High-level Interaction Design with Discourse Models for Automated GUI Generation

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Outline

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

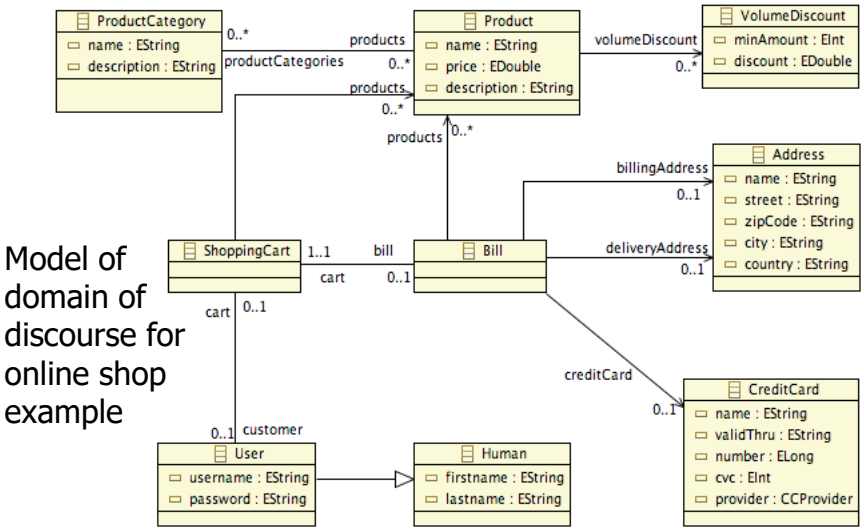
Speech acts

- 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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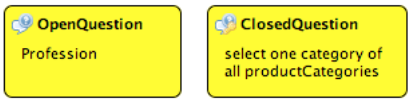
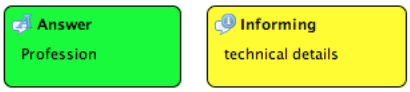
Communicative Acts – Open & Closed Question

- 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.

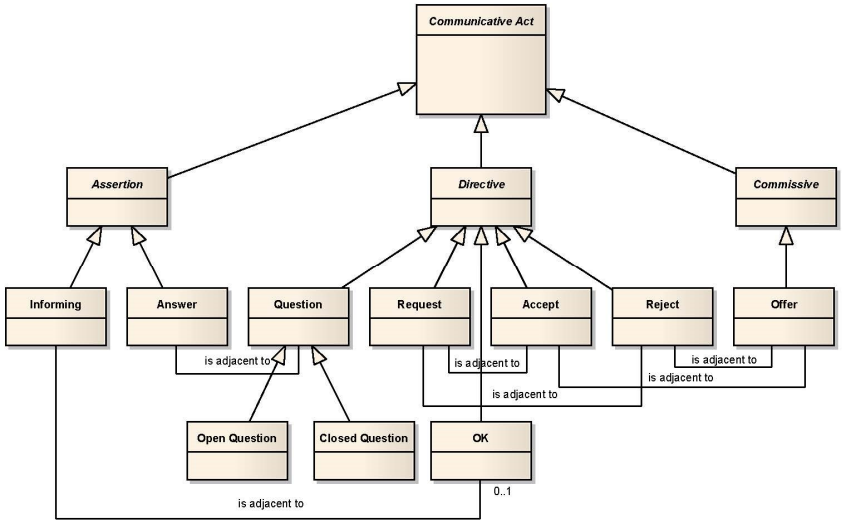


Communicative Acts – Informing & Answer

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

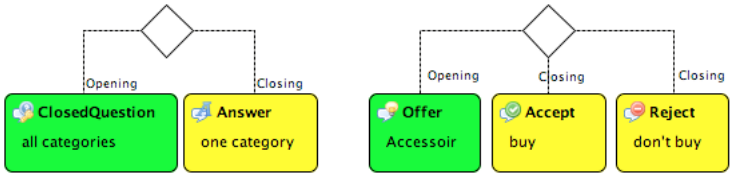


Communicative Acts Taxonomy



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

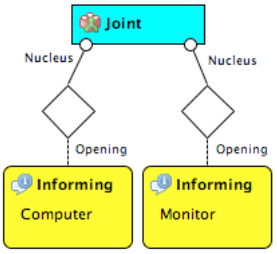


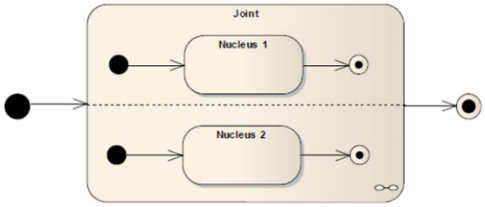
RST relations (in our approach)

