STI · INNSBRUCK

Modeling elements

Lecture 2

9.11.2009

© Copyright 2007 STI - INNSBRUCK www.sti-innsbruck.at

Course sylabus

STI · INNSBRUCK

- Mo 12.10. 13.15 - 14.45
  - **Introduction and motivation**. Definitions, principles, properties and characteristics. Typical usage scenarios. Model engineering.
- Mo 09.11. 13.15 - 14.45
  - **Modeling elements**. Core relationship types and their properties.
- Mo 23.11. 13.15 - 14.45
  - **ER modeling**. Basic modeling elements, foundational theory, examples. Differences to other modeling paradigms.
  - **OO modeling**. Basic modeling elements, UML. Differences to other modeling paradigms.
- Mo 07.12. 13.15 - 14.45
  - **Ontologies**. Definitions, types, modeling elements, RDFS, OWL, ontology reasoning. Differences to other modeling paradigms
  - Classroom experiment?

Course sylabus (cont)

- Mo 11.01. 13.15 - 14.45
  - **Process modeling**. Modeling elements, BPMN, BPEL, UML. Differences to other modeling paradigms.
  - **Modeling best practices**. Rules of thumb, modeling patterns.
- Mo 25.01. 13.15 - 14.45
  - Examination
- Mo 25.01. 15.00 – 1730
  - Proseminar

Summary of the previous lecture

- **Introduction and motivation**.

- Conceptual modeling.
- Data and process models.
- General principles.
- Model engineering.
- Modeling languages.
- Use cases.

Today‘s lecture

STI · INNSBRUCK

- **Modeling elements**.

- General principles.
- Basic elements and their properties: entities, attributes, associations, specialization/generalization.
- Relationships and their characteristics.

Basic principles

STI · INNSBRUCK

- Abstraction
  - Ignoring certain aspects in order to simplify the handling of something or to better understand other aspects.
  - The modeler decides what it is important or not and then chooses a representation that is more tractable than the original.
  - A representation of something can not be greater than that something.

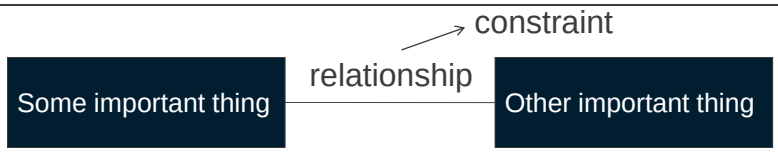
More basic principles

STI · INNSBRUCK

- Models should be divisible.
- Components/modules/chunks should be highly cohesive.
- Use informative names.
- Chunks should have low coupling.

Basic elements

STI · INNSBRUCK



The node is easy to find in the domain with high cohesion and low coupling.
Candidates for nodes:
• steps in flowcharts.
• functions in data flow diagrams.
• states in state machine diagrams.
• things or entities in ER models, knowledge bases.
• classes in OO modes.
• types.
Relationships/associations/relations/properties/attributes hold between instances of the entities.
Constraints/axioms/restrictions/rules further specify the nature of relationships.

Some definitions

STI · INNSBRUCK

- Cohesion:
  - In computer programming, cohesion is a measure of how **strongly-related and focused** the various responsibilities of a software module are. Modules with **high cohesion** tend to be **preferable** because high cohesion is associated with several desirable traits of software including robustness, reliability, reusability, and understandability whereas low cohesion is associated with undesirable traits such as being difficult to maintain, difficult to test, difficult to reuse, and even difficult to understand.
  - Cohesion vs. Coupling
  - Cohesion → loose coupling

Entities

STI · INNSBRUCK

- An entity represents a set of instances.
- An entity should be highly cohesive, precisely nameable, relevant.
- An entity should have a strong identity.

How to find entities

STI · INNSBRUCK

- Interview: talk to subject matter experts.
- Documentation: read what experts have written about the subject matter, read the requirements documentation, read proposals and invitations to tender.
- Observation and reflection.

