Requirements Meet Interaction Design

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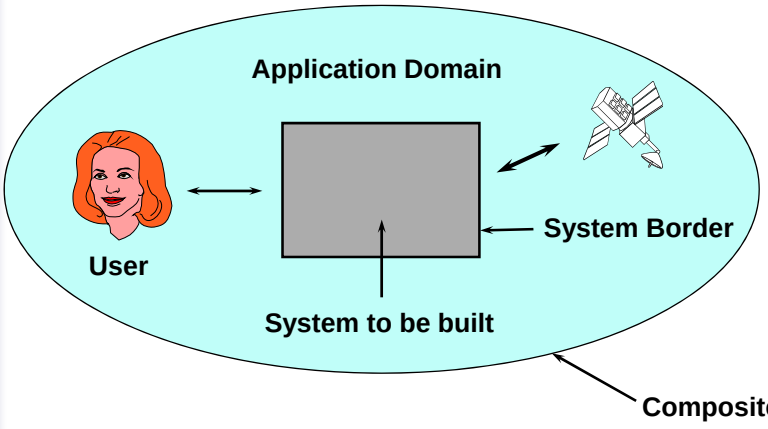
System overview



Outline

- Background
- Interaction design based on discourse modeling
- Use case specification
- Exercises
- Sketch of automated user-interface generation
- Summary and Conclusion

What are requirements?

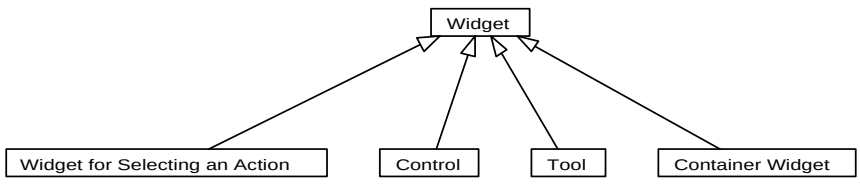
- User wishes / needs 
- *IEEE Standard:*
  "A condition or capacity needed by a user to solve a problem or achieve an objective."
- "The <*system*> shall be able to ..."
  - system to be built
  - composite system
- *Example:* "The ATM shall accept a cash card."
- Requirements modeling

Traditional UI development

- Based on toolkits employing widgets
- Widgets grouped according to their graphical appearance
- Highly-specialized designers and programmers needed
- Lots of UI code
- Error-prone, low maintainability
- Expensive

Widgets

- Interactive objects presented on the display
  - windows
  - buttons
  - scroll bars
- User interface elements
- Classification hierarchy of widgets



Interaction design

- Design of interactions between human and computer
- Relation to requirements engineering
- Relation to task analysis
- No commitment to specific user interface

Scenarios – Stories and narratives

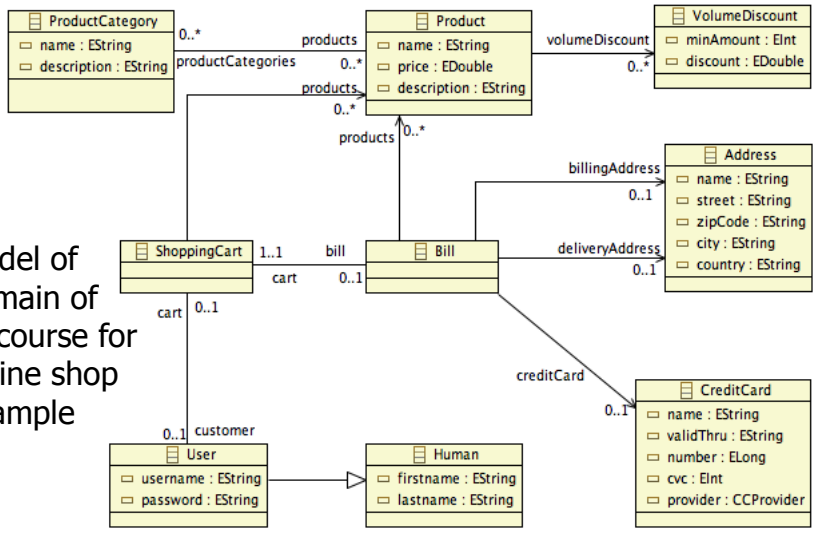
- For representation of
  - cultural heritage
  - explanations of events
  - everyday knowledge
- Human understanding in terms of specific situations
- Human verbal interactions by exchanging stories

Ontologies

- Tom Gruber
- Actually, the old Greeks
- Domain models
- Conceptualizations of a domain
- Often using taxonomies and object-based ideas
- Ontology languages based on knowledge-representation theories
- E.g., OWL based on description logic

Ontologies

Model of domain of discourse for online shop example



Speech acts

- John R. Searle
- Theory from philosophy of language
- Human speech also used to do something with intention — to act
- "Speaking a language is performing speech acts, act such as making statements, giving commands, asking questions and so on"
- Speech acts: basic units of language communication
- Communicative acts: abstraction from speech

Conversation Analysis

- Harvey Sacks; Luff, Gilbert and Frohlich
- Theory from sociology
- Focus on sequences of naturally-occurring talk "turns"
- To detect patterns that are specific to human oral communication
- Adjacency pair: e.g., a question should have a related answer
- Inserted sequence: subordinate interactions

