



Human-Computer Interaction based on Discourse Modeling

Institut für
Computertechnik
ICT
Institute of
Computer Technology

Hermann Kaindl
Vienna University of Technology, ICT
Austria
kaindl@ict.tuwien.ac.at

Outline

- Background
- AI theories underpinning discourse modeling for HCI
- Other theories underpinning discourse modeling for HCI
- Interaction design based on discourse modeling
- Exercise
- Sketch of automated user-interface generation



Institute of Computer Technology

Traditional UI development

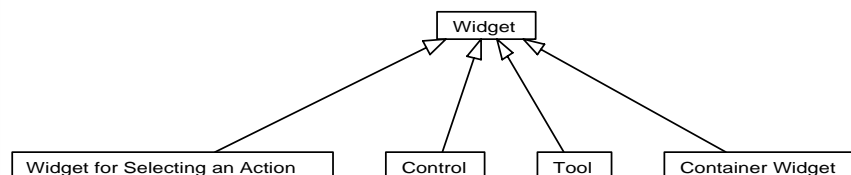
- Based on toolkits employing **widgets**
- Widgets grouped according to their graphical appearance
- Highly-specialized designers and programmers needed
- Lots of UI code
- Error-prone, low maintainability
- Expensive



Institute of Computer Technology

Widgets

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



Institute of Computer Technology

Interaction design

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



Institute of Computer Technology

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



Institute of Computer Technology

Outline

- Background
- ➔ ■ AI theories underpinning discourse modeling for HCI
- Other theories underpinning discourse modeling for HCI
- Interaction design based on discourse modeling
- Exercise
- Sketch of automated user-interface generation



Institute of Computer Technology

Scripts

- Schank and Abelson
- **Script**: structure that describes appropriate sequences of events in a particular context
- Handles well-known everyday situations
- Predetermined and stereotyped sequence of actions



Institute of Computer Technology

Scripts – Restaurant script example

Sketch of stereotypical sequence of actions in (U.S.) restaurant:

A customer enters a restaurant and waits to be seated.

A waiter guides the customer to an empty table and hands over a menu.

The customer studies the food list in the menu and chooses something.

The waiter comes to the table and takes the order.

...



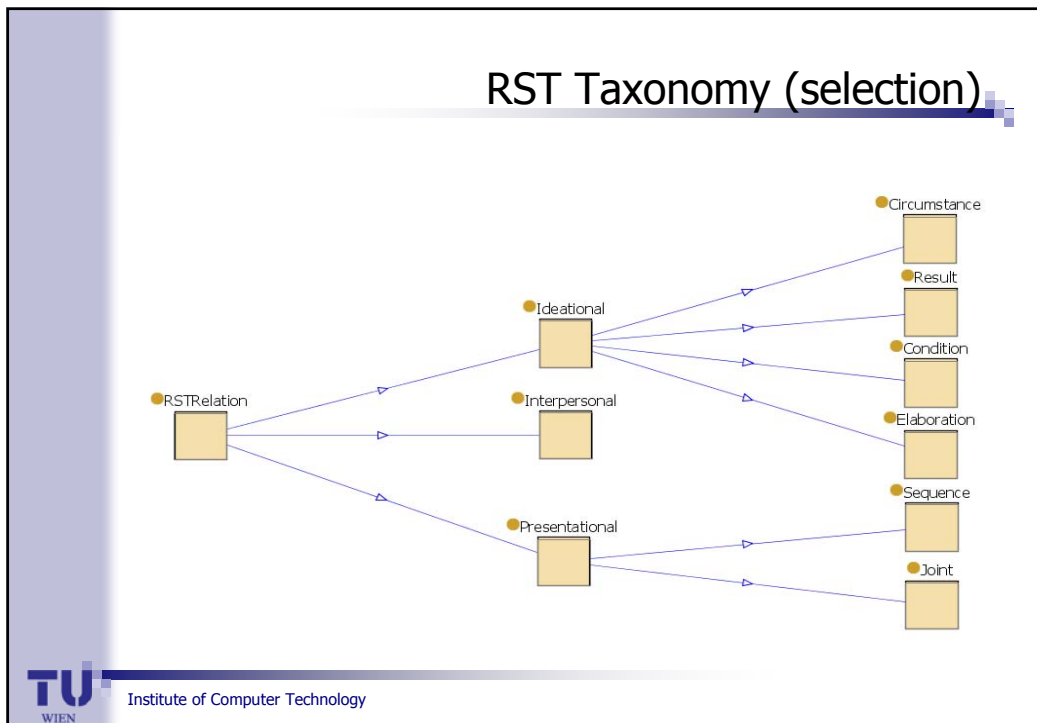
Institute of Computer Technology

Rhetorical Structure Theory (RST)

