
- Taking objects ordered by NN model's weight and rarity
- Changes in the inventory clear blacklists

Exploration and mapping

- Allow to visit certain points of interest
- Measuring node curiosity
- Use node identification algorithm

Restarts

- Contest environment allows to restart the game
- Avoid situations that proved to be lethal
- Remember the sequence leading to the best score

Mapping algorithm

Problems

- Same location with multiple descriptions
- Multiple locations with same description

Solution

- (assuming deterministic movement)
- Label each visited location by the description's first sentence
- Recursively search through the graph and merge the nodes when
 - they have the same label,
 - their adjacent nodes, reached by the same movement command, can be merged.
- Current map is constantly replaced by the minimized one

Usage

- Improves exploration by estimating the number of undiscovered edges
- Allows to reach any before-visited location (using best-known path)

Parameter optimization

Spearmint

Optimizing parameters for black-box model, using Bayesian approach.

Parameters to optimize

- number of synonyms from word2vec
- number of commands used before changing place
- constants used for grading commands
- turning on/off certain features of the algorithm
- ...

Performance evaluation

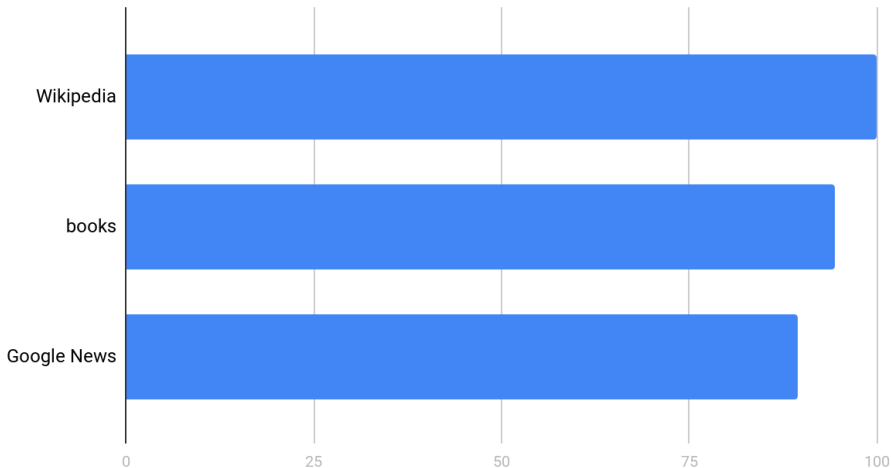
- 20 chosen games
- evaluation function:

$$\sum_{game} \frac{score}{max_score} + (0.2 \text{ if } score > 0)$$

EXPERIMENTS

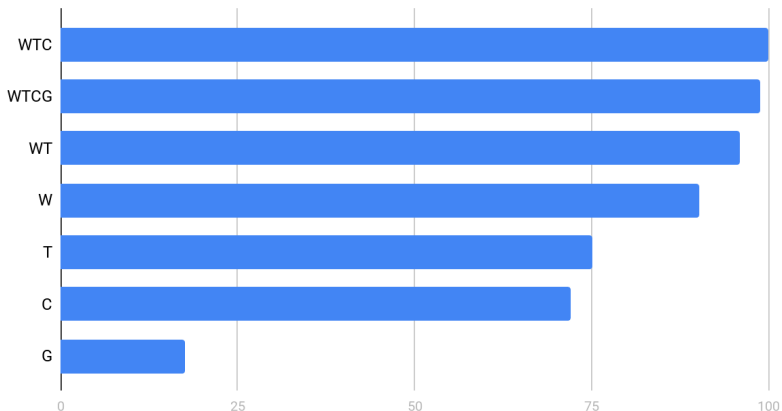
Choosing the language corpus

Score (rescaled in a way that best = 100%)



Choosing sources of the commands

Score (rescaled in a way that best = 100%)



W - walkthroughs

T - tutorials

G - descriptions in games

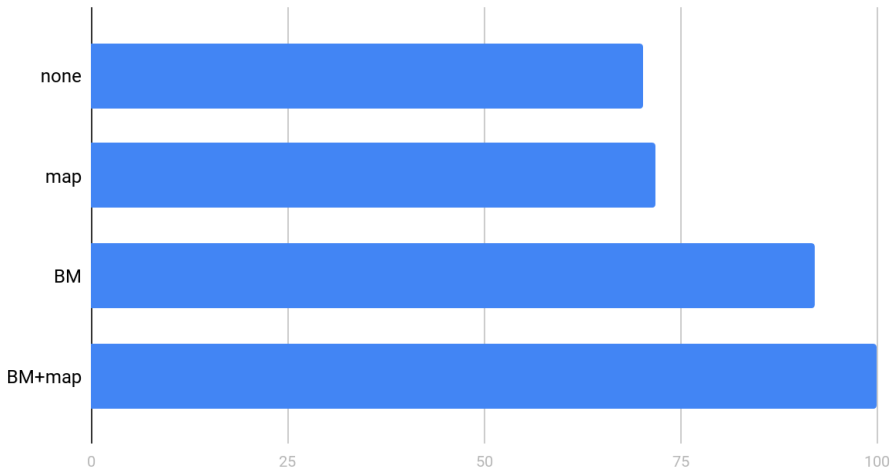
C - commands from routines

Decompiled game routine

```
Routine R0175, 1 local
Action routine for:
"get out / off / up"
"stand"
"stand up"
"leave noun"
"exit"
JG #05,G12 [TRUE] L0001
JG G12,#008e [TRUE] L0001
JIN G12,"Class" [FALSE] L0002
L0001: CALL_VN R0587 (#04,G12)
```