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

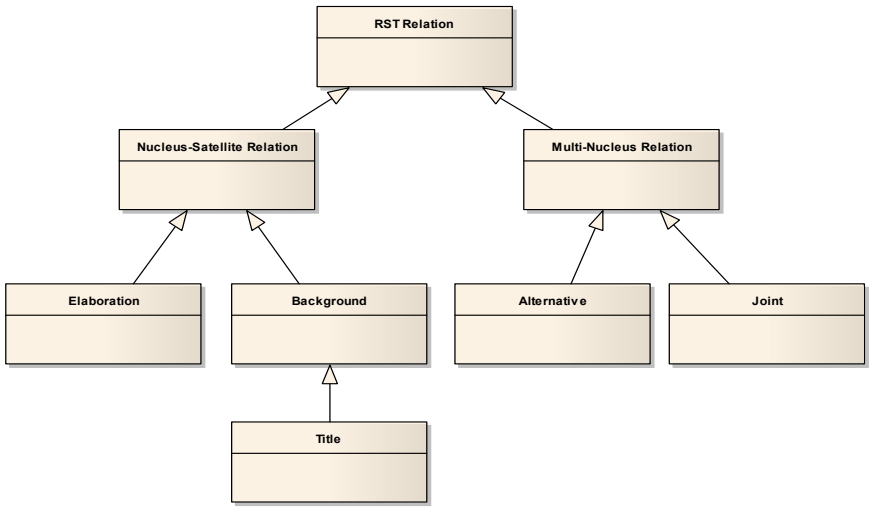
RST relation – Joint

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).



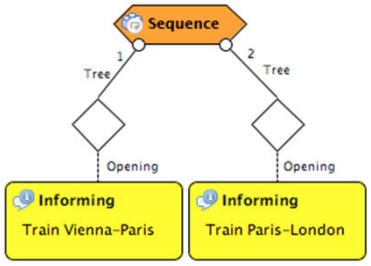


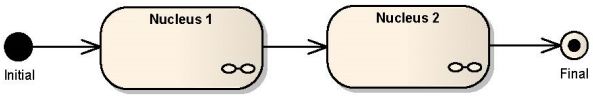
Taxonomy of RST relations



Procedural construct – Sequence

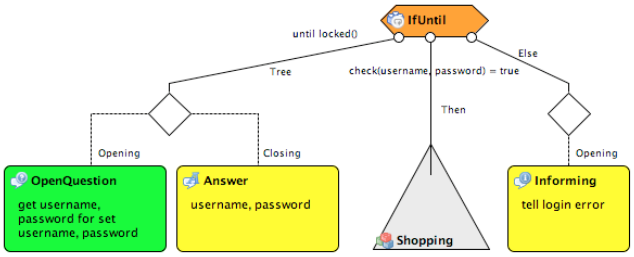
Defined order of uttering the communicative acts or subtrees.