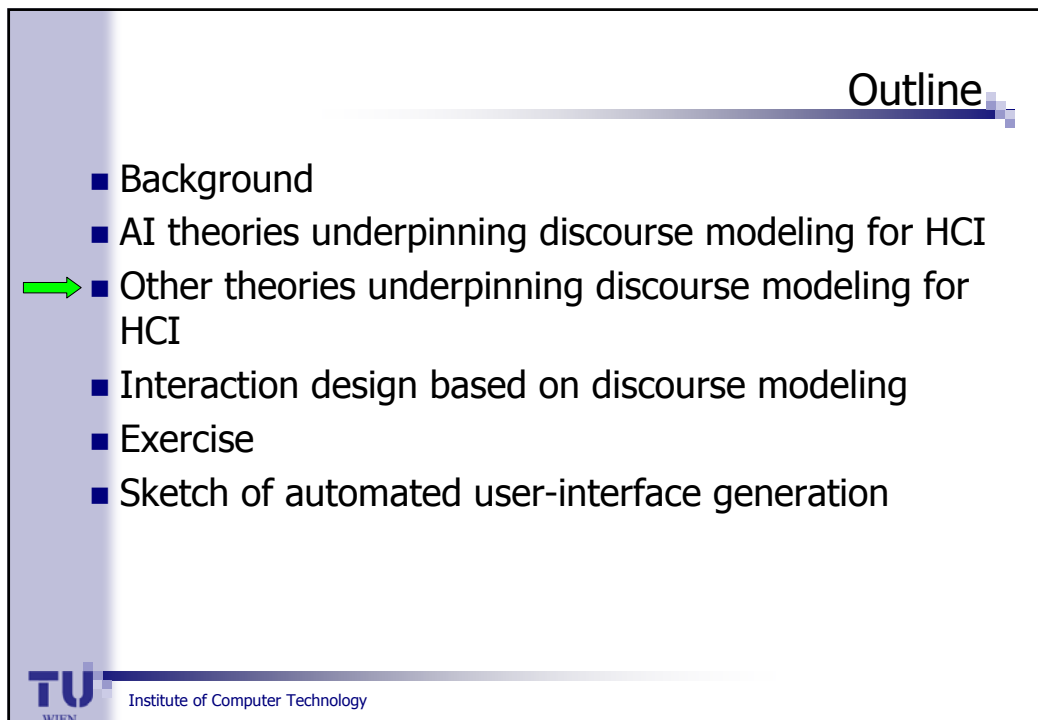
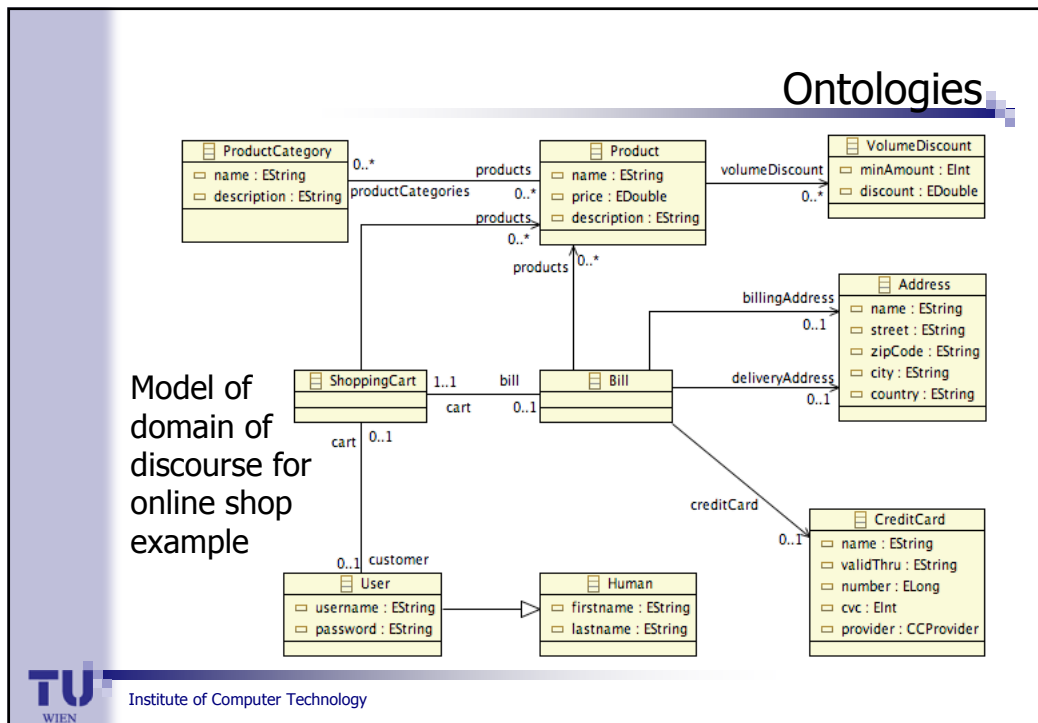
- Mann and Thompson
- Linguistic theory
- Internal relationships among text portions and associated constraints and effects
- Relationships in a text are organized in a tree structure
- **Rhetorical relations** associated with non-leaf nodes, and text portions with leaf nodes