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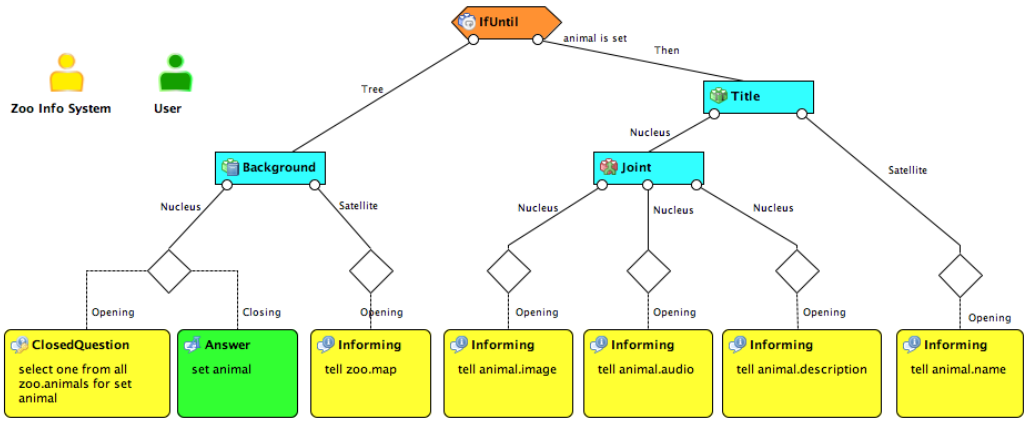
Discourse Example



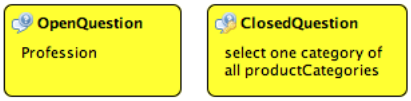
Discourse Model

Discourse "atoms" and "molecules"

- Metaphorical view
  - Communicative acts as atoms
  - Adjacency pairs as molecules
- Communicative acts instead of RST text portions
  - Interaction instead of text
- Two dimensions
  - Tree with discourse relations (monologue)
  - Adjacency pair (dialogue)
- Integration of RST and procedural constructs with Conversation Analysis

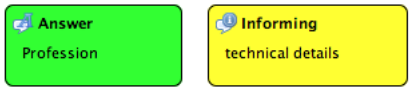
Communicative Acts – Open & Closed Question

- Open Questions enable asking for a particular type of information, respectively, an instance of a domain class.
- Closed Questions restrict the possible answer to a list of provided domain instances to choose from.



Communicative Acts – Informing & Answer

- Both are used to convey information.
- Answer communicative acts are always directly related to questions, whereas Informing is uttered standalone or together with acknowledgment.



Communicative Acts – Request

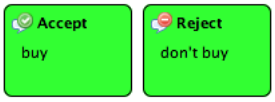
Used to request the communication partner to act. Thus, the propositional content of a request is always an action that has to be carried out. The action can be defined either for the given application, or it can be the request to utter a particular communicative act.

Communicative Acts – Offer

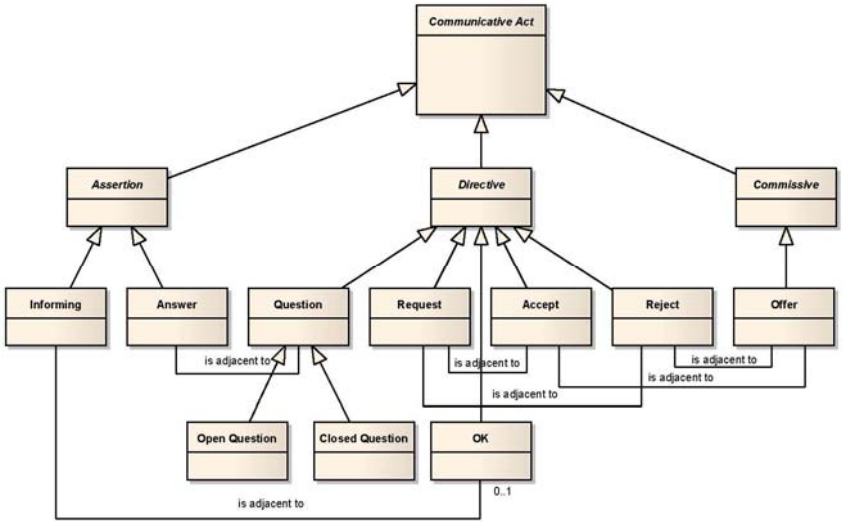
Offers to carry out an action or to add information to the shared knowledge.

Communicative Acts – Accept & Reject

Accept and Reject provide for accepting or rejecting a particular request or offer.

