K.G.C.E.
Karjat - Raigad

Assignment 1 Part B

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1]

PEAS descriptors for WUMPUS World:

The WUMPUS World's agent is an example of a knowledge-based agent that represents knowledge representation, reasoning & planning.

Knowledge-Based agent links general knowledge with current percepts to infer hidden characters of current state before selecting actions. Its necessity is vital in partially observable environments.

PEAS represents Performance Measure, Environment, Actuators, & Sensors. The PEAS description helps in grouping the agents.

P- Performance measures:
- a] Agent gets the gold & return back safe = '+1000 points'
- b] Agent dies = '-1000 points'
- c] Each move of the agent = '-1 point'
- d] Agent uses the arrow = -10 points

E- Environment:
- a] A cave with 16 (4x4) rooms
- b] Rooms adjacent (not diagonally) to the Wumpus are stinking
- c] Rooms adjacent (not diagonally) to the pit

are breezy
d] The room with the gold glitters
e] Agent's initial position - Room [1,1] & facing right side
f] Location of Wumpus, gold & 3 pits can be anywhere, except in Room [1,1]

A- Actuators:
Devices that allow the agent to perform the following actions in the environment.
a] Move forward
b] Turn right
c] Turn left
d] Shoot
e] Grab
f] Release

S- Sensors:
Devices that allow & helps the agent in sensing the following from the environment.
a] Breeze
b] Stench
c] Glitter
d] Scream (When the Wumpus is killed)
e] Bump (When the agent hits a wall)

Wumpus World Characterization:
a] Partially Observable:
Knows only the local perceptions

b] Deterministic:
Outcome is precisely specified

c] Sequential:
Sebsequent level of actions performed.

d] Static:
Wumpus, pits are immobile

e] Discrete:
Discrete environment

f] Single-agent:
The knowledge-based agent is the only agent whereas the wumpus is considered as the environment's feature.

2]

Elements of Cognitive system:

A] A way of interpreting input:

a] A cognitive computing system needs to answer a question or provide a result based on an input.

b] That input might be a search term, text phrase, a query asked in natural language, or it may be a response to an action of some sort (ex: procurement of a product).

c] The first thing a system needs to do is understand the context of the signal.

d] Examples: location, speed of motion; Such context info will enable the system to narrow down the pontential responses to those that are more appropriate.

e] Cognitive computing systems need to start somewhere; they need to "know" or expect something about the user to interpret the input.

f] The more contextual clues that can be derived, defined or implied, the easier it will be to narrow the appropriate type of information to be returned.

B] A body of content/information that supports the decision:

a] The purpose of cognitive computing is to help humans make choices & solve problems.

But the system does not make up the answer. Even synthesis of new knowledge is based on foundational knowledge.

b] The "corpus" or domain of information is a key component of a cognitive computing system.

c] The more effectively that information is curated, the better the end results.

d] Knowledge structures are important, taxonomies & metadata are required, & some form of information hygiene is required.

e] High-value knowledge & information can be made more accessible & useable through cognitive computing systems, but the quality of such core knowledge is essential to the success of the application.

f] In order to create a cognitive system, there needs to be organizational structures for the content which provide meaning to rather unstructured content.

c] A way of processing the signal against the content / info corpus:

a] ML has for long been applied to categorization & classification approaches, & advanced text analytics.

b] The processing might be in the form of a query/matching algorithm or may involve other mechanisms to interpret the query, transform it, reduce ambiguity, derive syntax, define word

sense, deduce logical relationships or otherwise parse/process the signal against the corpus.

c] Machine learning has many flavours.

d] The key here is to iteratively improve the system's performance over time by approximating an output & using that as an input for the next round of processing.

e] In some cases, incorrect answers (as judged by a human or another data source) might be input for the next time the system encounters the problem or question.

D] These 3 components of cognitive mechanisms can be broken down into a pretty broad combination of algorithm techniques.

E] Cognitive computing systems have additional characteristics not depicted here for simplicity sake; however, most of these other characteristics fall into one of these broad classes of functionality.

3]

Language Model:

A] A simple definition of a Language Model is an AI model that has been trained to predict the next word or words in a text based on the preceding words, its part of the technology that predicts the next word you want to type on your mobile phone allowing you to complete the message faster.

B] The task of predicting the next word/s is refered to as self-supervised learning, it does not need labels it just needs lots of text.

C] The process applies its own labels to the text.

D] A language mode can mono linguistic or poly linguistic.

E] There is a broad classification of Language Models that fit into two main groups that are:

a] Statistical Language Models:

These models use traditional statistical techniques like N-grams, Hidden Markov Models (HMM) & certain linguistic rules to learn the probability distribution of words.

b] Neural Language Models:

i] These are new players in the NLP town & have surpassed the statistical language models in their effectiveness.

ii] They use different kinds of Neural

Networks to model language.