Institute of Computer Technology



- ### 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
- TU WIEN Institute of Computer Technology



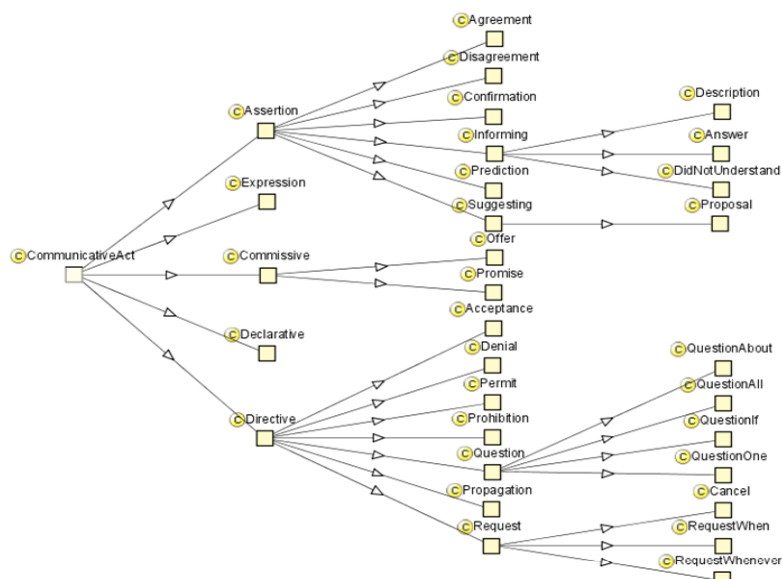
Speech acts

- 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



Institute of Computer Technology

Communicative Acts Taxonomy (selection)



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



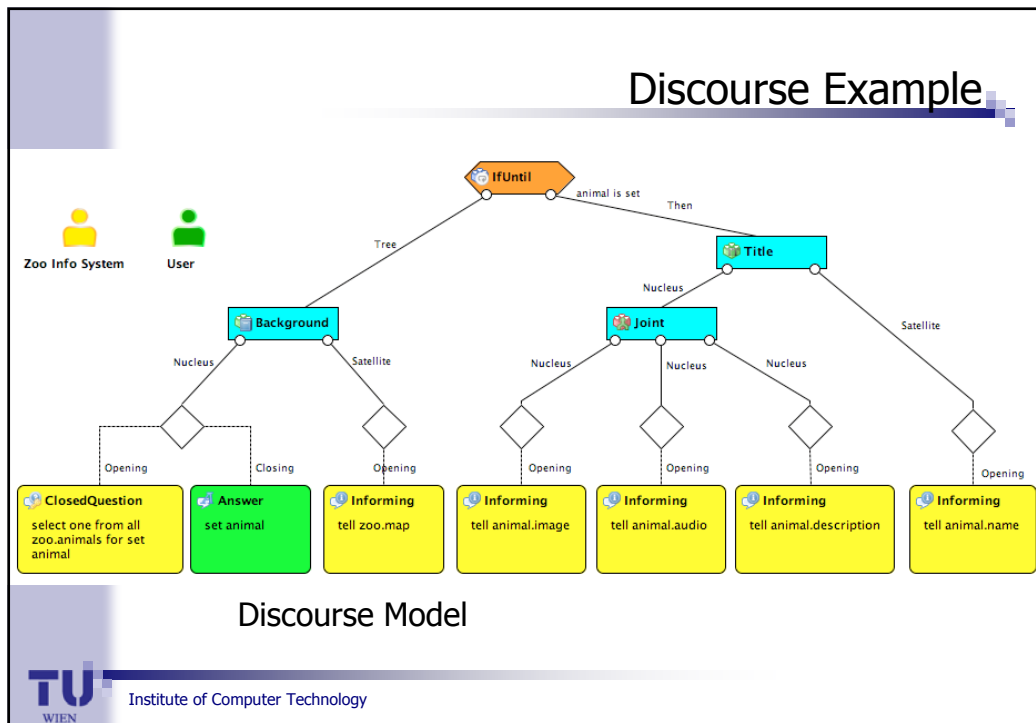
Institute of Computer Technology

Outline

- Background
- AI theories underpinning discourse modeling for HCI
- Other theories underpinning discourse modeling for HCI
- ➔ ■ Interaction design based on discourse modeling
- Exercise
- Sketch of automated user-interface generation



