

Does “software” evolve?

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Outline

- Thank you!
- Meaning of evolution
- Role of Models
- Research in evolution
 - Directions
 - Current
- Conclusions

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A little background

- Acceptance and popularity of research in software evolution
- Wide ranging research
- Work of Lehman and Belady (1985) (check the ERCIM website)
- Parnas's software aging (1994)
- Importance of words ("Le parole sono importante.")

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Definition of evolution

- development: a process in which something passes by degrees to a different stage (especially a *more advanced or mature* stage); "the development of his ideas took many years"; "the evolution of Greek civilization";
- (biology) the sequence of events involved in the evolutionary development of a *species* or taxonomic group of organisms

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Definition of software

- Bits?
- Electrons and voltage?
- Piece of paper?
- Disk?
- Algorithms, data structures?
- Mathematics and logic?

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software

- The Merriam-Webster Dictionary defines it as, “something used or associated with and usually contrasted with hardware: as a: the entire set of programs, procedures, and related documentation associated with a system and especially a computer system; specifically: computer programs

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Software and its models

- High level models describe the concepts to be implemented
- Models describe many possible implementations
- A particular software code is one possible implementation
- Most (all?) work on software evolution works on code

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Models describe a software “species”

- Species evolve, organisms age, decay, and die!
- Software models evolve, software codes age (and are retired?)
- Evolution, aging, and decay are all present in software

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Models are layered

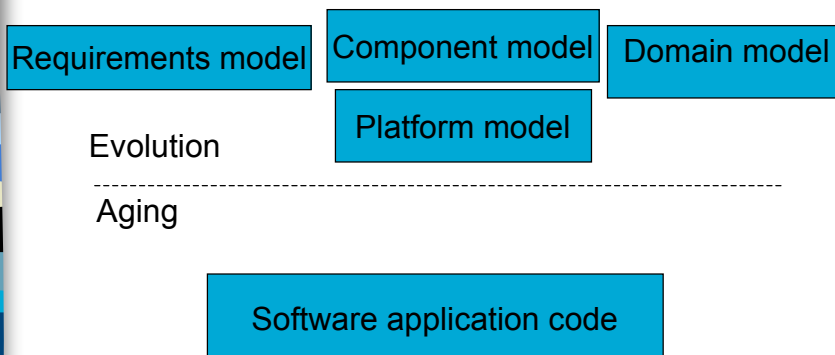
- Domain models
- Architectural models
- Architectures
- Design models
- Designs
- Software implementations (multiple versions)
- Not only a hierarchy: domains, platforms, components

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A complete picture?



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Case study: Vienna international festival website

Year	Language	Feature	Input form
1995	HTML++	Static	Plain text
1996	HTML++	Off-line ticket purchase	
1997	Jessica	On-line tickets	
1998	Jessica		MySQL
1999	Jessica		
2000	XML/XSL	Shopping cart	
2001	XML/XSL		Content management system
2002	XML/XSL		
2003	MyXML		
2004	MyXML		
2005	MyXML	Semantic Web	

Table 1. Evolution of the festival Website

- Introduction of structure
- Design of layout and implementation
- Separation of content
- Growth of business logic
- Separate graphic design; input by clients
- Separation of content, layout, logic
- Multiple devices

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Separating species from individuals in software

- *Product family* engineering
 - Family architecture
 - Multiple products
- *Domain* specific engineering
- *Architecture*-centered development
- *Component*-based development
- *Model*-driven development

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Two thorny issues in evolution research

- We can only make partial measurements/observations
- We can only measure/observe stale information (“Yesterday’s weather”?)

Possible solution: identify and record the factors that cause software evolution

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Research directions, 1

- What *forces* cause evolution?
 - Are they product-specific?
 - Are they domain-specific?
 - Are they architecture-specific?
 - How to identify it?
 - How to record it?
 - How to relate it to the model/code?
- Example: open-source vs. closed source (Godfrey; Walt Scacchi)
- Example: systems vs subsystems (Gall et al.)

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Research directions, 2

- Role of components
 - Components evolve independently or in relation to assemblies in which they are used?
 - How to track component evolution?
 - Do component models support evolution?
- Example: Repository mining?
- Example: Component model portability (oberleitner)

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Research directions, 3

- Do software evolution assumptions still hold?
 - Centralized versus distributed systems
 - Local versus distributed development
 - Monolithic versus component-based systems
 - COTS-based systems
 - Internet-based systems
 - Dynamically linked systems

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Research directions, 4

- Domain-specific evolution
 - Open-source
 - Client-server, p2p
 - Distributed
 - Web-oriented
 - ...
 - Architecture-specific evolution
 - Technology-specific evolution
- Not all software is made the same...

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What about current research?

- Retrospective analysis (validating the architect's claims)
- Empirical validation of theories
- Model evolution
- Mining repositories (with surprising implications)

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Conclusions

- Software is more than source code; models and meta-models are important to software evolution
- Individual software products age; our understanding of them evolves
- Evolution studies should concentrate on the species as well as individuals

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