Interaction Design with Discourse Models for Automated Web GUI Generation and Customization

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Outline

- Background
- Interaction design based on discourse modeling
- GUI Generation
- Customization
- Improving Low-vision Accessibility
- Conclusion

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

Interaction design for GUI generation

- Design of interactions between human and computer
- Two different views for specifying Interaction Design for automated GUI generation:
  - Task-based (e.g., CTT) vs.
  - Discourse-based
- Tool support for automated transformation
  - of CTT models to UIs by MARIAE;
  - of Discourse-based models by UCP:UI

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

Speech acts

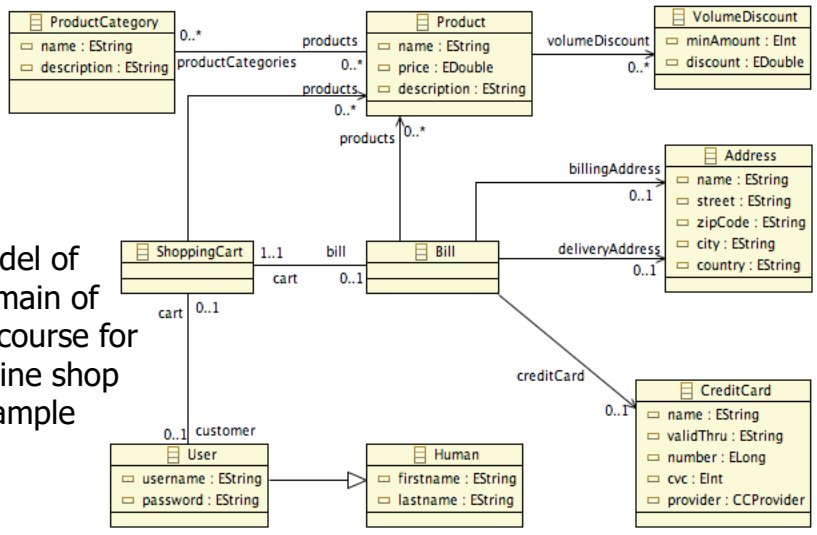
- John R. Searle
- Theory from philosophy of language
- Human speech also used to do something with intention — to act
- "Speaking a language is performing speech acts, act such as making statements, giving commands, asking questions and so on"
- Speech acts: basic units of language communication
- Communicative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

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



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

Rhetorical Structure Theory (RST)

- Mann and Thompson
- Linguistic theory
- Internal relationships among text portions and associated constraints and effects
- Relationships in a text are organized in a tree structure
- Rhetorical relations associated with non-leaf nodes, and text portions with leaf nodes

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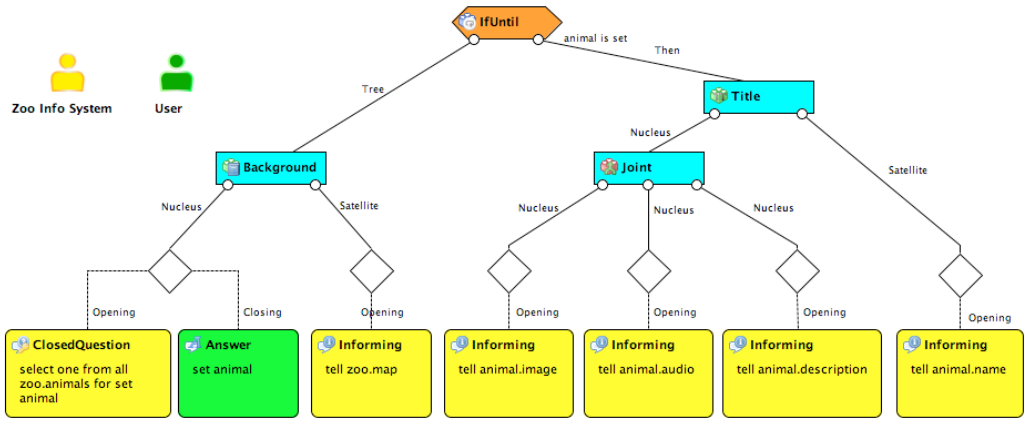
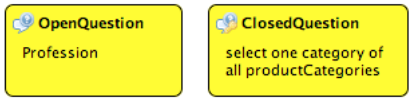
Discourse Example



Discourse Model

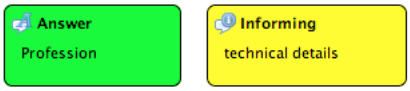
Communicative Acts – Open & Closed Question

- 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.