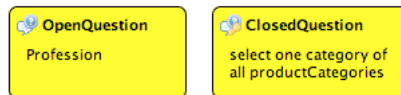
Institute of Computer Technology



- ### 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
- TU WIEN** Institute of Computer Technology

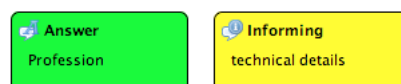
Communicative Acts – Open & Closed Question

- 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.



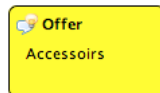
Communicative Acts – Request

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.



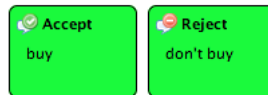
Communicative Acts – Offer

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

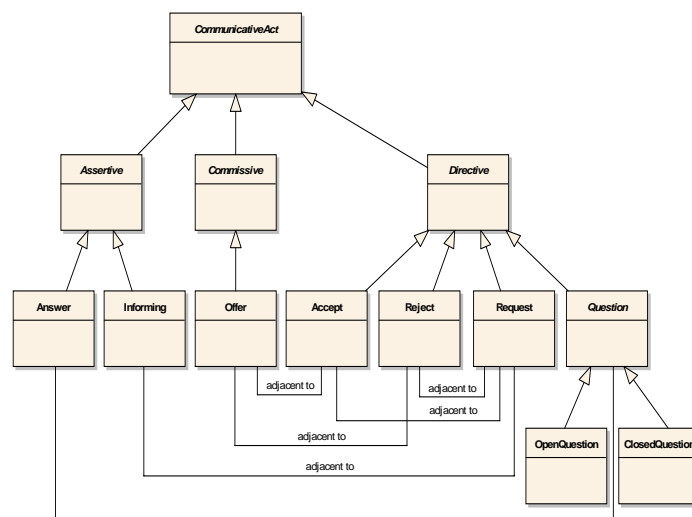


Communicative Acts – Accept & Reject

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

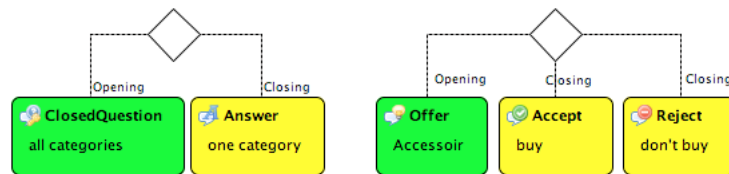


Communicative Acts Taxonomy



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

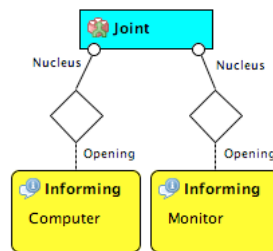


RST relations (in our approach)

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

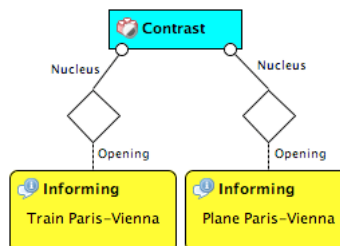
RST relation – Joint

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).



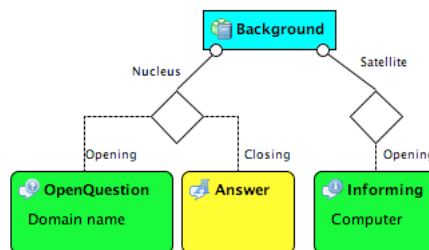
RST relation – Contrast

Relates similar subtrees and compares them with respect to differences.



RST relation – Background

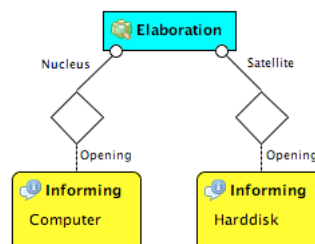
- General information of any sort that is likely to help understand the nucleus.
- Thus, satellite of the background relation shall only contain Informing communicative acts.



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):

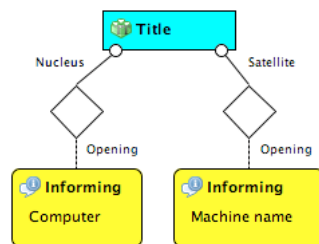
- set :: member
- abstraction :: instance
- whole :: part
- process :: step
- object :: attribute
- generalization :: specific



- The communicative acts can also be questions, for example, if one communicative partner wants to figure out additional details about the subject matter.

