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)

- **list-, set-, bag-, 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 $\mathcal{L}$:
  - $\mathcal{A} \subseteq \mathcal{N}$, $\lambda \in \mathcal{N}$
  - $N_1, \ldots, N_k \in \mathcal{N}$, $L \in \mathcal{L}$:
    - $L(N_1, \ldots, N_k) \in \mathcal{N}$
    - $L(N_1 \oplus \ldots \oplus N_k) \in \mathcal{N}$
  - $N \in \mathcal{N}$, $L \in \mathcal{L}$:
    - $L[N], L\{N\}, L\langle N \rangle, L[N] \in \mathcal{N}$
## 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</td>
</tr>
<tr>
<td></td>
<td>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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</tr>
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<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>

Conclusions:

- 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

- **Agassi plays Sampras, 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.
The complex Example - Step 2

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.
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.