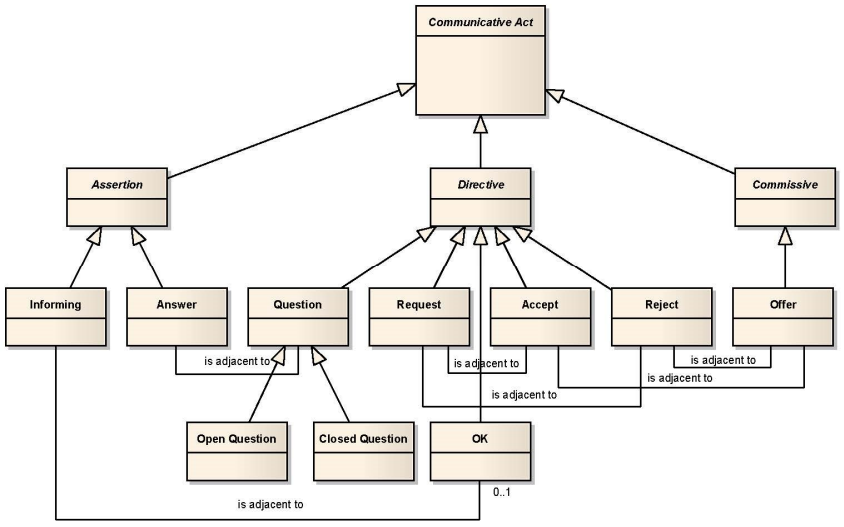
Communicative Acts – Offer

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

Communicative Acts – Accept & Reject

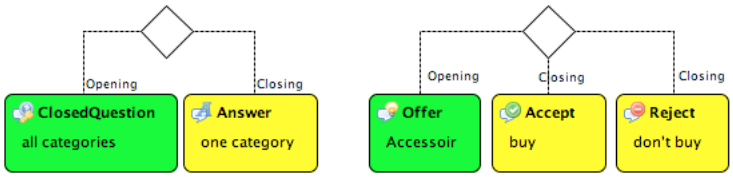
Accept and Reject provide for accepting or rejecting a particular request or offer.

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

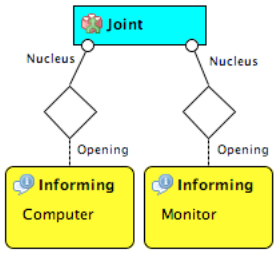


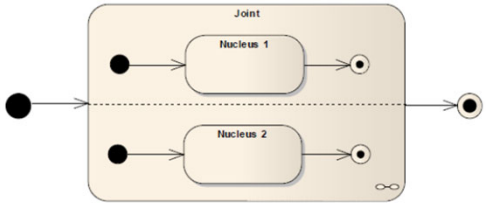
RST relations (in our approach)

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

RST relation – Joint

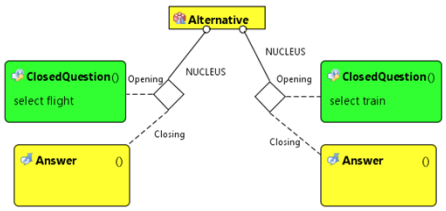
Relates independent subtrees with communicative acts of the same kind. It does not imply any order. So, it is also possible to issue both nuclei concurrently (e.g., on a GUI).

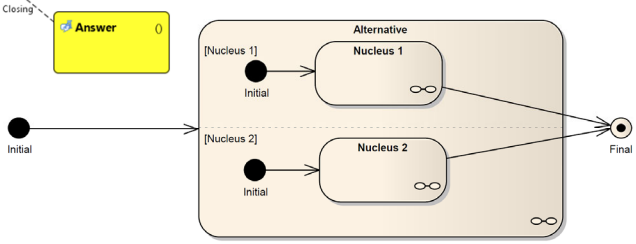




RST relation – Alternative

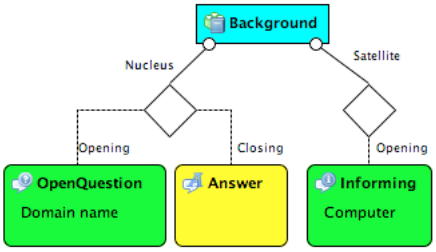
Relates alternative subtrees with communicative acts. Only one subtree can be finished.

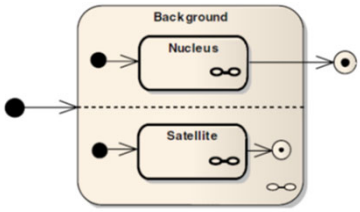




RST relation – Background

- 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.

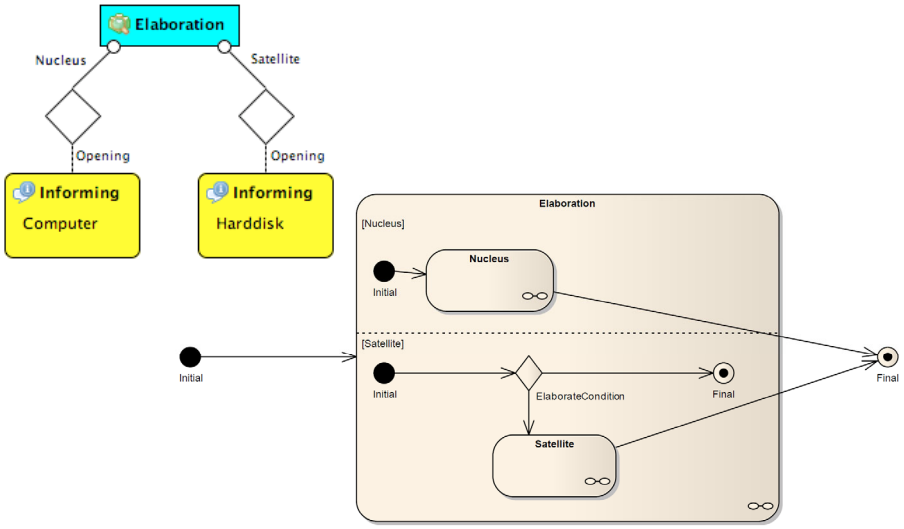




RST relation – Elaboration

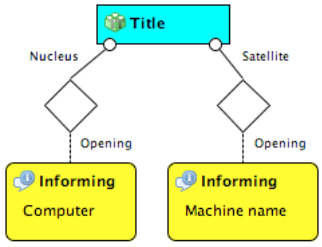
- Satellite contains additional detail about some element of subject matter which is presented in the nucleus, in one or more of the ways listed below (nucleus :: satellite):
  - set :: member
  - abstraction :: instance
  - whole :: part
  - process :: step
  - object :: attribute
  - generalization :: 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.)