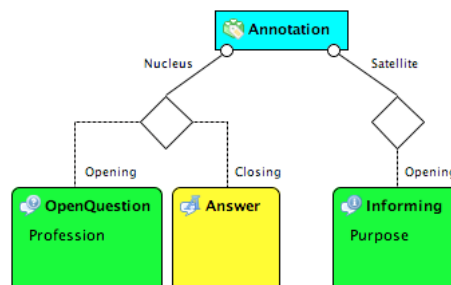
RST relation – Title

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

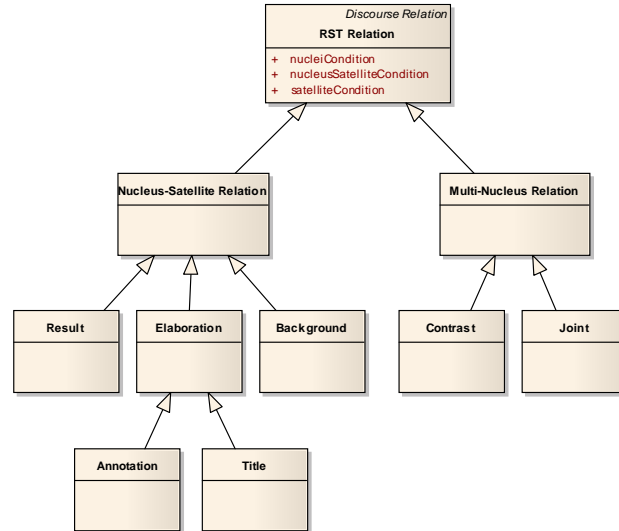


RST relation – Annotation

Another specialization of Elaboration, restricting the additional detail of some element of subject matter to meta information.

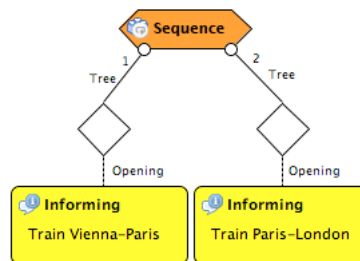


Taxonomy of RST relations



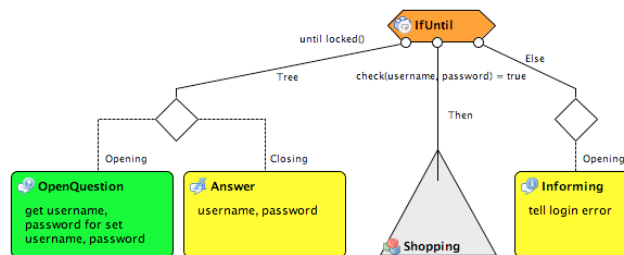
Procedural construct – Sequence

Defined order of uttering the communicative acts or subtrees.

