

CSCC40: Information Systems Analysis and Design

Lecture 5

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Acknowledgment: these slides are based on Prof. John Mylopoulos slides which are used to teach a similar course in the University of Toronto – St. George campus. Used with Permission.

II. Conceptual Modeling

**Engineering Software
Models in Software Engineering
What is Conceptual Modeling?
Origins**



Engineering Software

- All engineering disciplines are founded on models that are analyzable and can predict the properties of the artifact being engineered.
- Examples: Electric circuits, bridges, car engines.
- What kinds of models can we build for information systems?... And how do we analyze them?
- We will look at modeling and analysis techniques for requirements and for designs.

Conceptual Modeling

- Key problem: Have to give an unambiguous, easy to understand account of our understanding of an organization and how it works, also how the new system will fit in that organization.
- We can do so with English descriptions; but such descriptions are often cumbersome, incomplete, ambiguous and can lead to misunderstandings (...see next two slides!)
- As an alternative, we will use **conceptual models** (also called **visual models**) to describe proposed requirements and designs for the new system.
- Conceptual models (try to) capture people's understanding (conceptualization) of what is being modeled.
- Conceptual models are usually represented in terms of a graph structure.

Natural Languages can be Ambiguous

- This is clause 4 from the UN Security Council resolution 1441:
[on Iraq]
"Decides that false statements or omissions in the declarations submitted by Iraq pursuant to this resolution and failure by Iraq at any time to comply with, and cooperate fully in the implementation of this resolution shall constitute a further material breach of Iraq's obligations and will be reported to the Council for assessment in accordance with paragraphs 11 and or 12 below."
- The US apparently interprets this as meaning a material breach occurs if the declaration submitted by Iraq contains any false statements. Other security council members interpret it as meaning the breach only occurs if Iraq also does not cooperate with the inspection process.

What's the Problem?

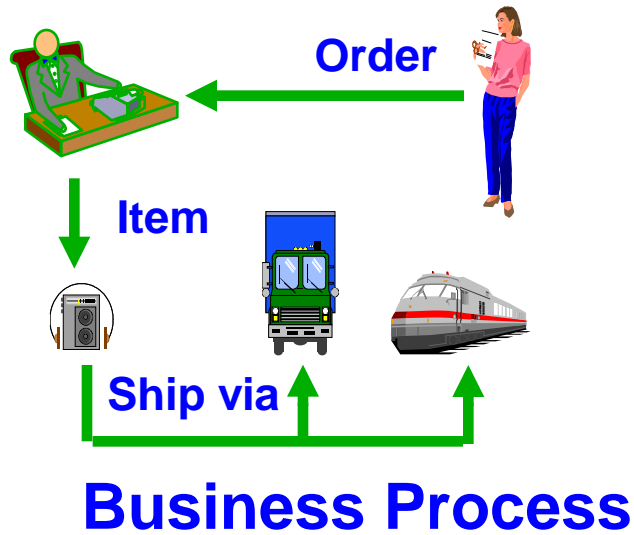
- The clause has the following logical structure:

(A or B and C and D) entails E

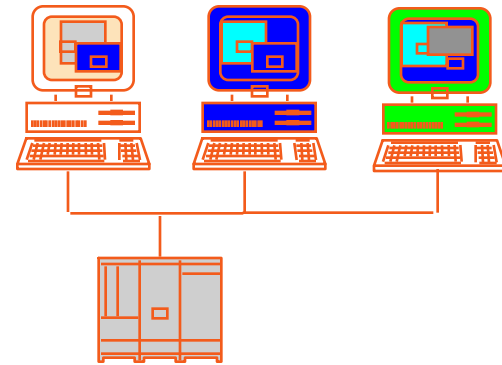
where

- ✓ A = false statements [in the declarations submitted by Iraq]
 - ✓ B = omissions in the declarations submitted by Iraq
 - ✓ C = failure by Iraq at any time to comply with [this resolution]
 - ✓ D = [failure by Iraq at any time to] cooperate fully in the implementation of this resolution
 - ✓ E = a further material breach of Iraq's obligations
- So the two proposed readings are as follows:
 - ✓ ((A or (B and C and D)) entails E -- US interpretation
 - ✓ ((A or B) and (C and D)) entails E -- other security council members' interpretation

What is Conceptual Modeling?