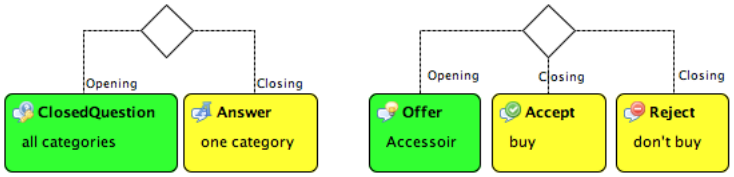


Communicative Acts Taxonomy



Adjacency Pair

- Relates an initial communicative act with one subsequent communicative act or two alternative subsequent communicative acts.
- Typical adjacency pairs of communicative acts are:
  - ClosedQuestion–Answer, OpenQuestion–Answer
  - Offer–Accept, Offer–Reject
  - Request–Informing, Request–Accept, Request–Reject

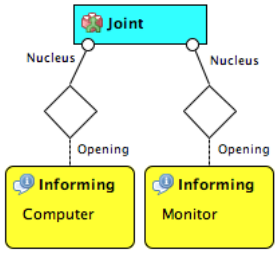


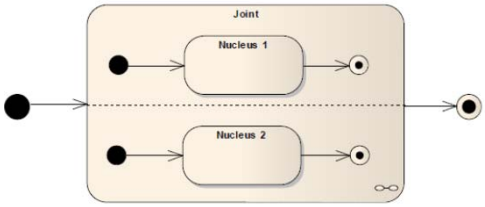
RST relations (in our approach)

- Nucleus: the main part of the communication
- Satellite: the helper part
- Communicative acts instead of text portions

RST relation – Joint

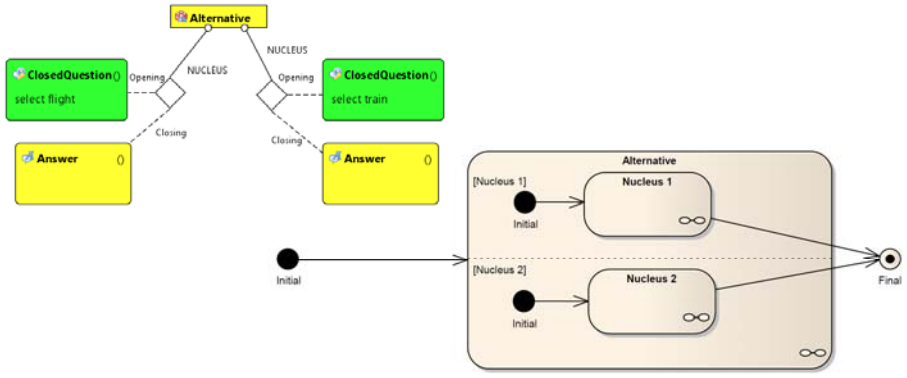
Relates independent subtrees with communicative acts of the same kind. It does not imply any order. So, it is also possible to issue both nuclei concurrently (e.g., on a GUI).





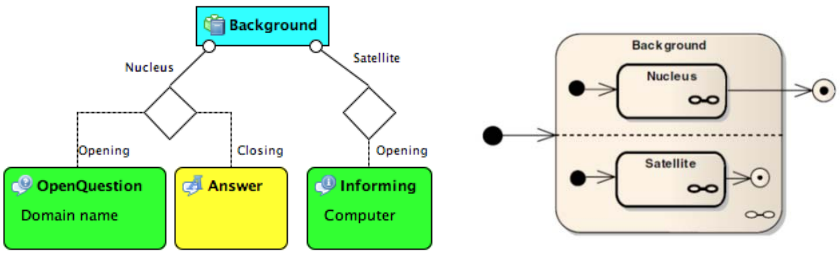
RST relation – Alternative

Relates alternative subtrees with communicative acts. Only one subtree can be finished.



RST relation – Background

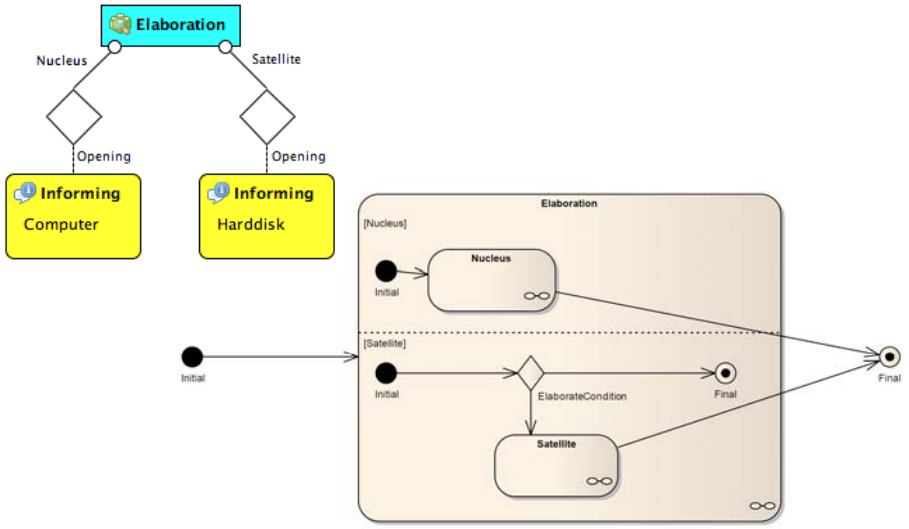
- General information of any sort that is likely to help understand the nucleus.
- Thus, satellite of the background relation shall only contain Informing communicative acts.