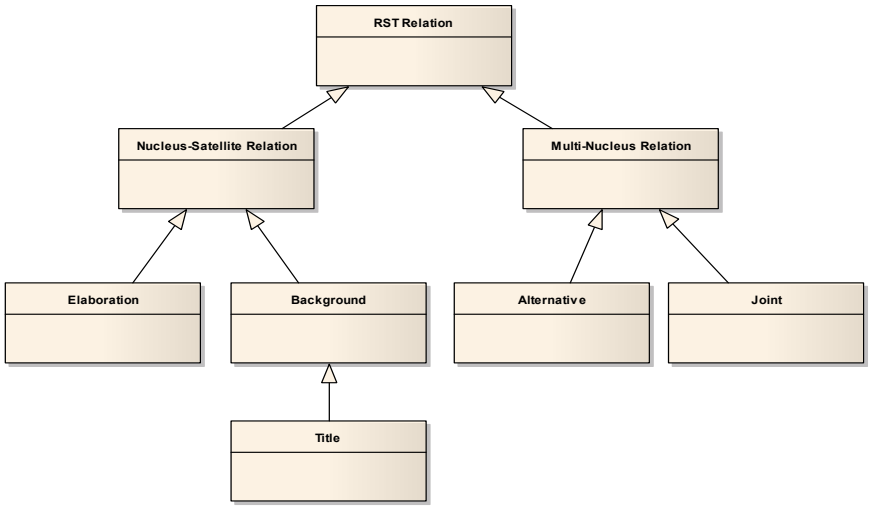


RST relation – Title

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

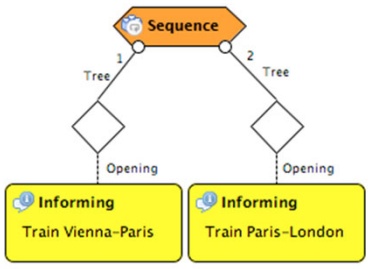


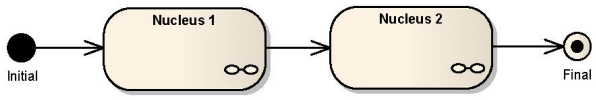
Taxonomy of RST relations



Procedural construct – Sequence

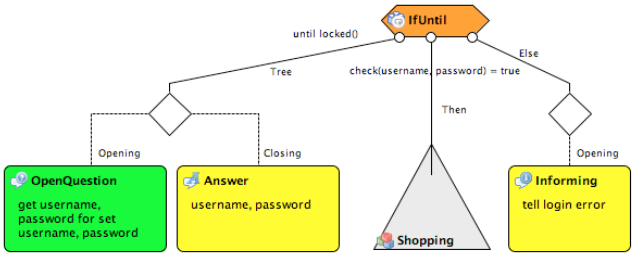
Defined order of uttering the communicative acts or subtrees.



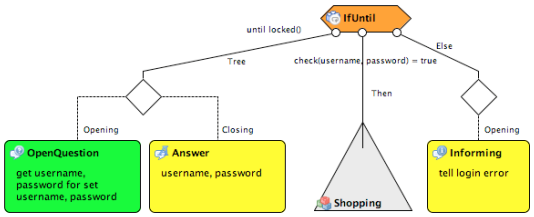


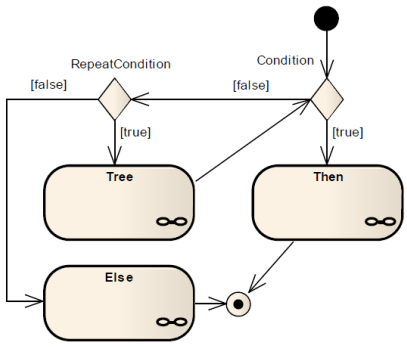
Procedural construct – IfUntil

- 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

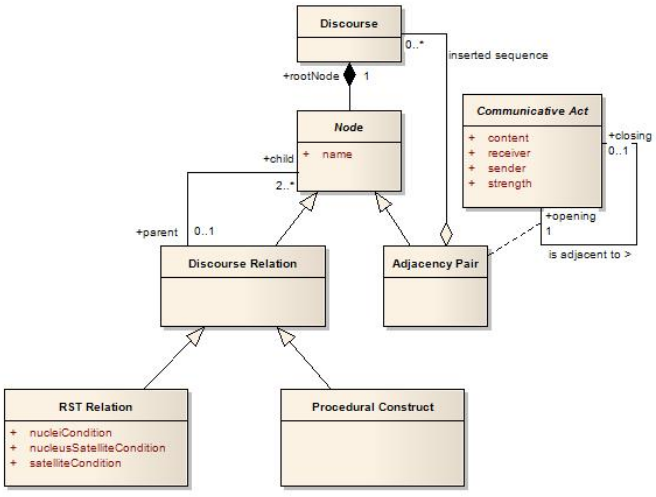


Procedural construct – IfUntil (cont.)