How to find entities

STI · INNSBRUCK

- Typical candidates for entitites: NOUNS.
  - But: actors of use cases do not necessarily correspond to entities.
- Other terms as well
  - Verbs: an association which starts to take on attributes and associations of its own turns into an entity: „Officer arrests suspect“.
  - Verbs: events: „Illness episode“.
  - Passive form: re-formulate in active form.
  - No pronouns.

Cohesion and identity

- An entity should represent one thing, all of that thing and nothing but that thing.
- You can prove cohesion by
  - Giving the entity a representative name.
  - Noun (+ adjective, sometimes however also captured as attribute value).
    - Blackmail victim, robbery victim.
    - Blue car, red car.
    - **Cars** is not cohesive.
- Avoid ambiguous terms.
  - Manager, handler, processor, list, information, item, data…
- Instances vs classes of things.
- Identity ~ individuality: entities change values, but are still the same entity
  - Child/Adult: age

Relevance

- Goint out too far vs. going down too far.
- Investigate homonyms and synonyms.
  - Homonym: two words are homonyms if they are pronounced or spelled the same way but have different meanings
  - Synonym: two words that can be interchanged in a context are said to be synonymous relative to that context
- Questions
  - Can medicine and drug be considered synonyms?
  - Do they have the same properties/characteristics/attributes/relationships?
  - Do they have a critical mass of commonalities?

Characterizing entities

STI · INNSBRUCK

- Two types of principal characteristics:
  - Measurable properties: attributes.
  - Inter-entity connections: associations.
  - Use associations to model something with an identity.
  - Arrest details as attribute of the suspect vs. Arrest as an association.
    - Do we measure degrees of arrestedness or do we want to be able to distinguish between arrests?
  - Color of an image as attribute vs. entity.
  - A „pointing finger“ rather than a „ruler“ indicates identity.

Attributes

STI · INNSBRUCK

- An attribute is a measurable property of an entity.
  - Scalar values: choice from a range of possibilities.
  - An attribute is NOT a data structure. It is not complicated to measure.
- Value of attributes: integer, real numbers, enumerations, text.
- Attributes do NOT exhibit identity.
- Attributes should have precise representative names.
- Derived attributes.

How to find attributes

STI · INNSBRUCK

- Interview: talk to subject matter experts.
- Documentation: read what experts have written about the subject matter, read the requirements documentation, read proposals and invitations to tender.
- Observation and reflection.

How to find attributes

STI · INNSBRUCK

- Nouns in „-ness“
  - Velocity-ness, job-ness, arrested-ness…
- „How much, how many“ test.
  - If you evaluate this, then it is probably an attribute.
  - If you enumerate these, it is probably an entity.
- Do NOT collapse one-to-one relationships.
- Status attributes are problematic because of open-ended range or fixed, but very large possible values, or because of complex state dependencies.

Ranges of attributes

STI · INNSBRUCK

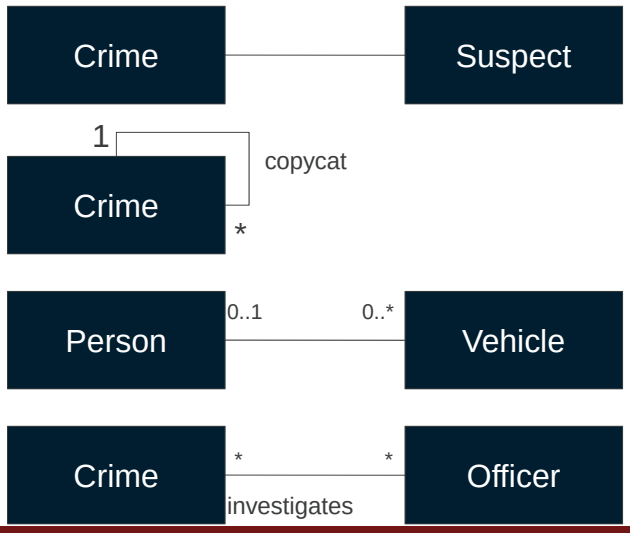
- Age abstracted as an integer.
- Latitude and longitude: real numbers/NSEW.
- Names abstracted as text.