RST relation – Elaboration

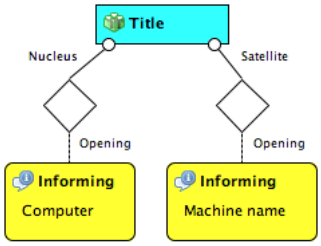
- Satellite contains additional detail about some element of subject matter which is presented in the nucleus, in one or more of the ways listed below (nucleus :: satellite):
  - set :: member
  - abstraction :: instance
  - whole :: part
  - process :: step
  - object :: attribute
  - generalization :: specific
- The communicative acts can also be questions, for example, if one communicative partner wants to figure out additional details about the subject matter.

RST relation – Elaboration (cont.)

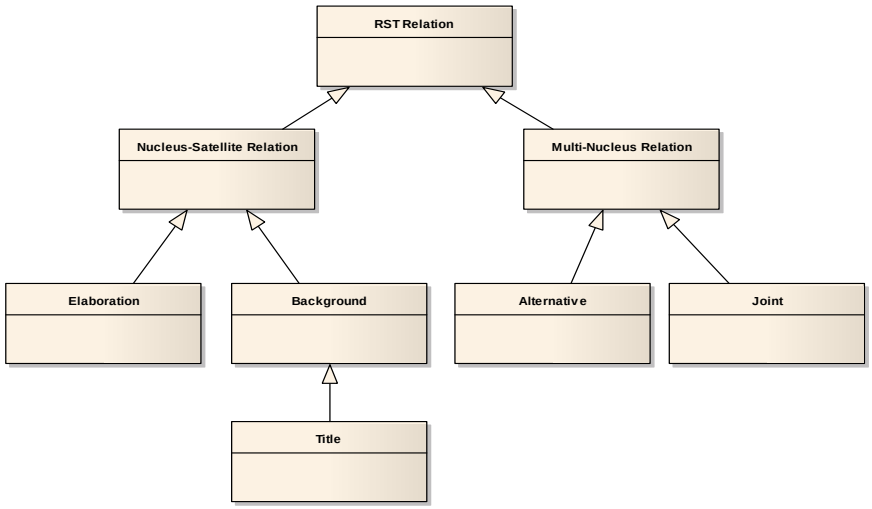


RST relation – Title

Specialization of Elaboration, restricting the additional detail of some element of subject matter to a short description, either title or caption.

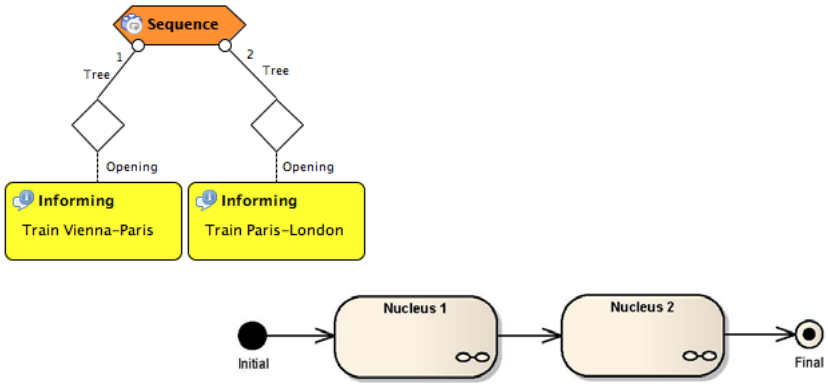


Taxonomy of RST relations



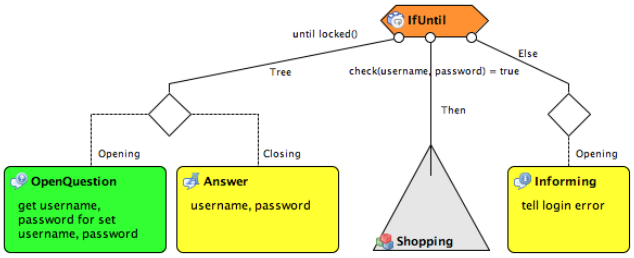
Procedural construct – Sequence

Defined order of uttering the communicative acts or subtrees.

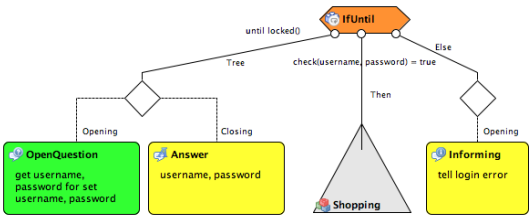


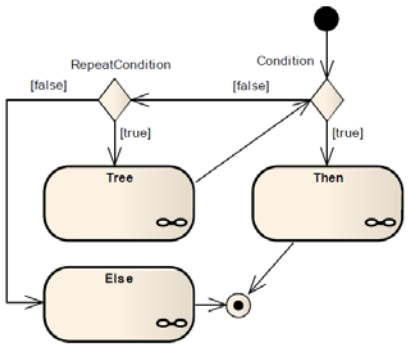
Procedural construct – IfUntil

- If-statement combined with a conditional loop
- Utterance of the <Then> subtree depends on successful execution of the related Condition.
- Repetition of the <Tree> branch until Condition becomes fulfilled, while RepeatCondition is fulfilled