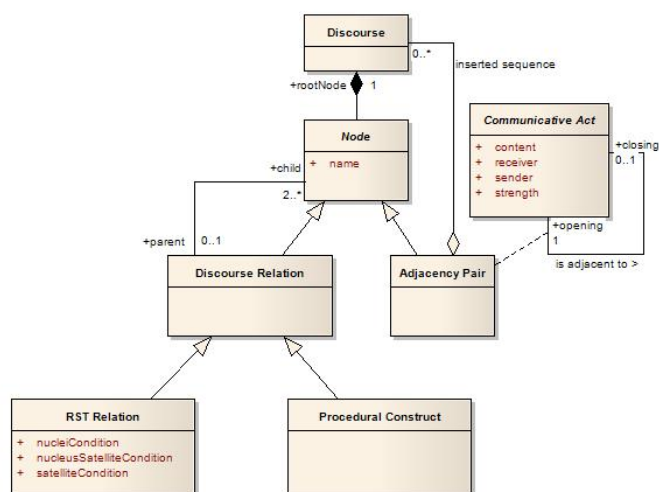


Procedural construct – IfUntil

- 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



Conceptual Discourse Metamodel



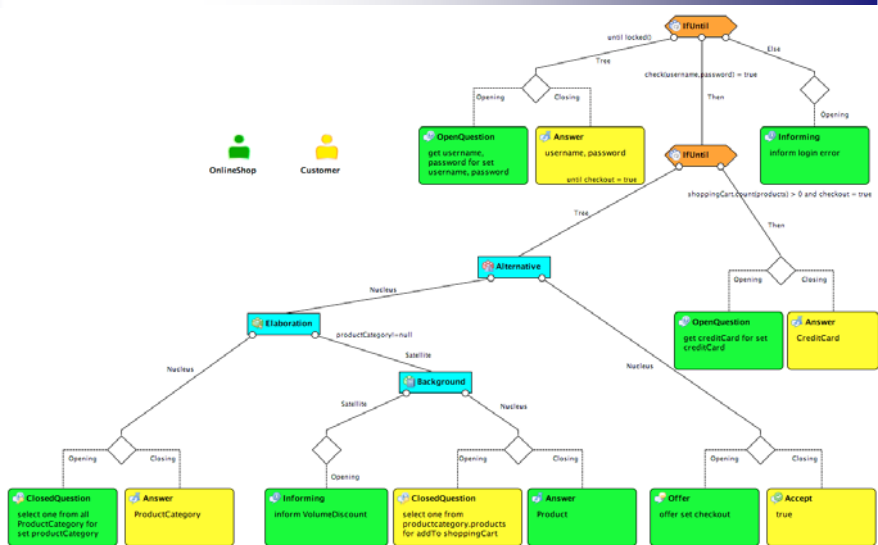
Domain representation

- Speech act usually talks about something in the domain of discourse
- Model of the domain
- Integration and use of ontologies



Institute of Computer Technology

Example model



Institute of Computer Technology

Outline

- Background
- AI theories underpinning discourse modeling for HCI
- Other theories underpinning discourse modeling for HCI
- Interaction design based on discourse modeling
- ■ Exercise
- Sketch of automated user-interface generation



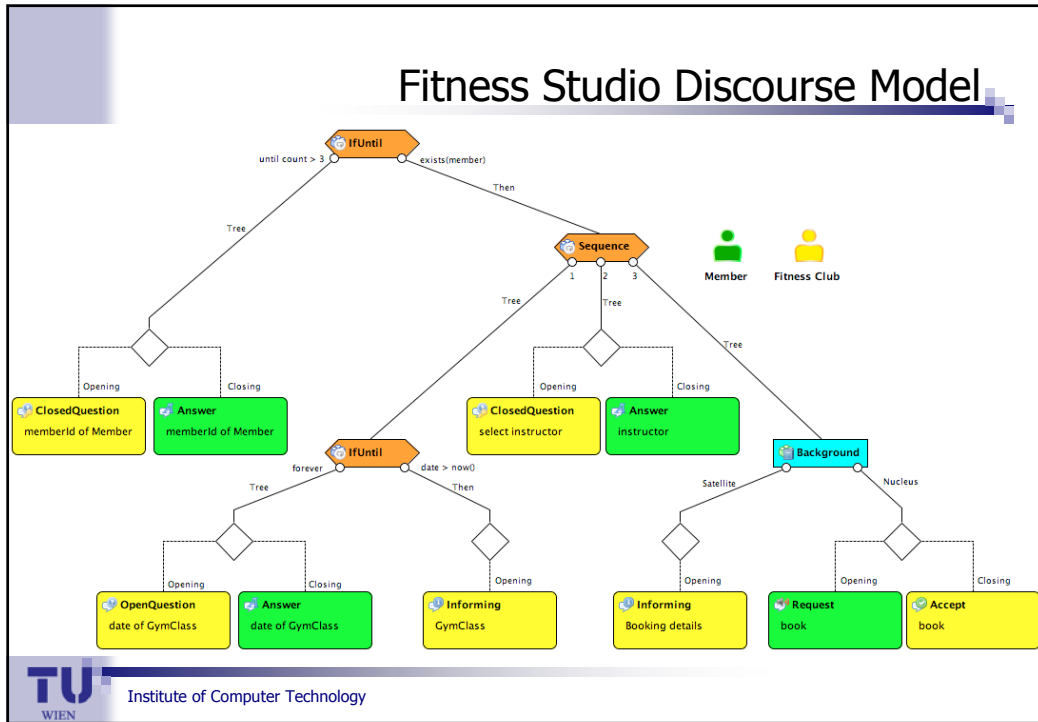
Institute of Computer Technology

Exercise – Fitness Studio

- Interaction design model according to our approach, for the website of a fitness club which should allow registered users to book the various courses that the club offers.
- Try to understand the model sketch of a discourse for this application!



