Knowledge Representation and Engineering

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Contents

1 Info

2 IN-PROGRESS Introduction and Concepts

2.1 Introduction

We introduce two different areas dealing with "knowledge"

Knowledge Representation Artificial Intelligence area concerned with how to represent and manipulate knowledge in an automated way.

Knowledge Engineering Computer Engineering area concerned with procedures and methods helping developers to systematically and formally construct knowledge bases.

A generic knowledge-based system deals with an input I and an output $O = f(I, K)$

- e.g. $I =$ Symptoms, $K =$ Medical knowledge, $O =$ Drug
- The knowledge is provided by a **knowledgebase**
- The system behaves in an **intelligent** way

But why should we use a knowledgebase instead of a database? Consider a database having the following tables:

- `PERSONS` table

Id	Name
A	Albert
B	Beth
C	Cindy
...	...

- `PARENTSHIPS` table

X	Y
A	B
B	C
B	D
...	...

We can ask the following questions

- Is `A` a parent of `B`?
  - `SELECT X FROM PARENTSHIPS WHERE X="A",Y="B";`
- Who are the parents of `B`?
  - `SELECT X FROM PARENTSHIPS WHERE Y="B";`
- Who are the sons of `A`?
  - `SELECT X FROM PARENTSHIPS WHERE Y="B";`
- Who are the ancestors?
  - With a table of `ANCESTORS`
    - With n people, `ANCESTORS` is in $O(n^2)$
    - If 1 generation has (on average) 2.36 ancestors, then 20 generations have 28.7 million ancestors
  - With some explicit "knowledge" (e.g. intelligence)
    - `ANCESTOR`
      - If `X` is a parent of `Y` then `X` is an ancestor of `Y`

- If `X` is an ancestor of `Z` and `Z` is a parent of `Y` then `X` is an ancestor of `Y`

* We can rely on this knowledge base to answer the question

```
if PARENT(X,Y) then return true;
else
 search Z: PARENT(Z,Y)
 if Z does not exist then return false;
 else
  return Ancestor(X,Z.father) or Ancestor(X,Z.mother);
```

Decision Support Systems are computer systems helping users to make decisions in complex domains.

2.2 Data, Information, and Knowledge

Data Raw and without context, it simply exists in its form (either usable or not)

Information Data + Meaning, it can change the perception of the receiver about something

Meaning For Davenport and Prusak, the five C's describe what gives meaning

Contextualization Purpose of data

Categorization Classified or generalization to concepts

Calculation Mathematical or statistical analysis

Correction Removal of erros

Condensation Removal of unnecessary elements

Knowledge Information + "something", generalized to increase applicability. What is "something"?

- For Davenport and Prusak, the four C's describe it as

  Comparison Similarity to other contexts
  Consequence Implication in decision taking
  Connection Relationship with other information
  Conversation Feedback of people

- For Tobin, "something" is an application

Wisdom Knowledge + Intuition + Experience

Expertise Wisdom + Selection + Principles + Constrains + Learning

Capability Expertise + Integration + Distribution + Navigation