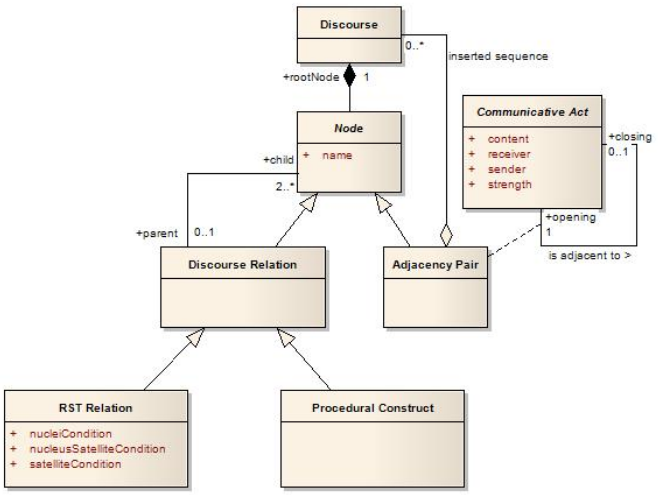


Procedural construct – IfUntil (cont.)

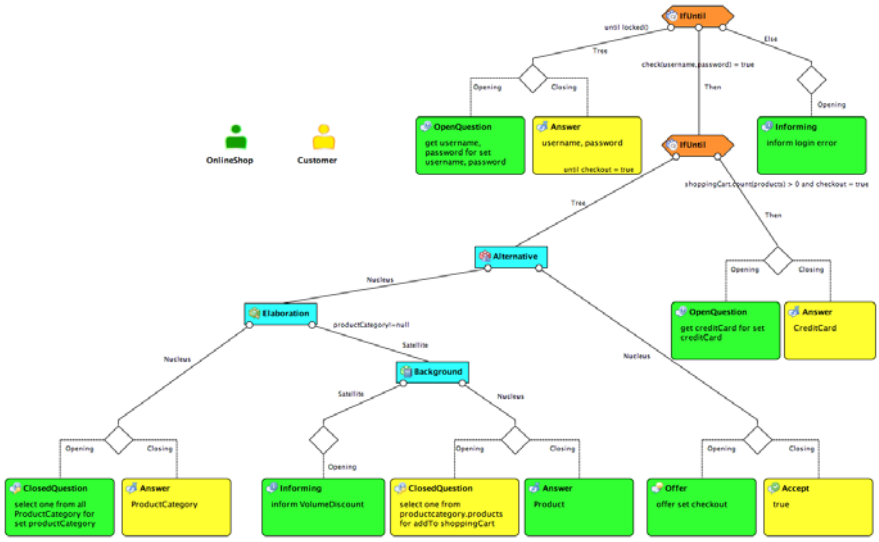




Conceptual Discourse Metamodel



Example model



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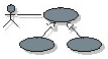
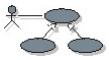
Use cases

- "particular cases of how the system is to be used"
- Use-Case Report (according to Unified Process):
  1. Brief Description
  2. Flow of Events
  3. Special Requirements
  4. Pre-conditions
  5. Post-conditions
  6. Extension Points
  7. Relationships
  8. Use-Case Diagrams
  9. Other Diagrams