Evaluation domain-based mechanisms

Score (rescaled in a way that best = 100%)



Gameplay example (detective)

You are in a **closet**. There is a **gun** on the **floor**. Better get it. To **exit**, go east.

Calculating score

- uniqueness of the word,
- number of words matched,
- popularity of the command,
- cosine distance between the word and the synonym.

Unsuccessful commands go to the blacklist.

action	value
<i>get gun</i>	0.1736
<i>drop gun</i>	0.1129
<i>take gun</i>	0.0887
<i>open closet</i>	0.0557
<i>examine gun</i>	0.0309
<i>fire gun</i>	0.0252
<i>load gun</i>	0.0237
<i>examine closet</i>	0.0128
<i>buy gun</i>	0.0042
<i>sharp gun</i>	0.0006

Gameplay example (zork3)

You are in a shadowy land of low, rolling hills stretching out to the west and south. The land is bordered to the north by a massive stone wall. Ancient and weathered, the wall has crumbled enough at one point to permit passage. A cloaked and hooded person, carrying a sword not unlike your own, is standing blocking the way to the northeast. The hooded figure has a great deal of strength, perhaps matching your own.

> *examine figure*

There is nothing special to be seen. Your quick reflexes cannot stop the hooded figure's stroke! You are hit!

> *kill figure with sword*

The hooded figure is hit with a quick slash! The figure has a light wound which hasn't affected its seemingly great strength.

> *kill figure with sword*

You charge, but the hooded figure jumps nimbly aside. The hooded figure stabs nonchalantly with its sword and misses.

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What can you do with a rock? Affordance extraction via word embeddings; N. Fulda, D. Ricks, B. Murdoch, D. Wingate; IJCAI 2017

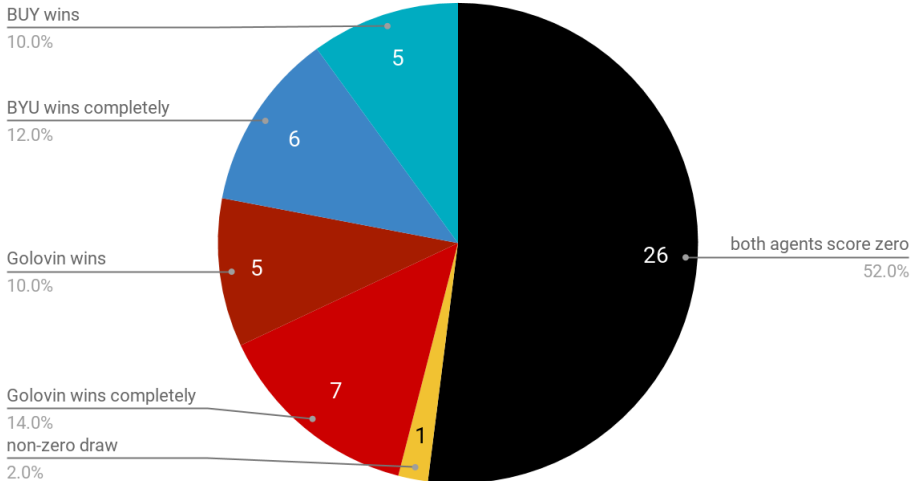
- Based on the verb-noun affordances detection
- Wikipedia as the word corpus
- word2vec used to conceptual similarities
- Q-learning to assign scores to state-action pairs

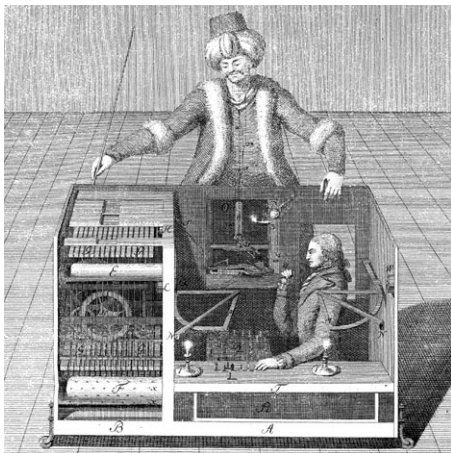
Comparison

- The set of 50 classic IF games, average of 10 tries each
- BYU-Agent:
 - 1000 epochs training
 - 1000 steps in each epoch
 - best score over all epochs
- Golovin
 - 1000 steps with the restarting mechanism
 - last score counts

Comparison with BYU-Agent

Games won





THANK YOU