4]

Machine Translation:

A] Machine translation (MT) is the task to translate a text from a source language to its counterpart in a target language.

B] There are many challenging aspects of Machine Translation:

a] The large variety of languages, alphabets & grammers;

b] The task to translate a sequence to a sequence is harder for a computer than working with numbers only;

c] there is no one correct answer.

C] Machine translation is a relatively old task. From the 1970s, there were projects to achieve automatic translation. Over the years, three major approaches emerged:

1] Rule-based Machine Translation (RBMT): 1970s-90s

2] Statistical Machine Translation (SMT): 1990s-2010s

3] Neural Machine Translation (NMT): 2014-

1] Rule-based Machine Translation:

a] A rule-based system requires expert's knowledge about the source & the target language to develop syntactic, semantic & morphological rules to achieve the translation.

b] An RBMT system contains a pipeline of Natural Language Processing (NLP) tasks including Tokenisation, Part-of-speech tagging & so on.
c] Most of these jobs have to be done in both source & target language.

Advantages:
- No bilingual text required
- Domain-independent

Disadvantages:
- Requires good dictionaries
- Manually set rules

2] Statistical Machine Translation:
a] This approach uses statistical models based on the analysis of bilingual text corpora.
b] It was first introduced in 1955, but it gained interest only after 1988 when the IBM Watson Research Center started using it.
c] The idea behind statistical MT is the following:

Given a sentence T in the target language, we seek the sentence S from which the translator produced T. We know that our chance of error is minimized by choosing

that sentence S that is most probable given T. Thus, we wish to choose S so as to maximize Pr(S|T).
- A Statistical Approach to Machine Translation, 1990.

d] Using Baye's theorem, we can transform this maximisation problem to the product of Pr(S) & Pr(T|S), where Pr(S) is the language model probability of S & Pr(T|S) is the translation probability of T given S.
e] In other words, we are seeking the most likely translation given how correct a candidate translation is & how well it fits in the context.
f] Therefore, an SMT requires three steps:
i] a language Model (correct word to context)
ii] a ~~lang~~ Translation Model (best translation to given word)
iii] a method to find the right order of words.

SMT examples:
- Google Translate (2006-2016)
- Microsoft Translator (upto 2016)
- Moses: Open Source toolkit.

Advantages:
- less manual work from linguistic experts

- One SMT suitable for more language pairs.

Disadvantages:
- Requires bilingual corpus
- Specific errors are hard to fix

3] Neural Machine Translation:
a] The neural approach uses neural networks to achieve machine translation.
b] Compared to the previous models, NMTs can be built with one network instead of a pipeline of separate tasks.
c] In 2014, seq2seq models were introduced opening new possibilities for neural networks in NLP.
d] Before the seq2seq models, the neural networks needed a way to transform the sequence input into computer-ready numbers.
e] With seq2seq the possibility of training a network with input & output sequences became possible.
f] The NMT emerged quickly. After a few years of research, these models outperformed the SMTs.
g] A problem with neural networks occurs if the training data is unbalanced, the model cannot learn from the rare samples as well as frequent ones.

NMT examples:
- Google Translate (from 2016)
- Microsoft Translate (from 2016)
- Translation on Facebook
- OpenNMT: open-source neural MT system.

Advantages:
- End-to-end models

Disadvantages:
- Requires bilingual corpus
- Rare word problem

5]

a. Phonology:

Phonology is essentially the description of the systems & patterns of speech sounds in a language.

It is, in effect, based on a theory of what every speaker of a language unconsciously knows about the sound patterns of that language.

Because of this theoretical status, phonology is concerned with the abstract or mental aspect of the sound in language rather than with the actual physical articulation of speech sounds.

b. Morphology

Morphology is the study of the way words are built up from smaller meaning bearing units, morphemes.

- 'antiintellectualism' - anti -ism -al - intellect

Free & bound morphemes

- intellect (free)
- anti- -ism, -al (bound)

Stems & affixes

Complex words contain a central morpheme, which contributes the basic meaning, & a collection of other morphemes serving to

modify this meaning in different ways.

c. Lexical Analysis:

Lexical analysis is the first phase of the compiler also known as a scanner.

It converts the high level input program into a sequence of Tokens.

Lexical analysis can be implemented with the deterministic finite Automata.

The output is a sequence of tokens that is sent to the parser for syntax analysis.

d. Syntactic analysis:

Syntactic analysis, also refered to as syntax analysis or parsing, is the process of analyzing natural language with the rules of a formal grammer.

Grammatical rules are applied to categories & groups of words, not individual words.

Syntactic analysis basically assigns a semantic structure to text.

e. Word Sense Disambiguation

Word-sense disambiguation is an open problem in computational linguistics concerned with identifying which sense of a word is used in a sentence.

The solution to this issue impacts other computer-related writing, such as discourse, improving relevance of search engines, anaphora resolution, coherence, & inference.