Knowledge Representation & Processing

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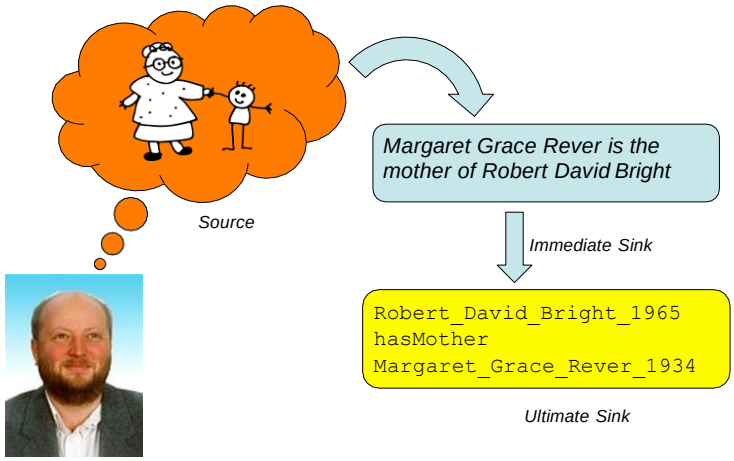
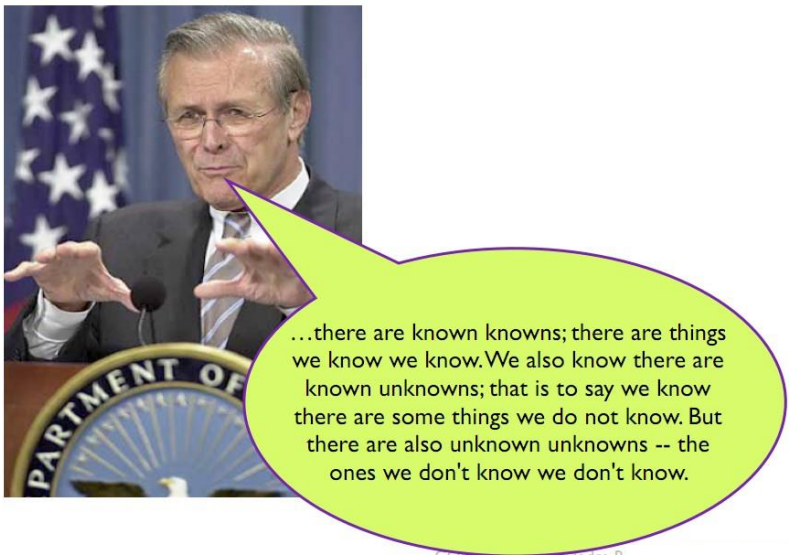
Knowledge Acquisition

From Knowing to Representation

- Source
  - A person, typically called the domain expert (DE, or "expert")
    - domain, subject matter, universe of discourse, area,...
  - Key features
    - They know a lot about the domain (coverage)
    - They are highly reliable about the domain (accuracy)
    - They know how to articulate domain knowledge
      - Though not always in the way we want!
    - They have good metaknowledge
- Immediate Sink
  - A document encoded in natural language or semi-NL
- Ultimate Sink
  - A document encoded in a formal/actionable KR language
    - I.e., an OWL Ontology!
- This KA is often called Knowledge Elicitation

Knowing to Representation





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Eliciting Knowledge

- Proposal 1: Ask the expert nicely to write it all down
- Problems:
  1. They know too much
  2. Much of what they know is tacit
     - Perhaps can give it on demand, but not spontaneously
       - I.e., it's there buthard to access
     - They can't describe it (well)
  3. They know too little
     - E.g., application goals
     - Target representation constraints
       - E.g., the language
     - Their knowledge is incomplete
       - Though they maybe able to acquire or generate it
  4. Expense
     - Busy and valuable people
     - They get bored

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The Knowledge Engineer (KE)

- Key Role
  - Expertise in KA
    - E.g., elicitation
  - Knows the target formalism
  - Knows knowledge (and software) development
    - Tools, methodologies, requirements management, etc.
- Does not necessarily know the domain!
  - Though the KE may also be a DE
    - Most DEs are not KEs
      - Though they may be convertible
  - May be able to "become (enough of an) expert"
    - E.g., if autodidact or good learner with access to classes
- Investment in the representation itself

Elicitation Technique Requirements

- Minimise DE's time
  - Assume DE scarcity
  - Capture essential knowledge
    - Including metaknowledge!
- Minimise DE's KE training and effort
  - Assume loads of tacit knowledge
    - Thus techniques must be able to capture it
- Support multiple sources
  - Multiple experts (get consensus?)
  - Experts might point to other sources (e.g., standard text)
- KEs must understand enough
  - So, the techniques have to allow for KE domain learning
  - KRs reasonably accessible to non-experts
- Always assume DE not invested
  - I.e., that you care more about the KR, much more