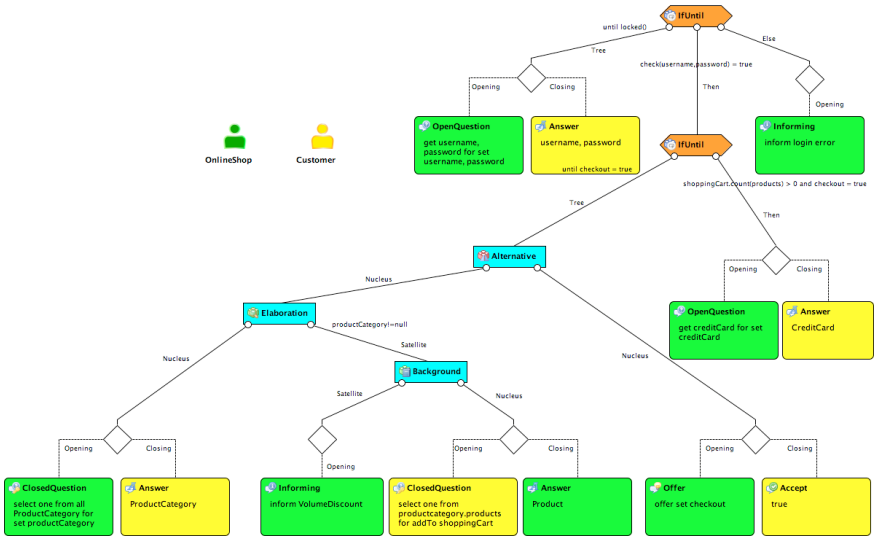




Conceptual Discourse Metamodel

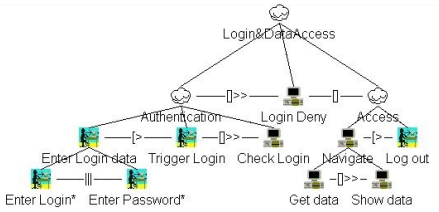


Exercise: Understand given model

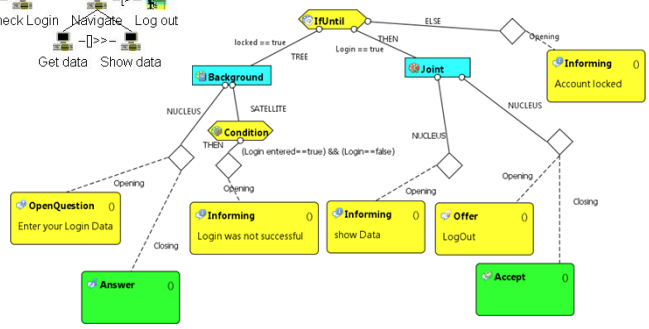


Examples of Interaction Design Models

- CTT Model of Login Example

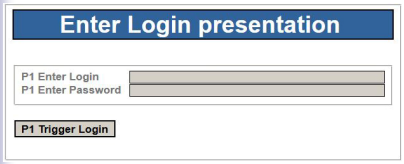


- Discourse Model of Login Example

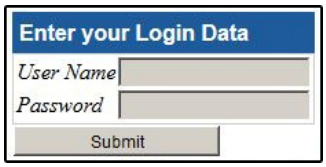


Automatically Generated Login Screens

- Login Screen Generated with MARIAE



- Login Screen Generated with UCP



Contrasting these Interaction Design Approaches in the Context of GUI Generation

- Source models on highest level of abstraction of Cameleon Reference Framework – Tasks & Concepts
- Tailoring for a specific device
- Different operators/relations between basic building blocks:
  - CTT Temporal Operators
  - UCP Discourse Relations
- Coupling betweenc GUI and Application Logi

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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

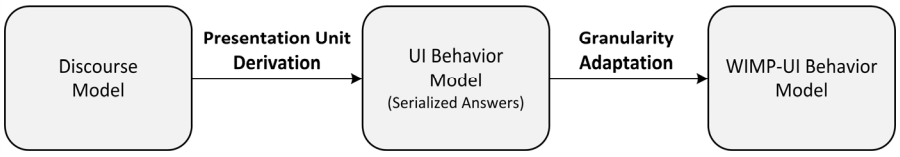
- Specification of (interfaces of) methods of the application logic
- Action-Notification Model
  - Access or change of data (Domain-of-Discourse Model), and
  - Application-specific actions
    - Actions of software, or
    - Physical actions (e.g., of a robot)
- References from Discourse Model to Action-Notification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

Rendering of Final User Interfaces

- Automated generation of final (multimodal) UIs
- Generation of GUIs (WIMP UIs)
  - Generation of Behavioral UI Model
  - Generation of Structural UI Model
  - Optimization (e.g., tailoring for smartphones)
  - Weaving of Structural and Behavioral Models
- Even for multiple platforms