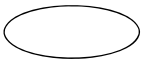


Use-case diagram

- UML graphical notation



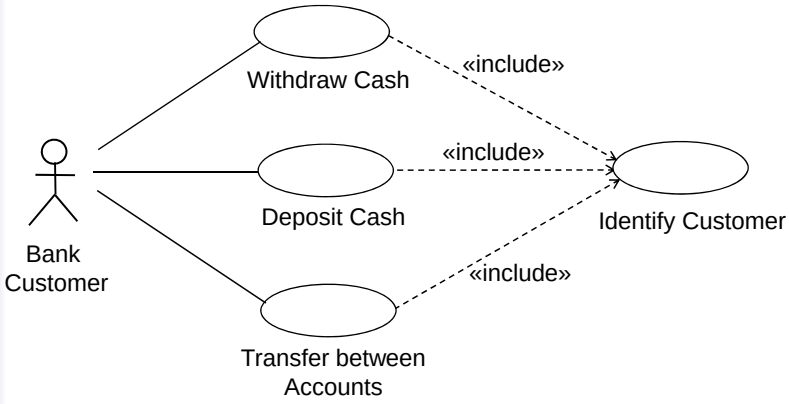
- Ellipse: use case



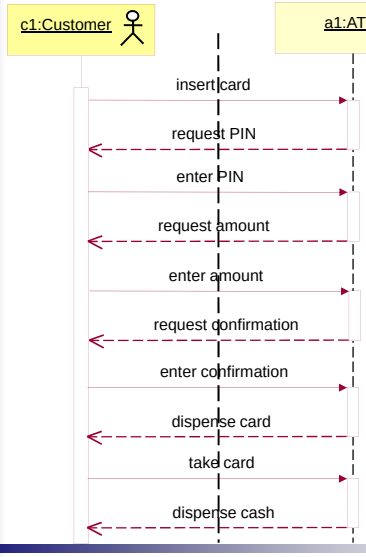
- Stick man: actor

- Connecting line: association

Use-case diagram

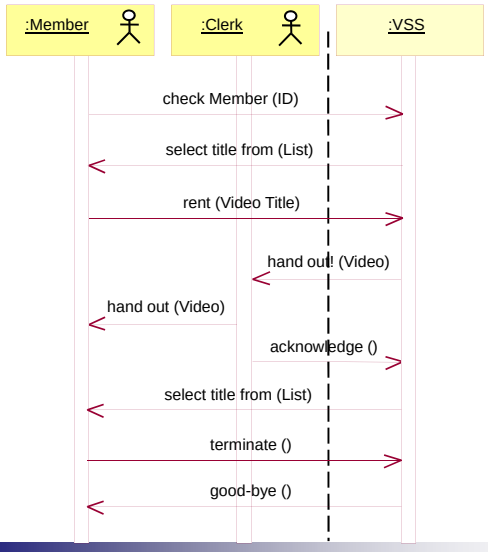


OOA model – UML sequence diagram



- Represents a scenario
- Interaction of instances
- Activation
- System border

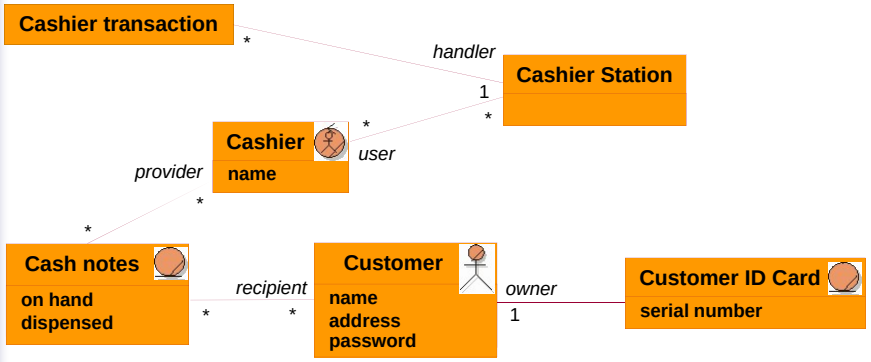
OOA model – UML sequence diagram



Unnamed instances
Concurrent objects

Domain model – ATM example

- UML class diagram (RUP "business object model")
- Associations with names of assoc. ends (roles)



Domain model

- *RUP (Rational Unified Process®)*
  "A domain model captures the most important types of objects in the context of the domain. The domain objects represent the entities that exist or events that transpire in the environment in which the system works."
- *SEM® (Systementwicklungsmethode, Siemens PSE)*
  "A domain model may represent important aspects of the situation as-is."

Specification based on discourse model

- Scenario: focus on thread of events or actions
- Difficult to specify variations in Use-Case Report
- Discourse model: specification of class of dialogues
- Possible flows well defined and understandable
- Additional information in RST relations

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Exercises

- **Given at the tutorial**

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Integration and Use of Ontologies

- Speech act usually talks about something in the domain of discourse.
- Selection from ontology in Domain-of-Discourse Model
- References from Discourse Model to Domain-of-Discourse Model

Interface to Application Logic

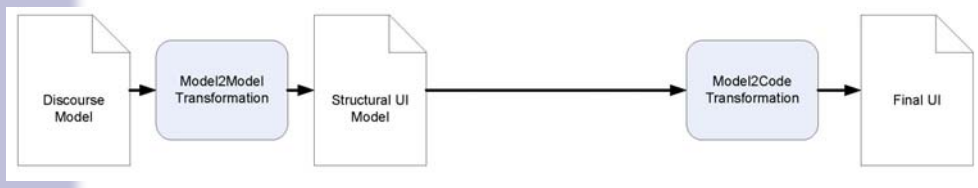
- Specification of (interfaces of) methods of the application logic
- Action-Notification Model
  - Access or change of data (Domain-of-Discourse Model), and
  - Application-specific actions
    - Actions of software, or
    - Physical actions (of a robot)
- References from Discourse Model to Action-Notification Model

Rendering of Final User Interfaces

- Automated generation of final (multimodal) UIs
- Generation of GUIs (WIMP UIs)
  - Generation of Structural UI Model
  - Optimization (for Smartphones)
  - Generation of Behavioral UI Model
  - Weaving of Structural and Behavioral Models
- Even for multiple platforms

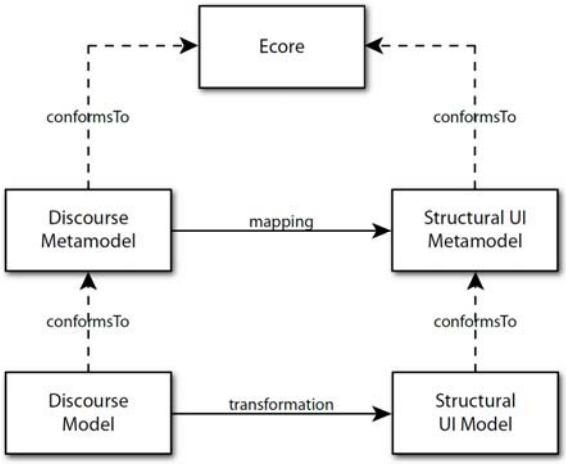
Generation of Structural UI Model

- Model-driven transformations
- Two major steps to structure of Final GUI



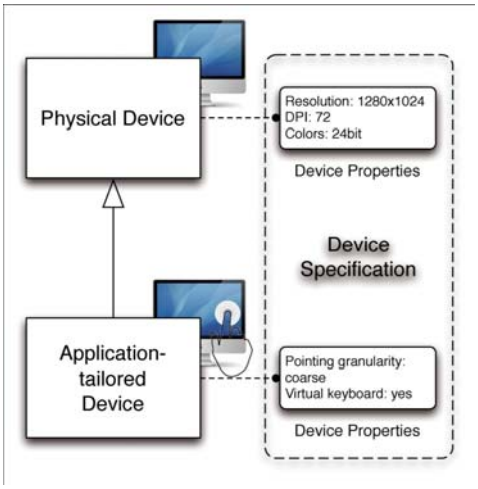
Generation of Structural UI Model – MDA

- Model Driven Architecture
- Metamodels
- Transformation Rules
- Model transformation by rule application