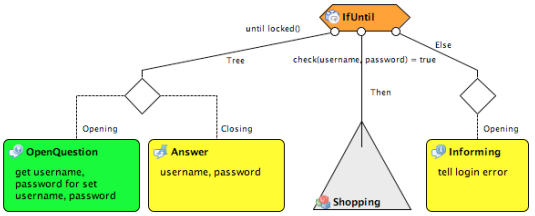


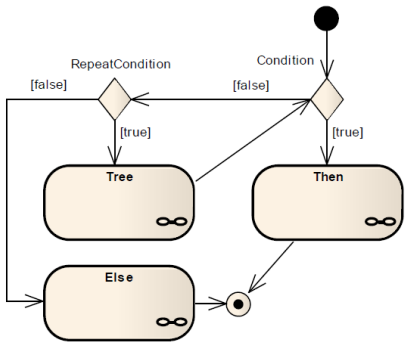
Procedural construct – IfUntil

- 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

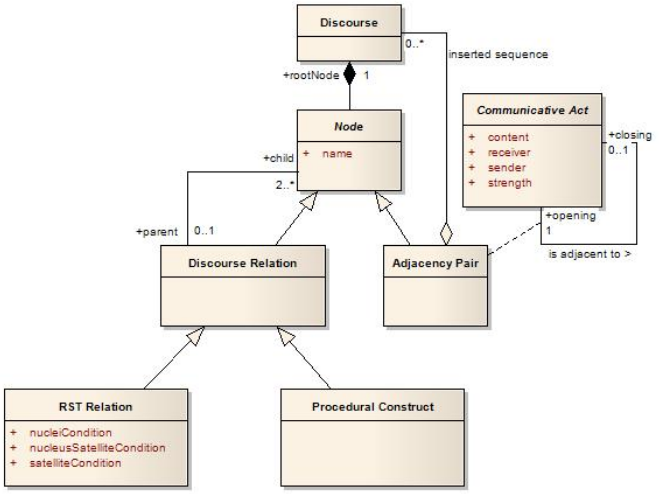


Procedural construct – IfUntil (cont.)





Conceptual Discourse Metamodel



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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

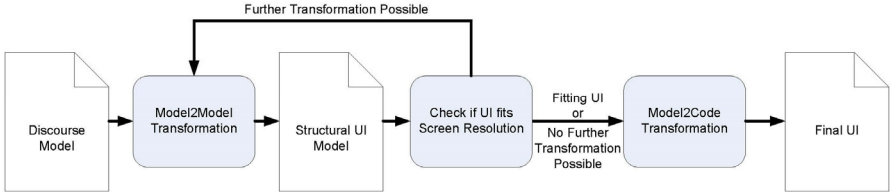
- Specification of (interfaces of) methods of the application logic
- Action-Notification Model
  - Access or change of data (Domain-of-Discourse Model), and
  - Application-specific actions
    - Actions of software, or
    - Physical actions (e.g., of a robot)
- References from Discourse Model to Action-Notification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

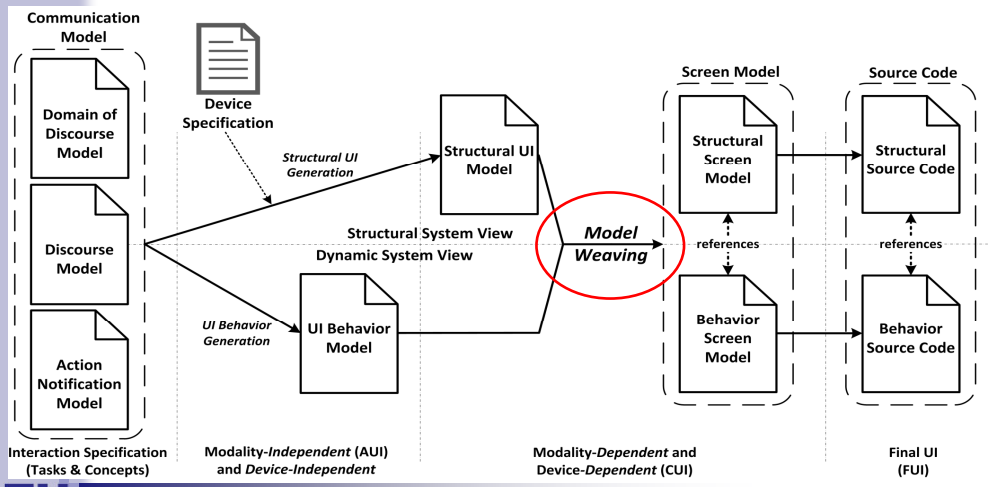
Tailoring for Specific Device (e.g., Smartphone)