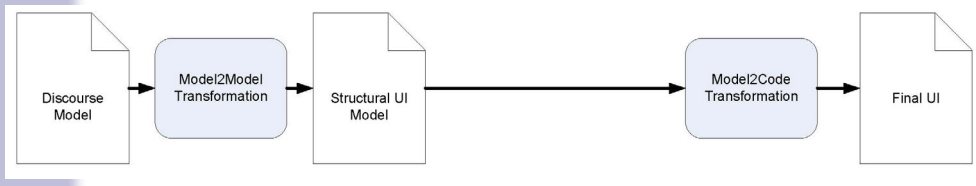
Generation of Behavioral UI Model

- 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



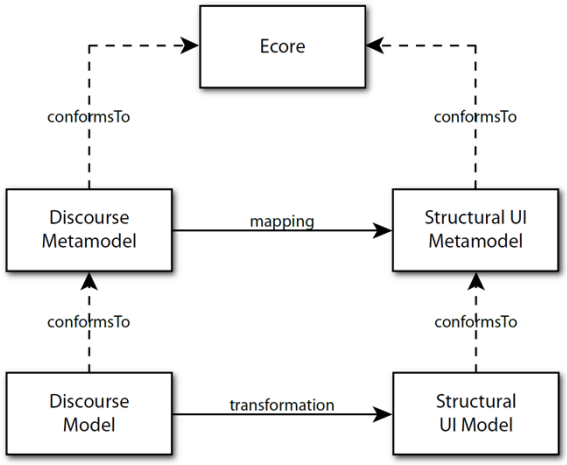
Generation of Structural UI Model

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



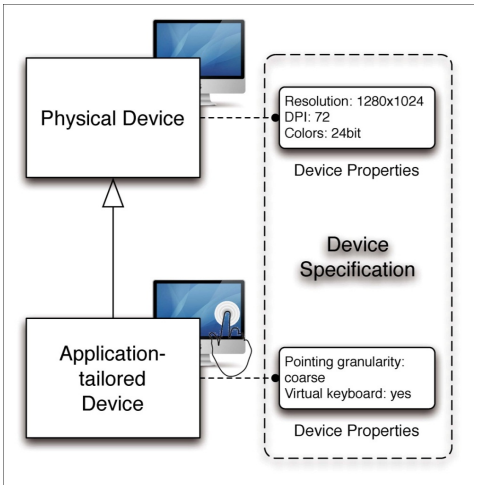
Generation of Structural UI Model – MDA

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



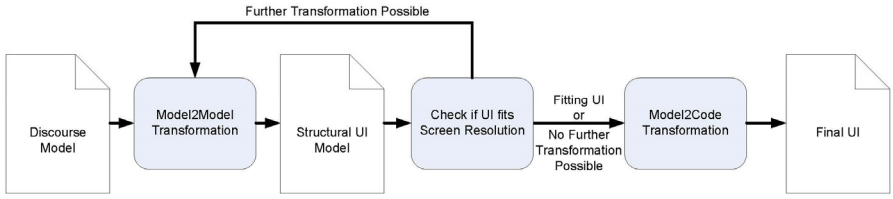
Generation of Structural UI Model – Devices

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



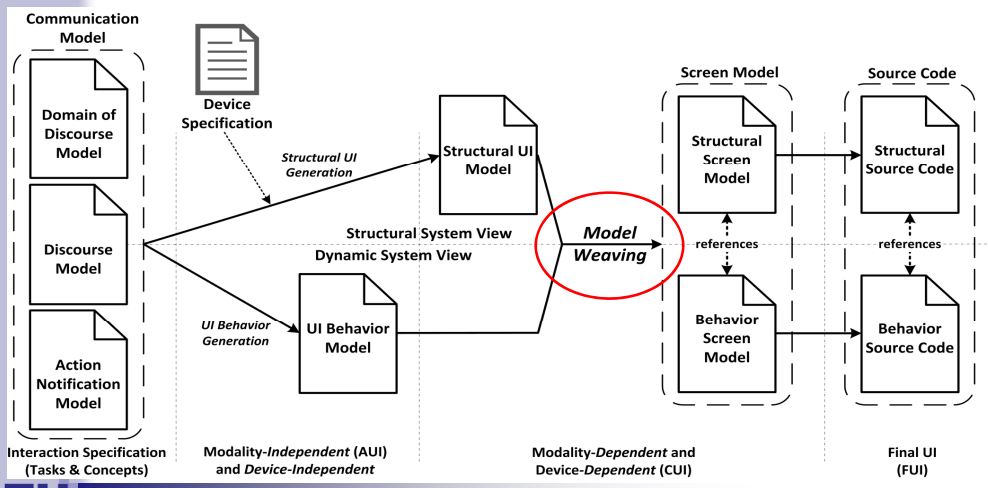
Tailoring for Specific Device (e.g., Smartphone)