Institute of Computer Technology



Questionnaire

Voluntarily, please fill in the subjective questionnaire at <http://ontoucp.org/cms/technology/questionnaire.html>

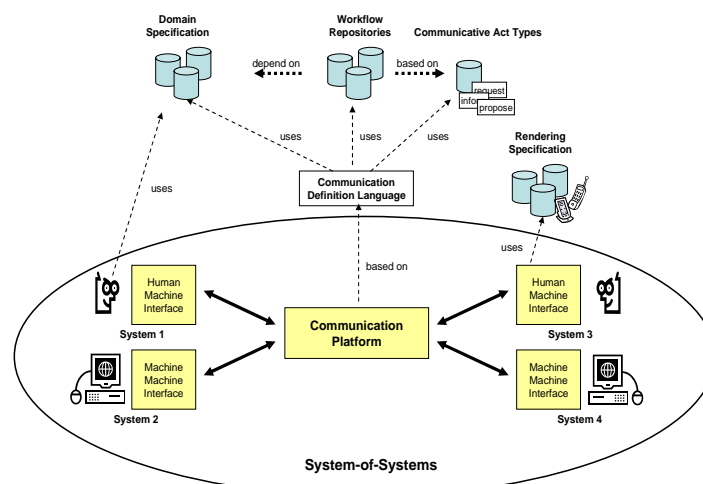
Outline

- Background
- AI theories underpinning discourse modeling for HCI
- Other theories underpinning discourse modeling for HCI
- Interaction design based on discourse modeling
- Exercise
- ➔ ■ Sketch of automated user-interface generation



Institute of Computer Technology

Unified Communication Platform



Institute of Computer Technology

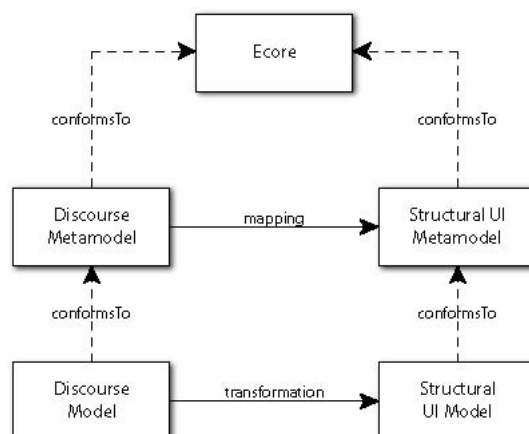
Automated generation of user interfaces

- Essential steps
 - Generation of structural UI model
 - Generation of finite state machine
 - Rendering of UI
- Even for multiple platforms



Institute of Computer Technology

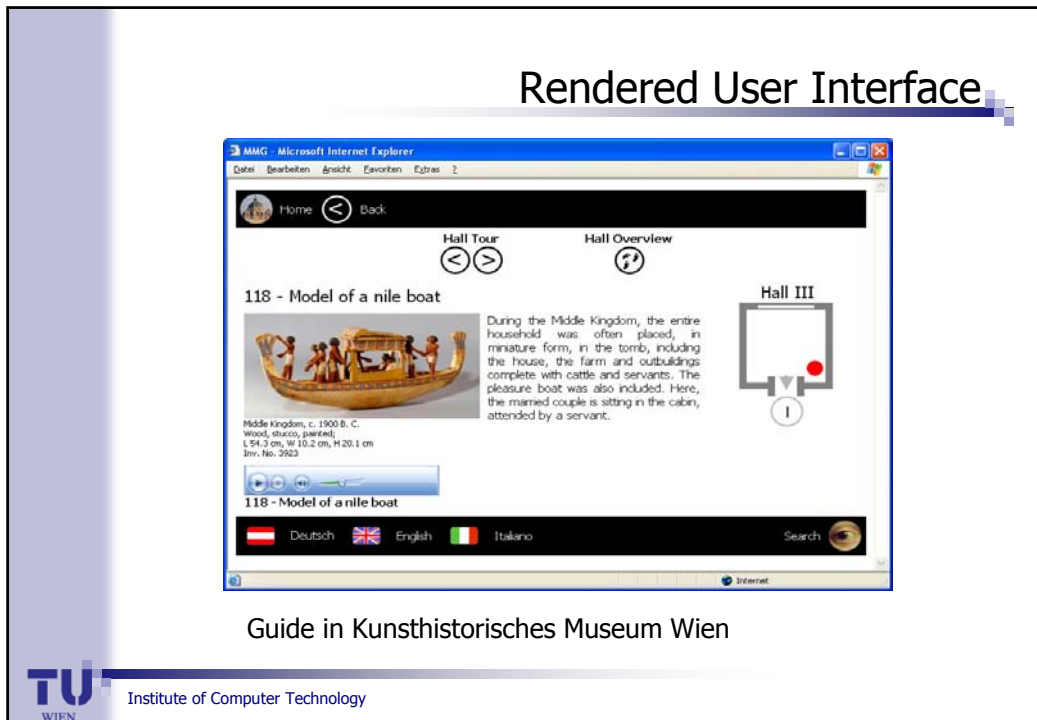
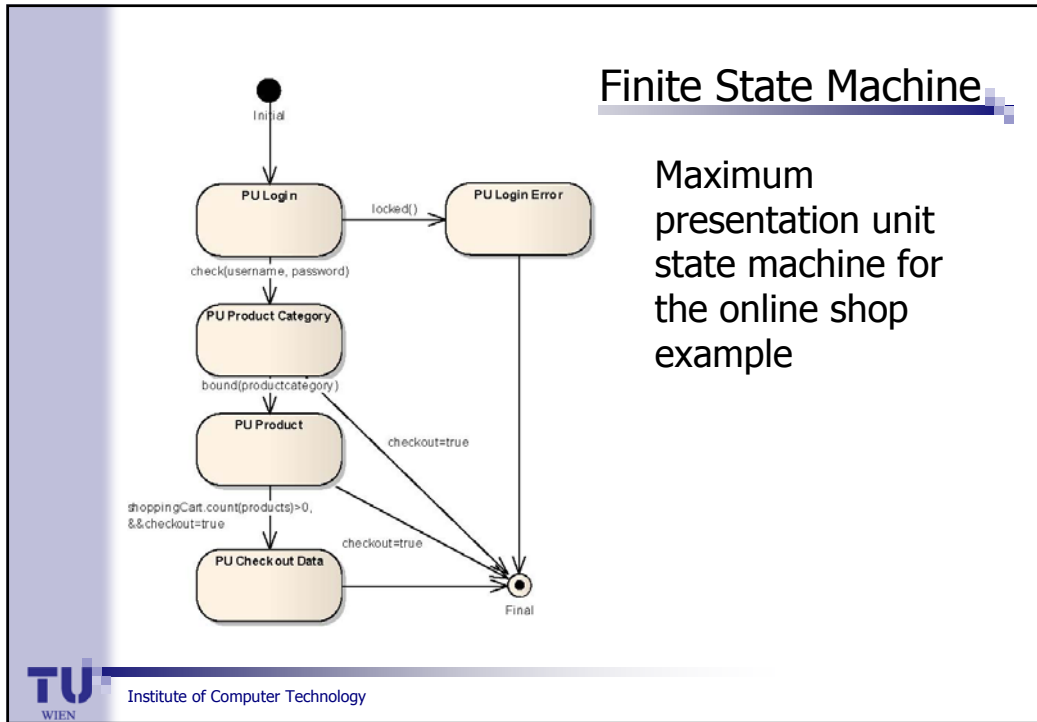
Generation of structural UI model