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

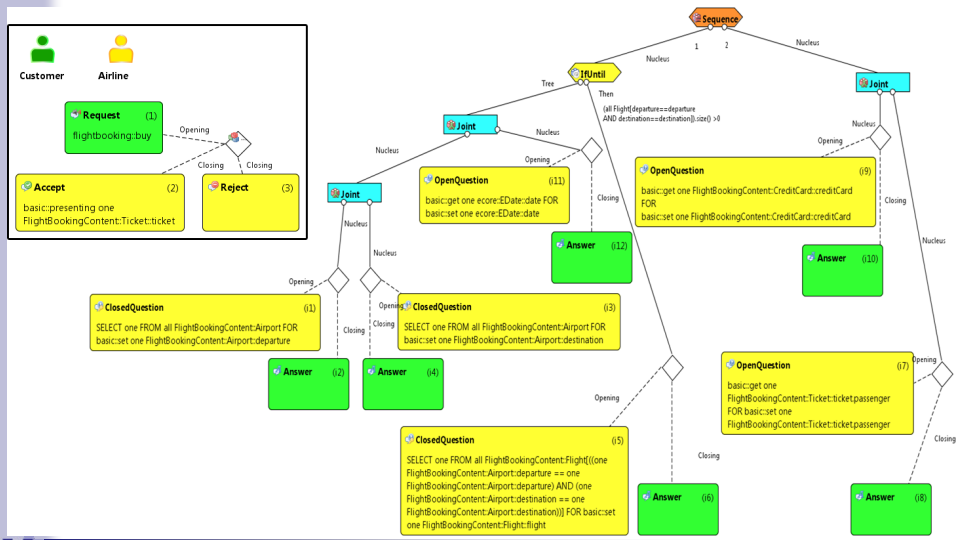


Weaving of Structural and Behavioral Models

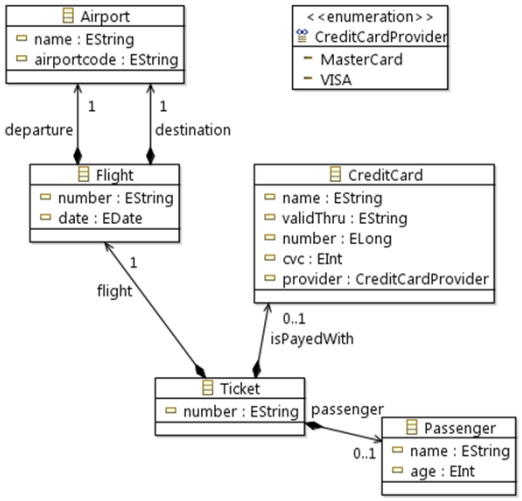
- Different levels of abstraction



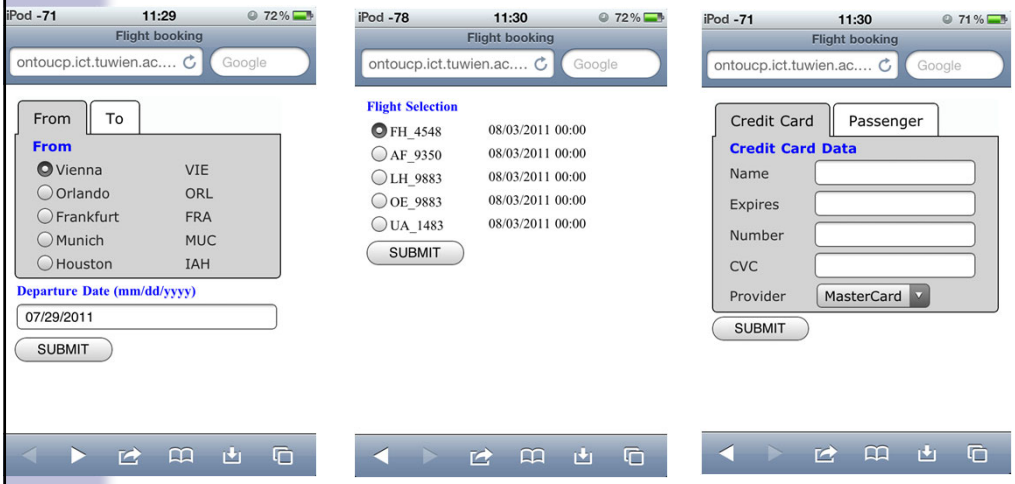
Flight Booking Discourse Model



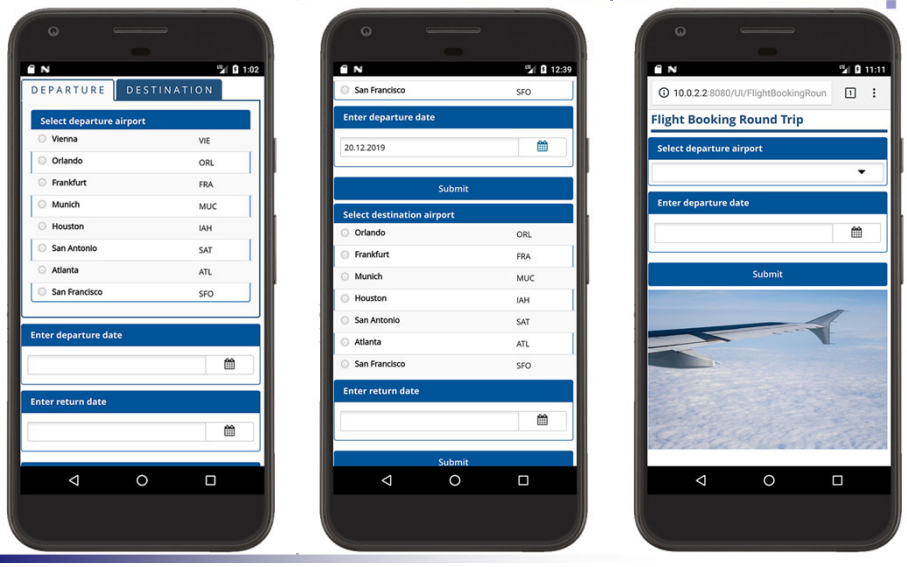
Flight Booking Domain-of-Discourse Model



Flight Booking Rendered for iPod Touch



Flight Booking Rendered for Smartphone



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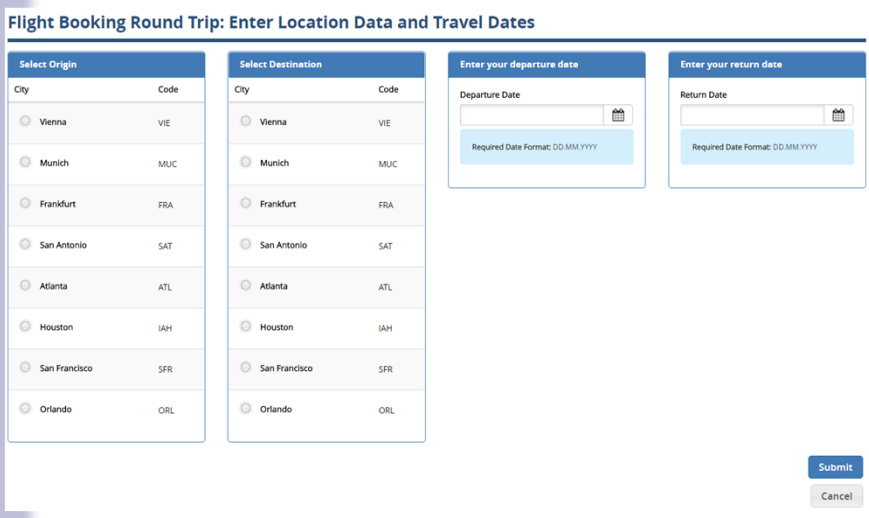
Background