Associations

STI · INNSBRUCK

- Associations are relationships where entities instances are aware of, and characterized by, other entity instances.
- Characterizing relationships vs. use relationships.
  - The former are part of the domain model.
- Properties of associations: reflexivity, cardinality, functional, inverse-functional, discountinuous multiplicity, transitivity, symmetry etc.
- Arity
- Derived associations.
- Associations can stand for any way in which one entity can be characterized by another. Label them.

Examples



How to find associations

- Interview: talk to subject matter experts.
- Documentation: read what experts have written about the subject matter, read the requirements documentation, read proposals and invitations to tender.
- Observation and reflection.

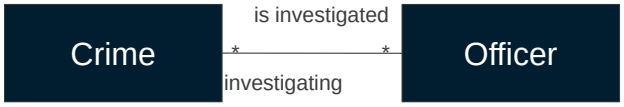
- Verbs, verbal phrases and things that could have been verbs.
  - „*The buttler murdered the duchess*“

Roles

- *Never draw more than three associations without going back and starting to label them.*
- The most common way to label associations is with role names.
- Nouns, adjectives.
- Verbs: indication of time‘s passing.
  - Short-term, one-to-one associations should be named with present participles.
  - Longer-term, one-to-many associations should be named with past participles, or with the simple present third-person singular.

Examples

Direction

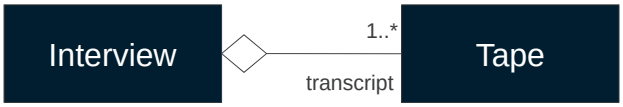


Aggregation

- Aggregations are relationships where entities instances are aware of, and characterized by, other entity instances.
- Difference between aggregation and association:
  - An association describes a relationship between instances of one or more classes.
  - An aggregation describes a part-whole relationship.
  - Existence-dependence

Existence-dependence

- Provides a reliable test to distinguish between an aggregation and an association.
- Component is mandatory for the existence of the composit.



- 1..* vs. existence-dependence.

Classifications

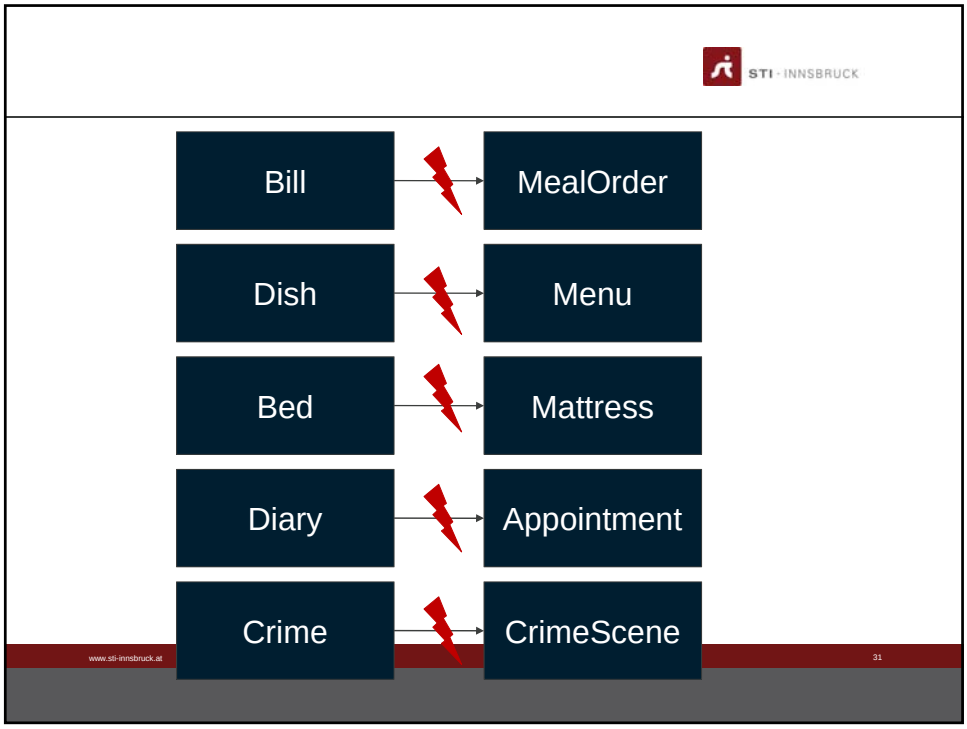
- Classification is a relationship between entities ~ sets of instances.
- It is done to communicate understanding, to reduce redundancy, to improve normalization.
- *Generalization/specialization, typing, is-a-kind-of, is-a, inheritance.*
- Some kind of things is a kind of another kind of thing and yet they couldn‘t both be said to be instances of the same kind of thing.
- The Liskov Substitutability Principle (LSP): If an instance of the supertype were expected and an instance of the subtype turned up it would be acceptable, suitable or substitutable in most contexts.
- *Is the ellipse a kind of circle or a circle a kind of ellipse?*
- *Is a warrant an arrest?*