Note on generalizability

- Many KA techniques are very specific
  - Specific to source (e.g., learning from relational databases)
  - Specific to targets (e.g., learning a schema)
- Elicitation techniques are generally flexible
  - Arbitrary sources and sinks
    - In both domain and form
  - NL intermediaries help
  - "Parameterisable" is perhaps more accurate

Elicitation Techniques

- Two major families
  - Pre-representation
  - Post-(initial)representation
- Pre-representation
  - Starting point! Experts interact with a KE
  - Focused on "protocols"
    - A record of behavior
  - Protocol-generation
  - Protocol-analysis
- Post-representation (modelling)
  - Experts interact with a (proto)representation (& KE)
  - Testing and generating

Pre-representation Techniques

- Protocol-generation
  - Often involves video or other recording
  - Interviews
    - Structured or unstructured (e.g., brainstorming)
  - Observational
    - Reporting
      - Self or shadowing
    - Any non-interview observation
- Protocol-analysis
  - Typically done with transcripts or notes
    - But direct video is fine
  - Convert protocols into protorepresentations
    - So, some modelling already!
- We can treat many things as protocols
  - E.g., Wikipedia articles, textbooks, papers, etc.

Modelling Techniques

- (Often characterized by aspects of the target (OWL in our case))
- Being picky
  - Pedantic refinement
- Sorting techniques
  - are used for capturing the way people compare and order concepts, and can lead to the revelation of knowledge about classes, properties and priorities
- Hierarchy-generation techniques
  - such as laddering are used to build taxonomies or other hierarchical structures such as goal trees and decision networks.
- Matrix-based techniques
  - involve the construction of grids indicating such things as problems encountered against possible solutions.
- Limited-information and constrained-processing tasks
  - are techniques that either limit the time and/or information available to the expert when performing tasks. For instance, the twenty-questions technique provides an efficient way of accessing the key information in a domain in a prioritised order.

Other Modelling Techniques

- Scenario descriptions
- Diagrams
- Problem solving
- Teaching
- Role Play
- Joint Observation
- Etc.

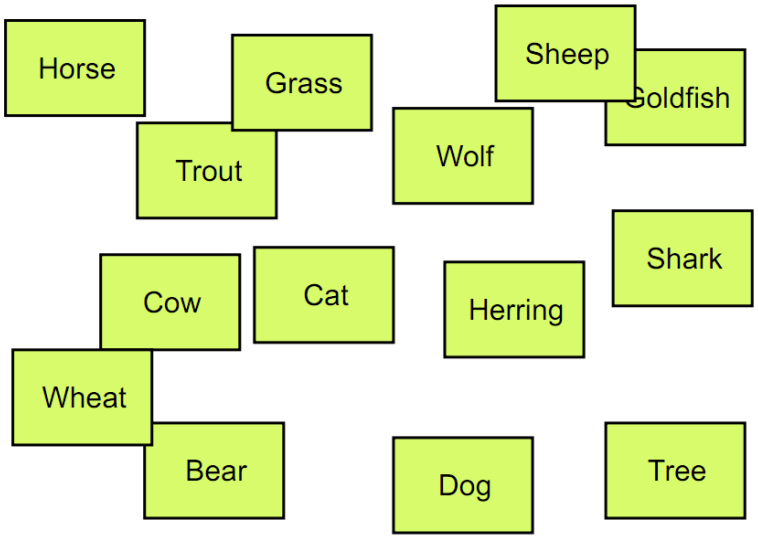
Example: An Animals Taxonomy

- Task:
  - generate a controlled vocab for an index of a children's book
- Domain:
  - Animals including (think of these as CQ)
    - Where they live
    - What they eat
      - Carnivores, herbivores and omnivores
    - How dangerous they are
    - How big they are
      - A bit of basic anatomy
        - » legs, wings, fins? skin, feathers, fur?
    - ...
      - (read the book!)
- Representation aspects
  - Hierarchical list with priorities

Protocol Analysis

- From interviews/behaviour to analysable items
  - Text! Text is good!
- From a text,
  - find key terms
  - harmonise them
    - capitalisation, pluralization (or not), orthography, etc.
- Keep track of
  - Significance
    - Core or peripheral terms
    - Illustrative? Defining?
  - Situation
    - Sentences or sections
- Output: List of Terms

Animal taxonomy Term Generation!



