English Sentence Structures and EER Modelling

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Conceptual Modelling in the Design Phase

- ER can provide well-defined and natural features
- ER can provide safe features leading to good database design
- IDNF
- Conceptual models must provide means for communication between designer and user
- NL constructs must find counterparts within model
- Need guidelines for conversion
- Provide justification of modelling features
Output of Requirements Analysis

The database stores information about a university. Each person should have a name, and an address that person lives at. Students, general staff, lecturers and professors are all persons. Every student has a student ID and a majoring subject. For the general staff we keep track of their position. Lecturers have a department where they work and a certain teaching area. Professors are also associated with a department, and have several areas of research expertise. Graduate students are students with a degree and study a specific topic. They are supervised by either lecturers or professors within a semester. Courses have a course number and a title, and are taught by a number of lecturers and professors within a certain semester. The course co-ordinators teach courses on the basis of a list of recommended textbooks each of which comes with a title and an ISBN.

Objective: find natural counterparts to basic constructs such as

- nouns, verbs, adjectives, and adverbs
- gerund, clauses, sentences, text

Challenge: sentences depend on each other
ER Features: Entity and Relationship Types

- $E = (\text{attr}(E), \text{id}(E))$

- $R = (\text{comp}(R), \text{attr}(R), \text{id}(R))$

- *order* of object type $O$ is
  - 0, if $O$ entity type,
  - $k$, if $k-1$ is max order of any component of $O$
EER Features: Specialisation and Generalisation

- Specialisation:
  \[ S = (\{C\}', \text{attr}(R), \{C\}') \]

- Generalisation:
  Cluster type \[ C = O_1 \oplus \cdots \oplus C_k \]
  with \[ \text{comp}(C') = \{O_1, \ldots, O_k\} \]
EER Features: Collection Types

collections:
- lists (duplicates, order),
- sets (no duplicates, no order),
- bags (duplicates, no order),
- rankings (no duplicates, order)

\( \text{list-type, set-type, bag-type, ranking-type } U \) with \( \text{comp}(U) = \{C\} \)
- list type \( U[C] \)
- set type \( U\{C\} \)
- bag type \( U\langle C\rangle \)
- ranking type \( U[C] \)
EER Features: Nested Attributes

- Flat attributes $\mathcal{A}$, labels $\mathcal{L}$, and null attribute $\lambda$

- $\mathcal{N}$ over $\mathcal{A}$ and $\mathcal{L}$:
  - $\mathcal{A} \subseteq \mathcal{N}$, $\lambda \in \mathcal{N}$
  - $N_1, \ldots, N_k \in \mathcal{N}$, $L \in \mathcal{L}$:
    - $L(N_1, \ldots, N_k) \in \mathcal{N}$
    - $L(N_1 \oplus \ldots \oplus N_k) \in \mathcal{N}$
  - $N \in \mathcal{N}$, $L \in \mathcal{L}$:
    - $L[N], L\{N\}, L\langle N \rangle, L[N] \in \mathcal{N}$

Diagram:
- COURSE
  - ID
  - Semester
- LECTURERs {LECTURER (Name,E-Mail,Department)}
  - READINGs [READING (ARTICLE (Title,Citation)\(\oplus\)
    BOOK (ISBN,Chapter,Title)) ]
### EER Features vs. English Sentence Structures

<table>
<thead>
<tr>
<th>English sentence concept</th>
<th>EER feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>transitive verb</td>
<td>relationship type</td>
</tr>
<tr>
<td>common noun</td>
<td>component of relationship type</td>
</tr>
<tr>
<td>adjective</td>
<td>attribute of component</td>
</tr>
<tr>
<td>adverb</td>
<td>attribute of relationship type</td>
</tr>
<tr>
<td>numerical expression</td>
<td>attribute of object type</td>
</tr>
<tr>
<td>preposition</td>
<td>role name of component</td>
</tr>
<tr>
<td>gerund</td>
<td>relationship type that is component of another relationship type</td>
</tr>
<tr>
<td>clause</td>
<td>relationship type with components</td>
</tr>
<tr>
<td>complex sentence</td>
<td>relationship type of order higher than 1</td>
</tr>
<tr>
<td>alternative phrase</td>
<td>cluster type</td>
</tr>
<tr>
<td>plural</td>
<td>collection type/nested attribute</td>
</tr>
<tr>
<td>“is a” sentence</td>
<td>specialisation</td>
</tr>
</tbody>
</table>
Comparison to Chen’s original correspondences


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<td>entity type</td>
</tr>
<tr>
<td>adjective</td>
<td>attribute of entity type</td>
</tr>
<tr>
<td>adverb</td>
<td>attribute of relationship type</td>
</tr>
<tr>
<td>numerical expression</td>
<td>attribute of entity or relationship type</td>
</tr>
<tr>
<td>gerund</td>
<td>relationship-converted entity type</td>
</tr>
<tr>
<td>clause</td>
<td>high-level entity type abstracted from group of interconnected low-level entity and relationship types</td>
</tr>
<tr>
<td>complex sentence</td>
<td>one or more entity types connected by relationship type in which each entity type can be decomposed recursively into low-level entity types interconnected by relationship types</td>
</tr>
</tbody>
</table>

- EER reflects (English) sentence structures more soundly and naturally
- higher-order object types reflect dependence between sentences
- this provides justification for introduction of new ER features
Examples: Nouns, Verbs, Preps, Adjectives, Adverbs

A customer is a person who buys products at a store. A 25-year-old customer buys a $200 dollar watch paying with her credit card.
Examples: Gerund and Alternatives

- Nadal plays Federer, and playing is supervised by Lars Graf.

- Academics are either lecturer or tutors, and employees are either academics or general staff.
Examples: Clauses and Sentences

- Managers decide which machine is assigned to which employee.

- A tour is organised by a travel agency into day trips on which tourists visit various sights and are led by a tour guide.
The complex Example - Step 1

Each person has a name. Each person has an address that person lives at. A student is a person. Each general staff is a person. A lecturer is a person. A professor is a person. Every student has a student ID and a majoring subject. Professors have several areas of research expertise.
A graduate student is a student. A graduate student has a degree and studies a specific topic. A supervisor is either a lecturer or a professor. Graduate students are supervised by a supervisor within a semester.
The complex Example - Step 3

Courses have a course number and a title. Courses are taught by a number of teachers within a certain semester. A teacher is either a lecturer or a professor. A textbook has a title and an ISBN. Teachers teach courses on the basis of a list of recommended textbooks.
Conclusion

- ER model does not just provide safe constructs that result in good database design, but also features that enable good communication between designer and user.

- essential to best *approximate* requirements

- additional EER features justified in the sense that modelling becomes more natural

- provides also a justification why the EER features exist

- higher-order object types reminiscent of nested sentence structure in natural language text
Future Work?
Questions?