How to find classifications

- Top-down, bottom-up, middle-out.
- Are all instances of entity A also instances of entity B?
- Are all A‘s also B‘s?
- Roles.
- Difference between classifications, associations, and aggregations.

Approaches

- Bottom up
  - Collection of most fine-grained entities first and then their „more general“ counterparts
  - Example: Dalmatian, Retriever, Setter; then Hunting Dog; then Dog; then Animal etc.
- Top down
  - Collection of most general entities first
  - Example: Animal; then carnivor and mammal, etc.
- Middle out
  - Combination of both


STI · INNSBRUCK
Bill
MealOrder
Dish
Menu
Bed
Mattress
Diary
Appointment
Crime
CrimeScene
www.sti-innsbruck.at
31


STI · INNSBRUCK
BASIC RELATIONSHIPS AND THEIR PROPERTIES
www.sti-innsbruck.at
32

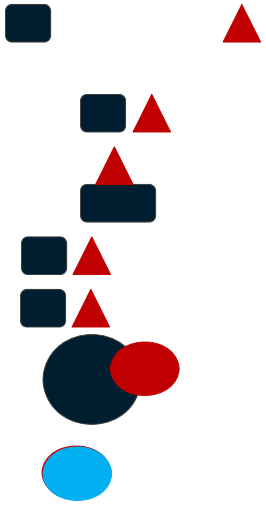
Relationships overview

- Spacial relationships
- Classification relationships
- Meronymy relationships
- Temporal relationships
- Case relationships

Spatial relationships

- left-of, right-of.
- above, below.
- in-front-of, behind.
- inside.
- outside.
- between.

- far.
- near.
- touching.
- beside.
- disjoint
- intersect
- coincident



Spatial Characteristics

STI · INNSBRUCK

- Reflexivity (coincident).
- Irreflexivity (all others).
- Symmetry (near, far, beside).
- Asymmetry (left-of, right-of, above, behind, inside).
- Transitivity (left-of, right-of, above, behind).
- Mutual exclusivity (examples: below, coincident, inside; touching, far; intersect, inside).

Definitions

STI · INNSBRUCK

- Reflexivity.
  - Every element related to itself (<= is reflexive, < not)
- Antisymmetry.
  - R(a,b) and R(b,a), then a = b
- Asymmery
  - For all a and b in X, if a is related to b, then b is not related to a.
- Transitivity.
  - A is related to an element b, and b is in turn related to an element c, then a is also related to c

Classification relationships

STI · INNSBRUCK

- Capture the intuitive semantics of the is-a relationship.
- Functional inclusion
  - A chair is-a piece of furniture.
  - A hammer is a tool.
- State inclusion
  - Polio is a disease.
  - Hate is an emotion.
- Activity inclusion
  - Tennis is a sport.
  - Murder is a crime.
- Action inclusion
  - Lecturing is a form of talking.
  - Frying is a form of cooking.
- Perceptual inclusion
  - A cat is a mammal.
  - An apple is a fruit.

