Knowledge Acquisition

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Knowledge Acquisition (KA)

• Operational definition
  – Given
    • a source of (declarative) knowledge
    • a sink
  – KA is the transfer of declarative statements from source to sink
    • we can generalise this to other sources, e.g., sensors

• We distinguish between KA and K refinement
  – i.e., modification of the statements in our sink
  – But this distinction is merely conceptual
    • Actual processes are messy

• Range of automation
  – Fully manual (what we’re going to do!)
  – (Fully) automated
    • Possibly plus refinement
    • e.g., machine learning, text extraction
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

Margaret Grace Rever is the mother of Robert David Bright

Robert_David_Bright_1965
hasMother
Margaret_Grace_Rever_1934
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 but hard 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
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!

- Horse
- Grass
- Sheep
- Goldfish
- Trout
- Wolf
- Shark
- Cow
- Herring
- Bear
- Cat
- Herring
- Dog
- Tree
- Wheat
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

- Horse
- Sheep
- Cat
- Wolf
- Bear
- Cow
- Dog
- Animal

Try 2 Rounds

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

Plant

Wheat

Grass

Tree

Fish

Herring

Goldfish

Shark

Trout
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

Coursework

- Take the KE done in class
  - Feel free to refine it further
- Encode it using Protege 4
  - Each category term becomes a class
    - Capture your hierarchy using subsumption/subclassing
- Submit your RDF/XML file
- Full description on Blackboard!