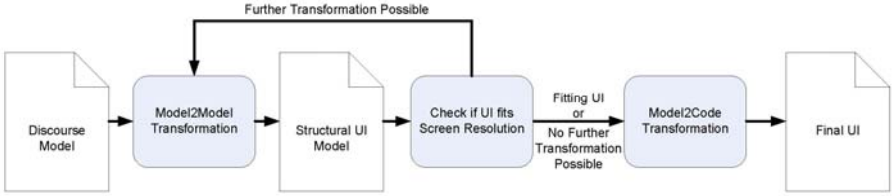
Generation of Structural UI Model – Devices

- Generation according to device specifications
- Application-tailored device specifications in addition to physical ones



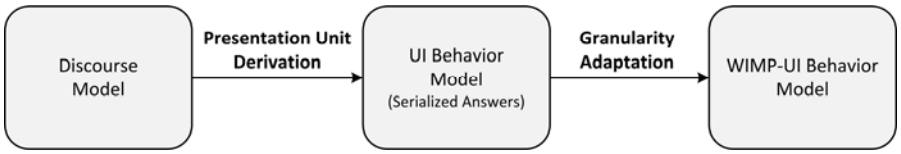
Optimization for Smartphones

- Objectives:
  - Maximum use of the available space
  - Minimum amount of navigation clicks, and
  - Minimum scrolling (except list widgets)
- Heuristic search for optimization (Branch & Bound)



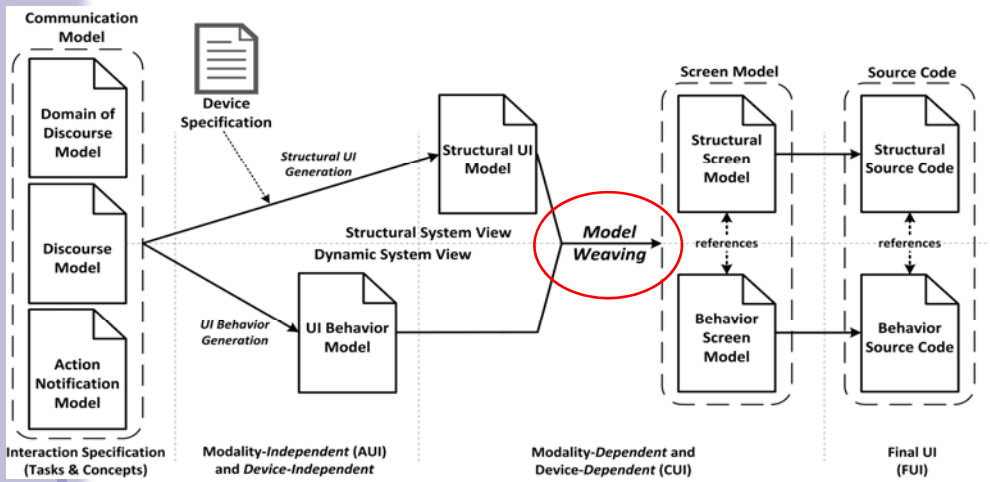
Generation of Behavioral UI Model

- UML state machines for each part defined
- Composition of state machines according to structure of Discourse Model
- Determination of Presentation Units (for GUI)
- Parallelism and Granularity of Communication Units