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

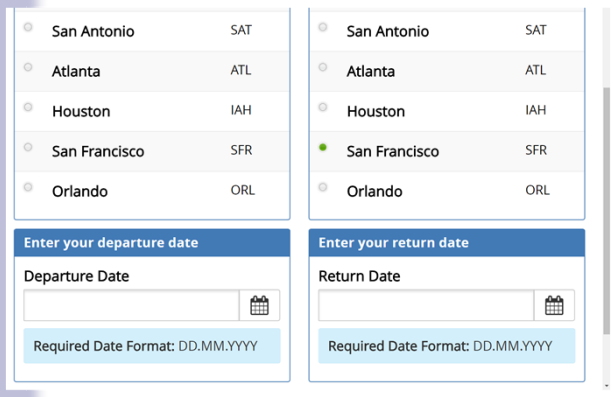
Running Example



Concept for Combining Design-time Generation with Responsive Design

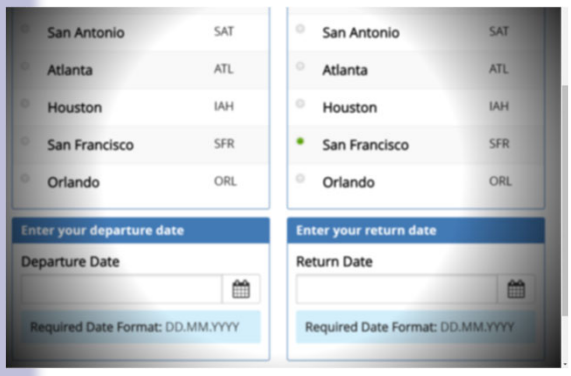
- Design-time
  - Responsible for: Grouping, Widget Selection
  - Results in an enriched CUI model, containing
    - the CUIs for different space requirements
    - allows the generation of one FUI containing the UI for different space requirements
- Responsive Design
  - Layouting according to device 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%