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

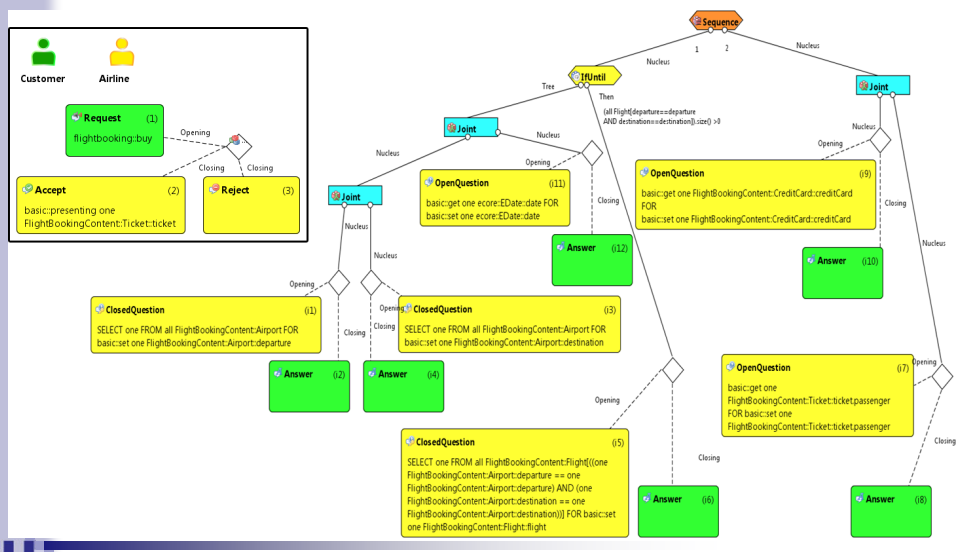


Weaving of Structural and Behavioral Models

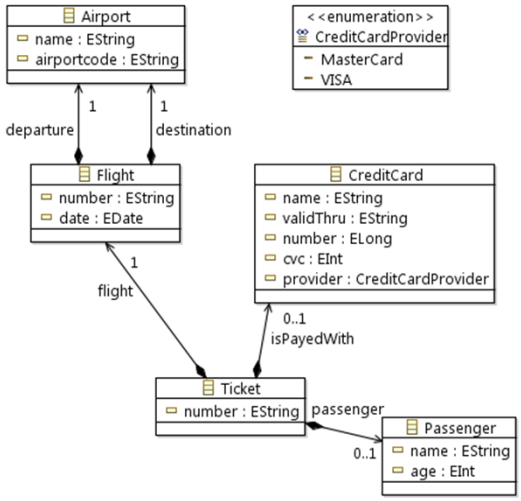
- Different levels of abstraction



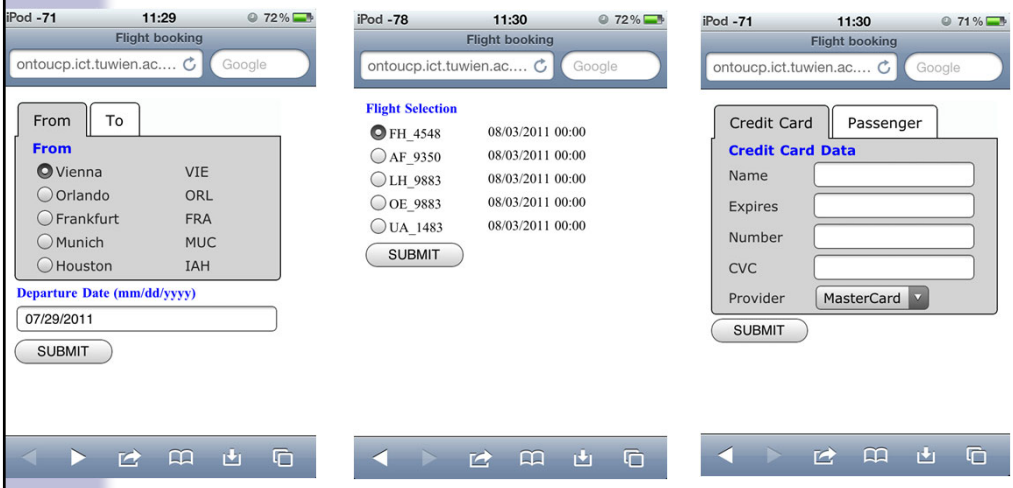
Flight Booking Discourse Model



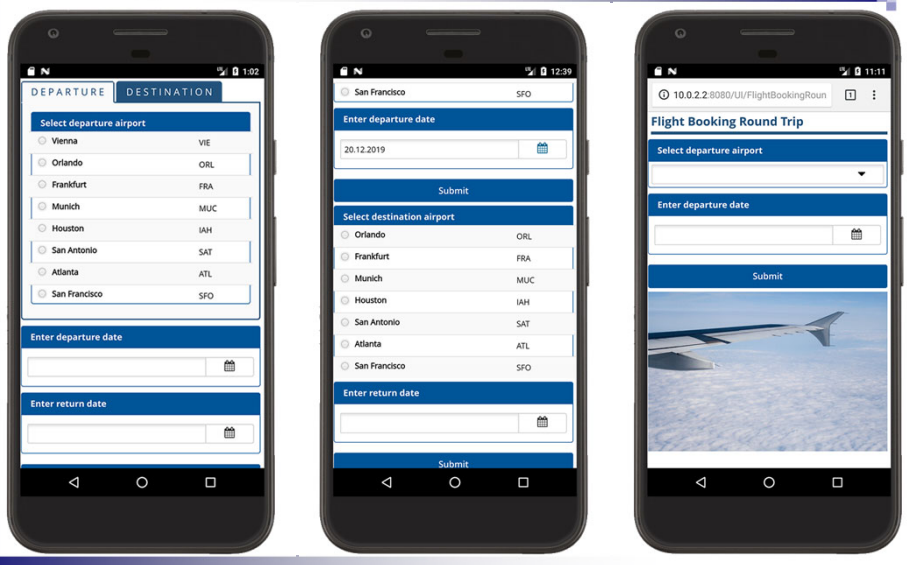
Flight Booking Domain-of-Discourse Model



Flight Booking Rendered for iPod Touch



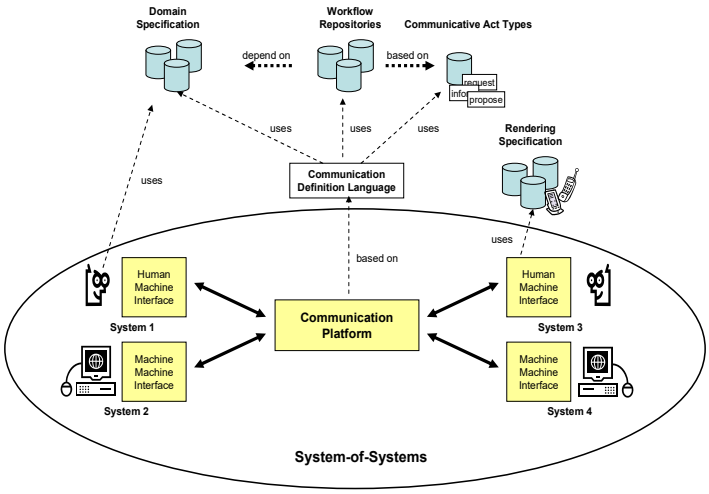
Flight Booking Rendered for Smartphone



Examples of Final User Interfaces – Desktop and Smartphones

- Simple flight-booking GUI:
  http://ucp.ict.tuwien.ac.at/UI/FlightBooking
  Vacation planning:
  http://ucp.ict.tuwien.ac.at/UI/accomodationBooking
- Potentially different GUIs tailored through optimization for different smartphones (screens)