Conceptual Modeling is modeling using a standardized graphical notation

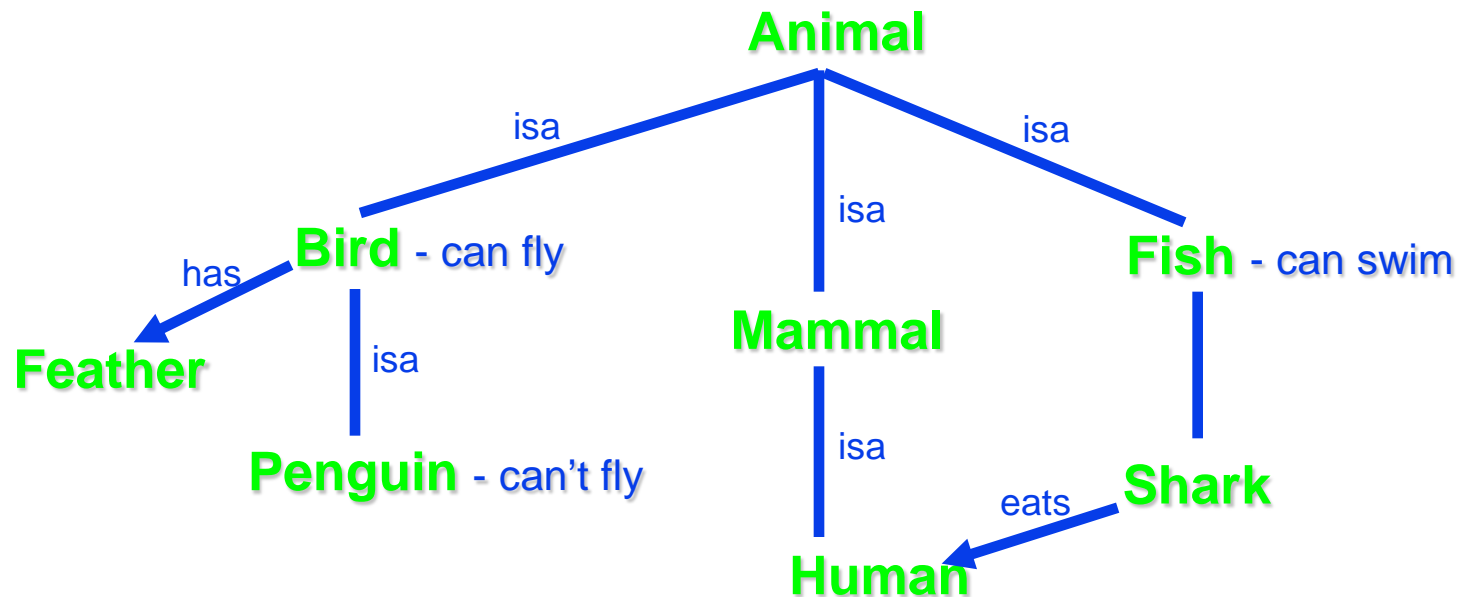


Computer System

Origins

- There have been literally thousands of proposals for conceptual models, in several different areas within and outside Computer Science.
- Ross Quillian proposed in his PhD thesis **semantic networks** in order to model the structure of human memory (1966)
- Ole-Johan Dahl proposed in 1967 **Simula**, an extension of the programming language ALGOL 60, for simulation applications which require some “world modeling”
- Jean-Robert Abrial proposed a **semantic model** in 1974, shortly followed by Peter Chen’s **Entity-relationship model** (1975) as advances over logical data models, such as Codd’s Relational model proposed only a few years before.
- Doug Ross proposed in the mid-70s the **Structured Analysis and Design Technique (SADT)** as a “language for communicating ideas”. The technique was used by Softech, a Boston-based company, in order to specify requirements for software systems.

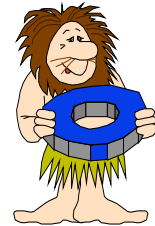
Semantic Networks



Novel ideas

- Models are built out of **concepts** and **associations**
- **Inheritance of attributes** -- strict or default, single or multiple
- Computation defined in terms of **spreading activation** -- e.g.,
 discovering the meaning of “horse food”
 horse --> animal --> eat --> food
 horse --> animal --> madeOf --> meat --> food

Simula (1966)



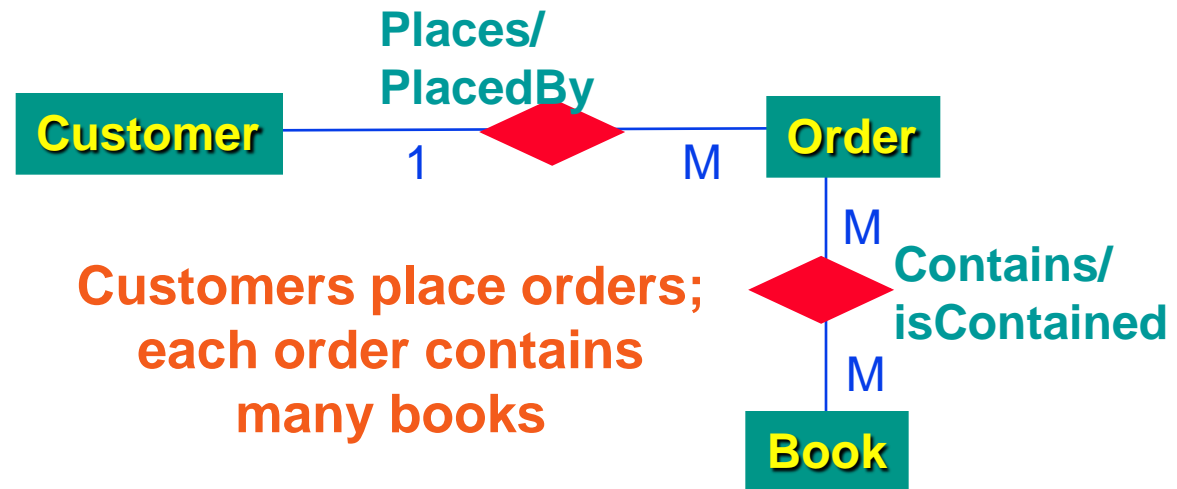
customer
haircutPeriod haircutPrice
enterQueue payBill newC, delC

barberShop
queue barbers
serveCustomer getPayment newBS, delBS

barber
haircutTime salary
giveHaircut newB, DelB

- Ole-Johan Dahl proposed it as an extension of the programming language ALGOL 60, for simulation applications.
- A (simulation) program consists of classes and instances; instances are partly data structures and partly processes.
- Instances ***model the simulated application***, classes define common features of instances, are organized into subclass hierarchies.