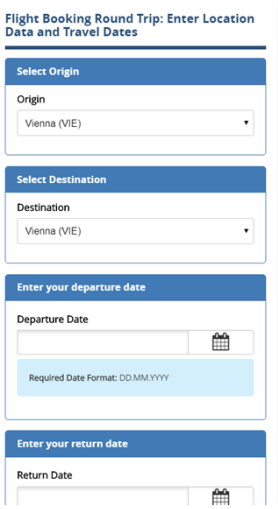
- Widget Layout changed by Bootstrap
- No additional actions required

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 Web GUIs automatically, taking some aspects of accessibility into account.

Thank you for your attention!

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Literature

- Carroll, J. M., (editor), *Scenario-Based Design: Envisioning Work and Technology in System Development*. New York, NY: John Wiley & Sons, 1995.
- Luff, P., Gilbert, N., Frohlich, D., (eds.), *Computers and Conversation*, Academic Press, 1990.
- Mann, W.C., and Thompson, S.A. Rhetorical Structure Theory: Toward a functional theory of text organization. *Text*, 8(3): 243–281, 1988.
- Searle, J.R. *Speech Acts: An Essay in the Philosophy of Language*. Cambridge University Press, Cambridge, England, 1969.
- Schank, R. C., and Abelson, R. P., *Scripts, Plans, Goals and Understanding*. Hillsdale, NJ: Lawrence Erlbaum, 1977.

Selected work of this tutorial presenter

- Bogdan, C., Kaindl, H., Falb, J., and Popp, R., "Modeling of interaction design by end users through discourse modeling". In *Proceedings of the 2008 ACM International Conference on Intelligent User Interfaces (IUI'08)*, Gran Canaria, Spain, 2008. ACM Press, pp. 305–308.
- Falb, J., Kaindl, H., Horacek, H., Bogdan, C., Popp, R., and Arnautovic, E., "A discourse model for interaction design based on theories of human communication". In *CHI '06 Extended Abstracts on Human Factors in Computing Systems*, New York, NY, USA, 2006. ACM Press, pp. 754–759.
- Falb, J., Kavaldjian, S., Popp, R., Raneburger, D., Arnautovic, E., and Kaindl, H., "Fully Automatic User Interface Generation from Discourse Models". In *Proceedings of the 2009 ACM International Conference on Intelligent User Interfaces (IUI'09)*, ACM. Sanibel Island, Florida, USA, 2009. ACM Press. Tool demo paper.
- Falb, J., Popp, R., Röck, T., Jelinek, H., Arnautovic, E., and Kaindl, H., "UI Prototyping for Multiple Devices Through Specifying Interaction Design". In *Proceedings of IFIP INTERACT 2007, LNCS 4662, Part I.* Heidelberg, Germany, 2007. Springer, pp. 136–149.

Selected work of this tutorial presenter (cont.)

- Kavaldjian, S., Bogdan, C., Falb, J., and Kaindl, H., "Transforming Discourse Models to Structural User Interface Models". In *MoDELS 2007 Workshops, LNCS 5002*. 2008. Springer, pp. 77–88.
- Popp, R., Falb, J., Arnautovic, E., Kaindl, H., Kavaldjian, S., Ertl, D., Horacek, H., and Bogdan, C., "Automatic Generation of the Behavior of a User Interface from a High-level Discourse Model". In *Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS-42)*, p. 10, Hawaii, 2009, IEEE Computer Society Press.
- Raneburger, D., Popp, R., Kaindl, H., Falb, J., and Ertl, D. "Automated Generation of Device-Specific WIMP-UIs: Weaving of Structural and Behavioral Models," In *Proceedings of the 2011 SIGCHI Symposium on Engineering Interactive Computing Systems (EICS'11)*, 2011, pp. 41–46.
- Raneburger, D., Popp, R., Kavaldjian, S., Kaindl, H., and Falb, J., "Optimized GUI Generation for Small Screens" In *Model-Driven Development of Advanced User Interfaces*, *SCI 340*. Springer, 2011, pp. 107–122.