Unified Communication Platform



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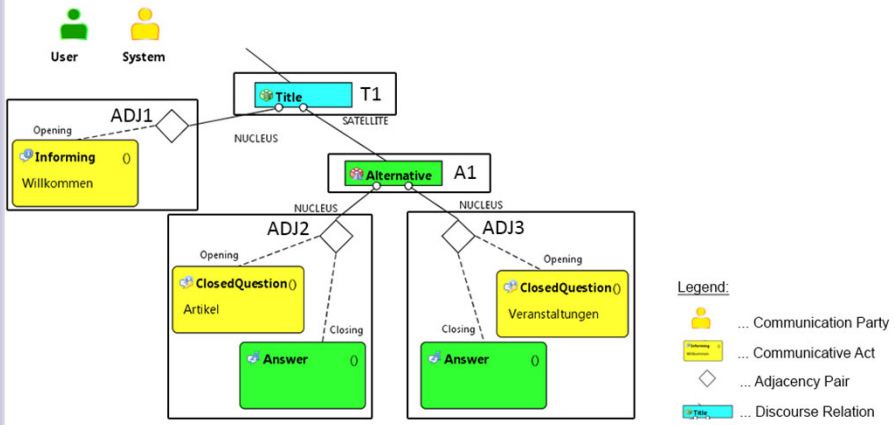
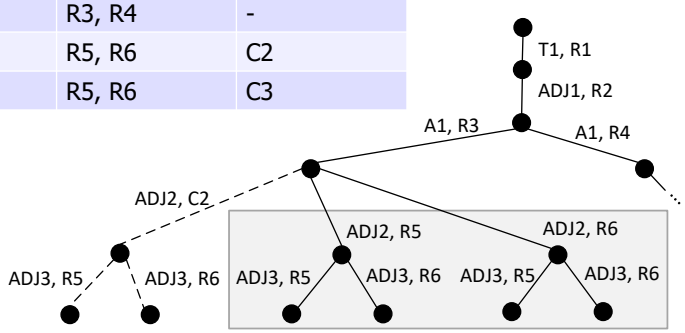
Discourse-based Communication Model Excerpt

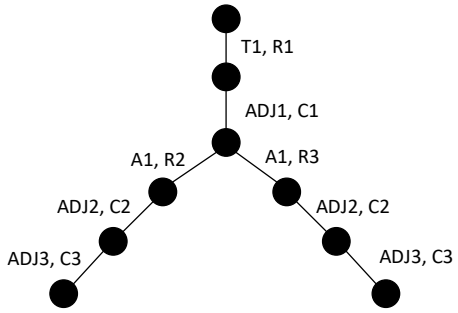


Search Tree for Vacation Planning Communication Model Excerpt

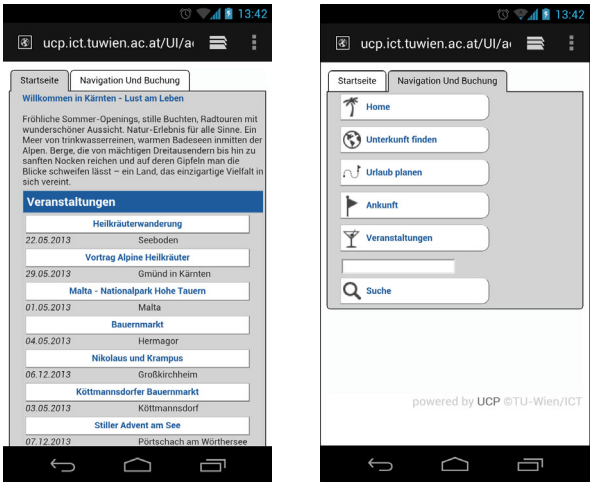
Pattern Identifier	Basic Rule(s)	Custom Rule
T1	R1	-
ADJ1	R2	C1
A1	R3, R4	-
ADJ2	R5, R6	C2
ADJ3	R5, R6	C3



Customized Search Tree

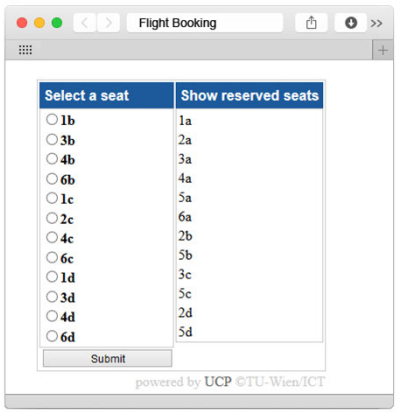


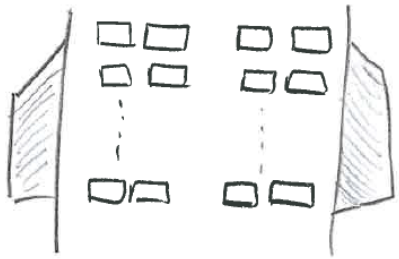
Vacation Planning GUI Displayed on a Samsung Galaxy Nexus Device



http://ucp.ict.tuwien.ac.at/UI/accomodationBookingSmartphone

Custom Widgets – Problem Statement





Result using predefined widgets

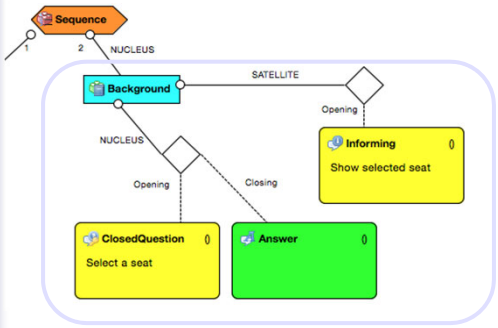
User expectation

Custom Widget Template

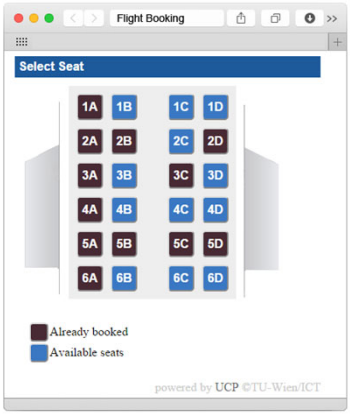
- Defined using an existing Template Language (Velocity Template Language)
- Defines graphic representation
- Adds design-time variability
- Knowledge about the run-time engine needed