Classification Characteristics

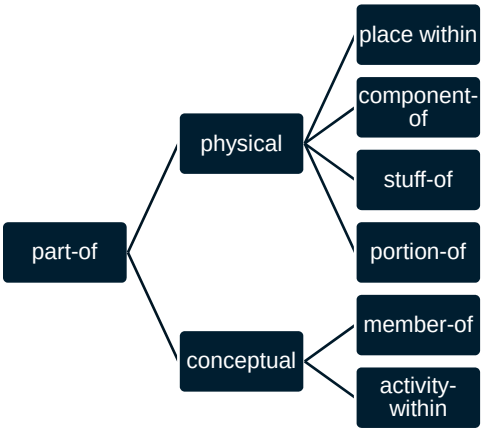
STI · INNSBRUCK

- Essential properties of an entity are inherited by its subentities.
- All instances of a subentity are instances of the superentity.
- Reflexivity.
  - Every element related to itself (<= is reflexive, < not)
- Antisymmetry.
  - R(a,b) and R(b,a), then a = b
- Transitivity.
  - A is related to an element b, and b is in turn related to an element c, then a is also related to c

Meronimy relationships

STI · INNSBRUCK

- Capture part-of relationships.



The Alps are part-of Europe

A chapter is part of a book.

A chair is partly wood.

A yard is part of a mile.

A tree is part of a forest.

Paying is part of shopping.

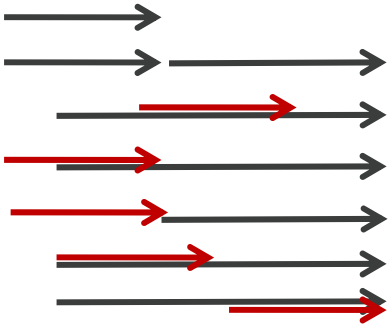
Meronimy Characteristics

STI · INNSBRUCK

- Irreflexivity.
- Asymmetry.
- Transitivity.

Temporal relationships

- X equals Y.
- X before Y, Y after X.
- X during Y, Y contains X.
- X overlaps Y.
- X meets Y.
- X starts Y.
- X finishes Y.



Temporal Characteristics

- Irreflexivity.
- Asymmetry.
  - For all a and b in X, if a is related to b, then b is not related to a.
- Transitivity (before, during, starts, finishes).

Dependency relationships

STI · INNSBRUCK

- depends-on-causally.
- depends-on-existentially.

Characteristics

STI · INNSBRUCK

- Transitivity.

Case relationships

- They differ from other families of relationships in that they do not depend solely on the nature of the meaning of the entities they relate.

- Agent-Action. Dog-bark; artist-paint.
- Agent-uses-Instrument. Skier-uses-skis.
- Agent-Object. Bakes-uses-flour.
- Action-Recipient. Laydown-bed.
- Action-Instrument. Paint-brush.

Characteristics

- Irreflexivity.
- Asymmetry.
  - For all a and b in X, if a is related to b, then b is not related to a.

Summary

- General principles.
- Basic elements and their properties: entities, attributes, associations, specialization/generalization.
- Relationships and their characteristics.

Further reading

- Object-Oriented Analysis and Design (John Deacon, Addison-Wesley).
  - Chapters 5-8.
  - http://www.johndeacon.net/OOAandD/index.asp#TutorLecturerResources
- IDEF5 Method Report: http://www.idef.com/pdf/Idef5.pdf

Assignment 2

STI · INNSBRUCK

a) Describe the automotive domain using 10-20 entities, attributes and relationships.

b) Model the following statements.
   - Barack Hussein Obama was the nominee of the Democratic Party for the office of President of the United States in the 2008 general election.
   - Peter saw Van Gogh's sunflowers in an MOMA exhibition at the Louvre in December last year.

Assignment 2 (cont)

STI · INNSBRUCK

c) In the context of financial accounting what might Customer, Investment, Cruise Ship and Tanker have in common? In the context of a mathematics package, what might Circle and Ellipse have in common? In the context of a fighter-pilot training simulator, what might Bird Flock, Detonation and Cannon Round have in common?

d) Summarize the meaning of aggregation, classification, association.

STI · INNSBRUCK

Thank You!

Questions?