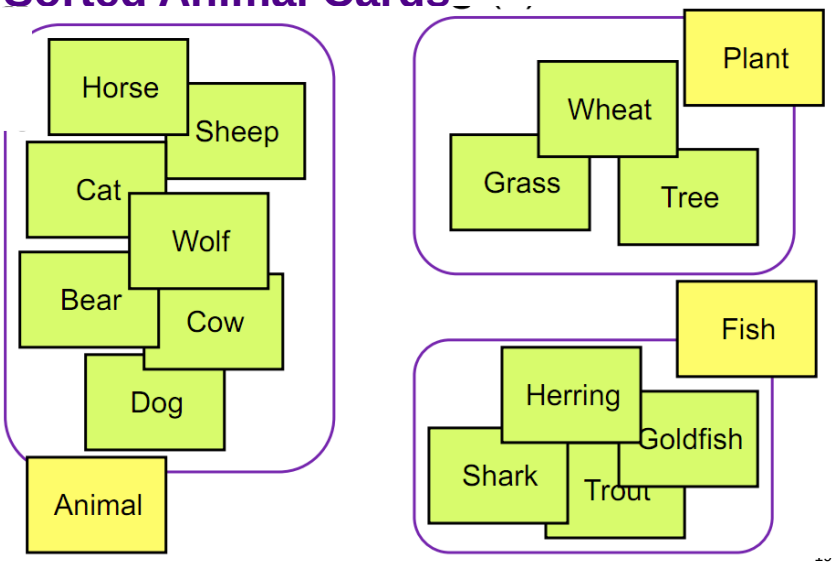
Sort of Knowledge

- "Declarative" Knowledge about Terms (or Concepts)
  - Aka Conceptual Knowledge
- Initial steps
  - Identify the domain and requirements
  - Collect the terms
    - Gather together the terms that describe the objects in the domain.
    - Analyse relevant sources
      - Documents
      - Manuals
      - Web resources
      - Interviews with Expert
- We've done that!
- Now some modelling
  - Two techniques today!
    - Card sorting
    - 3 card trick

Card Sorting!

- Card Sorting identifies similarities
  - A relatively informal procedure
  - Works best in small groups
- Write down each concept/idea on a card
  1. Organise them into piles
  2. Identify what the pile represents
     - New concepts! New card!
  3. Link the piles together
  4. Record the rationale and links
  5. Reflect
- Repeat!
  - Each time, note down the results of the sorting
  - Brainstorm different initial piles

Sorted Animal Cards



Try 2 Rounds

- Initial ideas
  - How we use them
  - Ecology
  - Anatomy
  - ...

Generative

- For elicitation, more is (generally) better
  - Within limits
  - Brainstormy
- Is critical knowledge tacit?
  - We can't easily know in advance
- Winnowing is crucial
  - Sometimes we elicit things which should be discarded
    - And trigger the discarding of other things!
  - Better to know what we don't care to know!

Knowledge Acquisition (KA)

- Operational definition
  - Given
    - a source of (propositional) knowledge
    - a sink
  - KA is the transfer of propositions from source to sink
- Elicitation (for terminological knowledge)
  - Initial Capture:
    - Source: People, "experts", "domain experts" (DE)
    - Sink: "Protocol" (record of behavior)
  - Term Extraction:
    - Source: Text (e.g., transcript, textbook, Wikipedia article)
    - Sink: List of terms (perhaps on cards)
  - Initial Regimentation:
    - Source: List of terms (on cards!)
    - Sink: Proto-representation
      - Hierarchy of categorized, harmonised terms (with notes!)

Triadic Elicitation: The 3 card trick

- Select 3 cards at random
  - Identify which 2 cards are the most similar?
    - Write down why (a similarity)
      - As a new term!
    - Write down why not like 3rd (a difference)
      - Another new term!
- Helps to determine the characteristics of our classes
  - Prompts us into identifying differences & similarities
    - There will always be two that are “closer” together
    - Although which two cards that is may differ
      - From person to person
      - From perspective to perspective
      - From round to round

Example

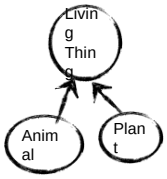
1. David Bright (1934)

2. Margaret Grace Reever (1934)

3. Robert David Bright (1965)

20 Questions

- Like the game!
  - The KE picks an object/concept in the domain
  - The DE tries to guess it
    - and asks a series of yes/no questions
      - "Is it an animal?" "Is it a vegetable?" "Is it a mineral?"
- KE notes the questions and their order
  - Can help determine key concepts, properties, etc.
    - Animals, vegetables, and minerals!
  - Can help structure the domain
    - "Is it a living thing?", "an animal?", "a plant?"
- Note that the technique is not the game!
  - Goals are different!
  - We're very interested in the questions, not the answers per se



Key Goal: Laddering

- Terms vary in generality
  - Tree vs. Plant
  - Dog vs. Rover
- Each sort may be implicit!
  - Goal: Flesh out the generality hierarchy
    - Get more specific (if too general)
    - Get more general (if mostly specific)
- How?
  1. Take a group and ask what they have in common
     - During sorting or 3-card or directly
  2. Then investigate relations of new term
     - Siblings, missing children, and (eventually) parents (back to 1)

So! The Task

- Capture
  - Look at the Menu
- Extract
  - List of terms; put them on cards!
- Organise
  - Hierarchy
- Encode
  - OWL in Protégé