Custom Widget Rule

Source



Target



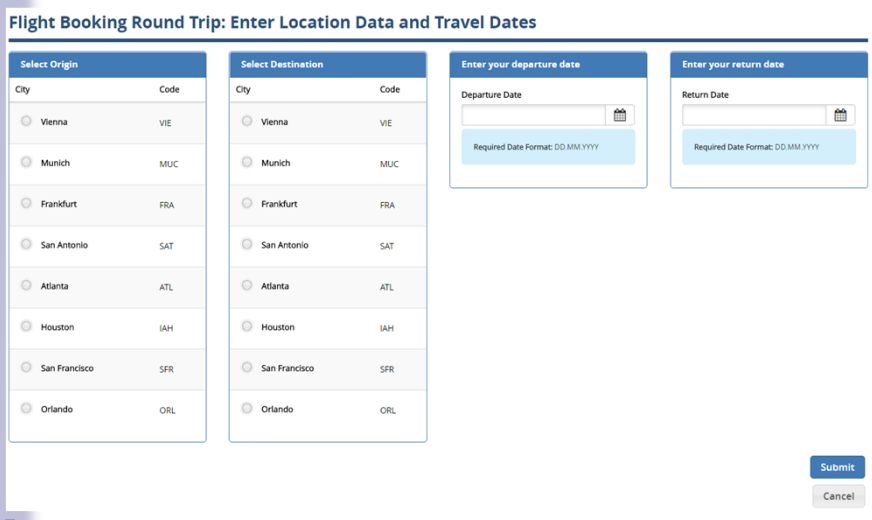
Outline

- Background
- Interaction design based on discourse modeling
- GUI Generation
- Customization
- Improving Low-vision Accessibility
- Conclusion

Background

- Laws require Web-sites and software applications to be accessible
- Low Vision Accessibility
- Runtime-generation and –adaptation approaches
- Responsive Design
- Design-time Generation

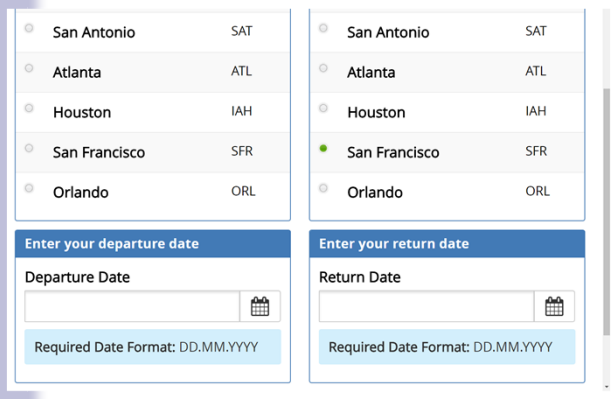
Running Example



Concept for Combining Design-time Generation with Responsive Design

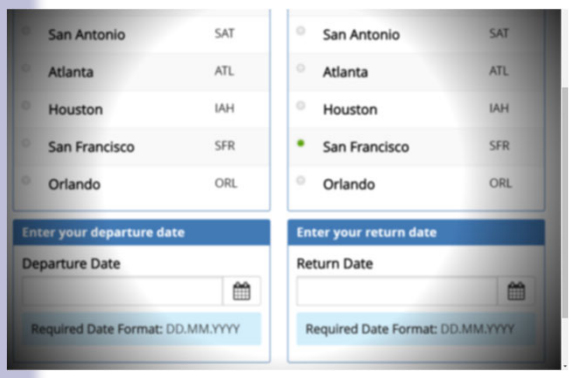
- Design-time
  - Responsible for: Grouping, Widget Selection
  - Results in an enriched CUI model, containing
    - the CUIs for different space requirements
    - allows the generation of one FUI containing the UI for different space requirements
- Responsive Design
  - Layouting according to device size as long as no switching of UI Parts is necessary
  - Switching of UI Parts, if required by space requirements

Wrapped widgets due to increased font size and zoom level of 125%



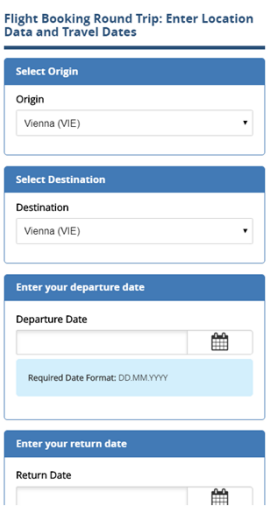
- Widget Layout changed by Bootstrap
- No additional actions required

Added blur and effects of a disabled person with glaucoma



- For a disabled person with glaucoma, this is not adequate.
- So, another UI has to be presented to the person

Widgets are replaced due to increased font size and zoom level of 125%



- Widget Replacement done based on different CUI possibilities
- Not directly supported by bootstrap
- Additionally added vue.js

Accessibility Evaluation

- Automated tools for identifying accessibility problems; we chose WAVE, SortSite, Total Validator and TAW, since they have a good coverage of the WCAG 2.0 guidelines
- HTML and CSS validators to check the Web-sites
- Manual accessibility analysis by taking each guideline and its corresponding success criteria for checking adherence of the application

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Conclusion

- Interaction design can be based on discourse modeling.
- These models can be used for generating GUIs automatically.
- In the course of the generation, the GUIs can be customized persistently.

Thank you for your attention!

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Institute of Computer Technology

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