Weaving of Structural and Behavioral Models

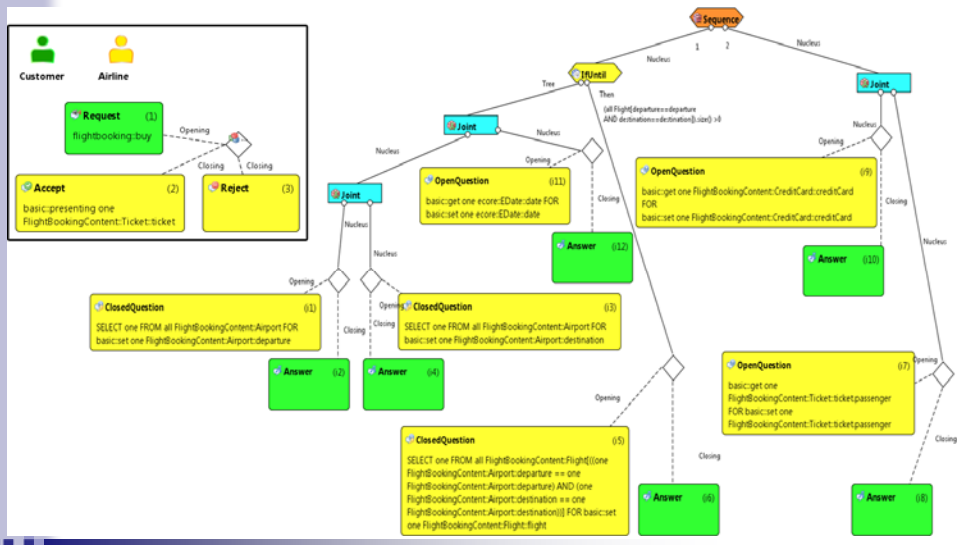
- Different levels of abstraction



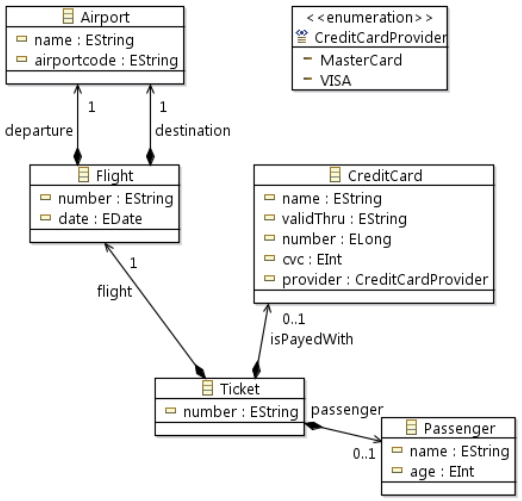
Examples of Final User Interfaces – Phones

- Simple flight-booking GUI
- Optimized for various Smartphones, see http://ontoucp.ict.tuwien.ac.at/UI/FlightBooking
- Potentially different UIs for different phones (screens)

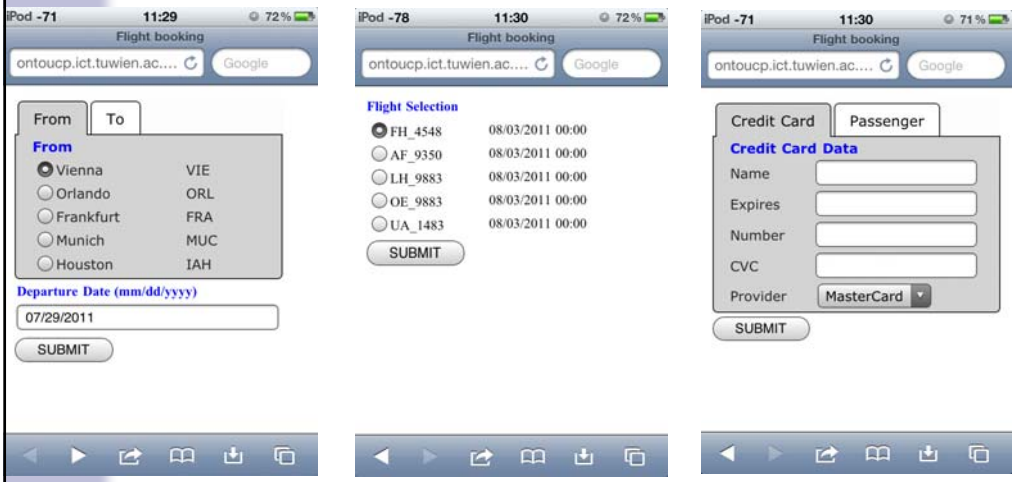
Flight Booking Discourse Model



Flight Booking Domain-of-Discourse Model



Flight Booking Rendered for iPod Touch

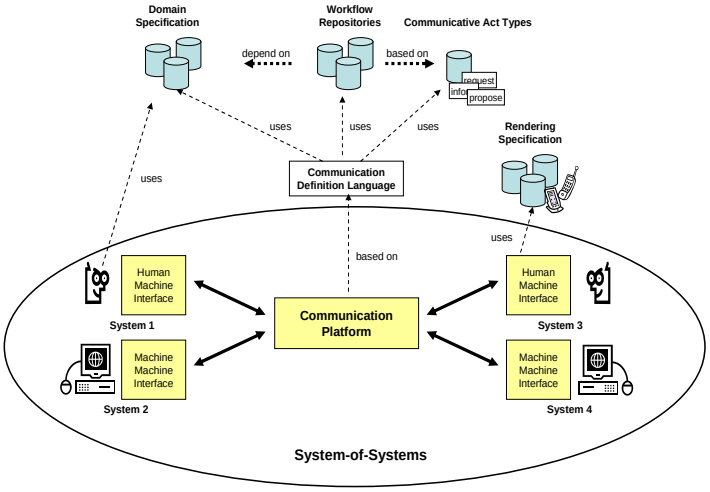


Examples of Final User Interfaces – Robots

- EU-funded research project CommRob: http://www.commrob.eu
- Semi-autonomous Robot Carts
- Specific transformation rules for a given GUI design
- Touchscreen

Final UI for Finger-based Touchscreen

Unified Communication Platform



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Summary and Conclusion

- Interaction design can be based on discourse modeling.
- These models can be used for generating user interfaces.
- These models can be also viewed as specifying classes of scenarios, i.e., use cases.
- Requirements meet interaction design to make applications both more useful and usable.

Thank you for your attention!

???

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Literature

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Selected work of this tutorial presenter

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