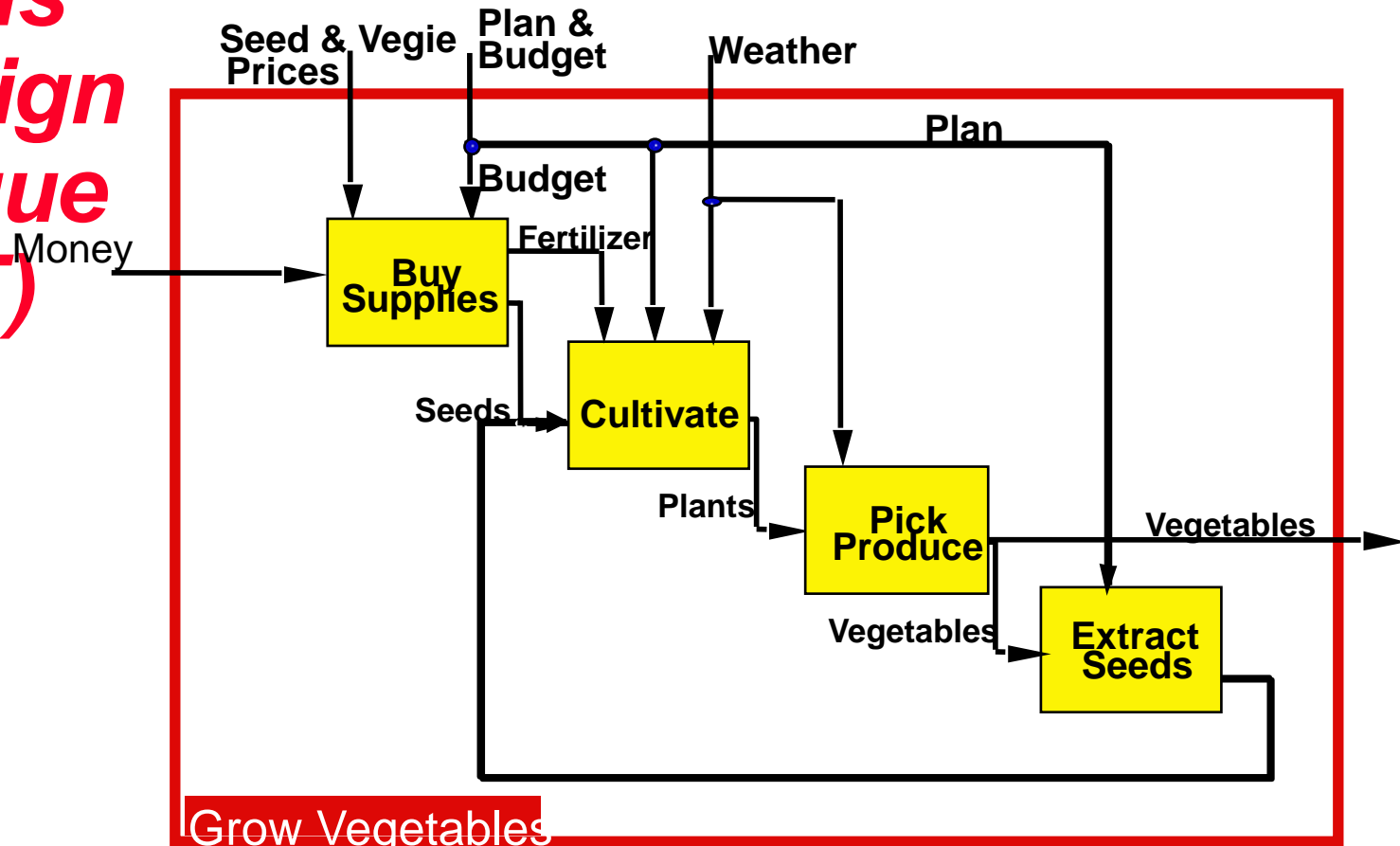
The Entity-Relationship Model



Novel ideas

- Assumes that application consists of **entities** and **relationships** (**ontological assumptions**)
- Shows how a conceptual schema can be mapped onto a logical one.
- [Abrial's semantic model was more akin to OO data models, but did offer entities and relations too]

Structured Analysis and Design Technique (SADT)



Novel Ideas

- Model operating environment of a software system.
- Application modeled in terms of **data** and **activity**.
- Application models organized in terms of box-inside-box notation.