Transformation process according to MDA (model-driven architecture)



Institute of Computer Technology



Summary and Conclusion

- Human-computer interaction can be based on discourse modeling.
- Discourse model represents interaction design.
- Discourse model used for automated user-interface generation.



Institute of Computer Technology

Thank you for your attention!

???



Institute of Computer Technology

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.



Institute of Computer Technology

Selected work of this tutorial presenter

- Bogdan, C., Falb, J., Kaindl, H., Kavaldjian, S., Popp, R., Horacek, H., Arnautovic, E., and Szep, A., "Generating an Abstract User Interface from a Discourse Model Inspired by Human Communication". In *Proceedings of the Forty-first Annual Hawaii International Conference on System Sciences (HICSS-41)*, p. 10, Hawaii, 2008.
- 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 2008)*, Maspalomas, Gran Canaria, Spain, 2008. ACM Press, pp. 305–308.
- Falb, J., Popp, R., Röck, T., Jelinek, H., Arnautovic, E., and Kaindl, H., "Using communicative acts in high-level specifications of user interfaces for their automated synthesis". In *Proceedings of the 20th IEEE/ACM International Conference on Automated Software Engineering (ASE'05)*, New York, NY, USA, 2005. ACM Press, pp. 429–430. Tool demo paper.
- 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.



Institute of Computer Technology

Selected work of this tutorial presenter (cont.)

- Falb, J., Popp, R., Röck, T., Jelinek, H., Arnautovic, E., and Kaindl, H., "Fully-automatic generation of user interfaces for multiple devices from a high-level model based on communicative acts". In *Proceedings of the Fortieth Annual Hawaii International Conference on System Sciences (HICSS-40)*, p. 10, Hawaii, 2007.
- 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.
- Kaindl, H., A Design Process Based on a Model Combining Scenarios with Goals and Functions, *IEEE Transactions on Systems, Man, and Cybernetics (SMC) Part A* 30(5), 2000, pp. 537–551.
- Kavaldjian, S., Bogdan, C., Falb, J., and Kaindl, H., "Transforming Discourse Models to Structural User Interface Models". In *MoDELS 2007 Workshops, LNCS 5002*. Heidelberg, Germany, 2008. Springer, pp. 77–88.

