Investigating techniques from the 2000's for class model extraction

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Industrial context

Request of a major (anonymous) IT service company

Design Low-cost migration of a legacy software suite composed of:

- man-machine interfaces (HTML, VBScript/ASP, Javascript)
- several databases, SQL procedures (SQL Server 2000)
- procedural source code (VB6)

Low-cost (money is invested in new developments)

- less effort than fully manual migration
- automatize as far as possible
- open-source, free, tools

Teaching context

Research and development project in Master course

- each student: 1 man/month
- distributed during 5 months (other classes and projects in parallel).
- read research papers (at least one per student)
- project managements activities: Gantt diagram, role/task distribution, meeting management
- reproduce solutions of papers

10 students

- 3 groups
- one common meeting every week (half of the meetings with IT service company partner), and other meetings inside the groups

Project organization

Main tasks

- Reducing migration to class model extraction and to 2 software systems from the suite
- Designing a migration chain
- Choosing relevant research papers about class model extraction
- Implement the found extraction heuristics
- Apply to the software systems

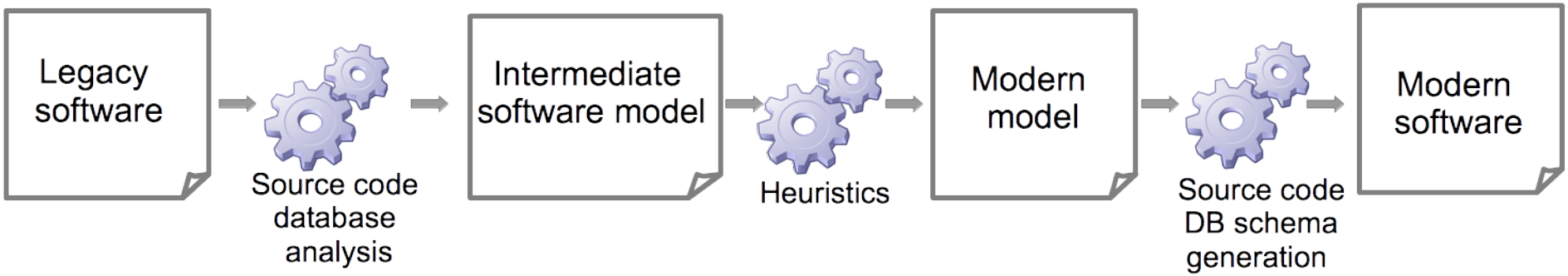
Group organization

- ACL Group (3): project management + 1 extraction heuristic
- CPS Group (3): analyze MMI code + 1 extraction heuristic
- Moretz Group (4): analyze SQL and VB code + 1 extraction heuristic

The proposed papers

- [Sahraoui et al., 1999]
- [Canfora et al., 1999]: minimization of coupling
- [Cimitile et al., 1999]: manual part, metrics+routine assig. algo.
- [van Deursen and Kuipers, 1999]
- [Lucca et al., 1997]: metrics+routine assig. algo.
- [Bhatti et al., 2008]: FCA on bad object design
- [Glavas and Fertalj, 2011]
- [Maletic and Marcus, 2001]: LSI + semantic clustering
- [Zou and Kontogiannis, 2003]: ad hoc alg. for amalgamating class properties

The generic process



Data extraction and encoding

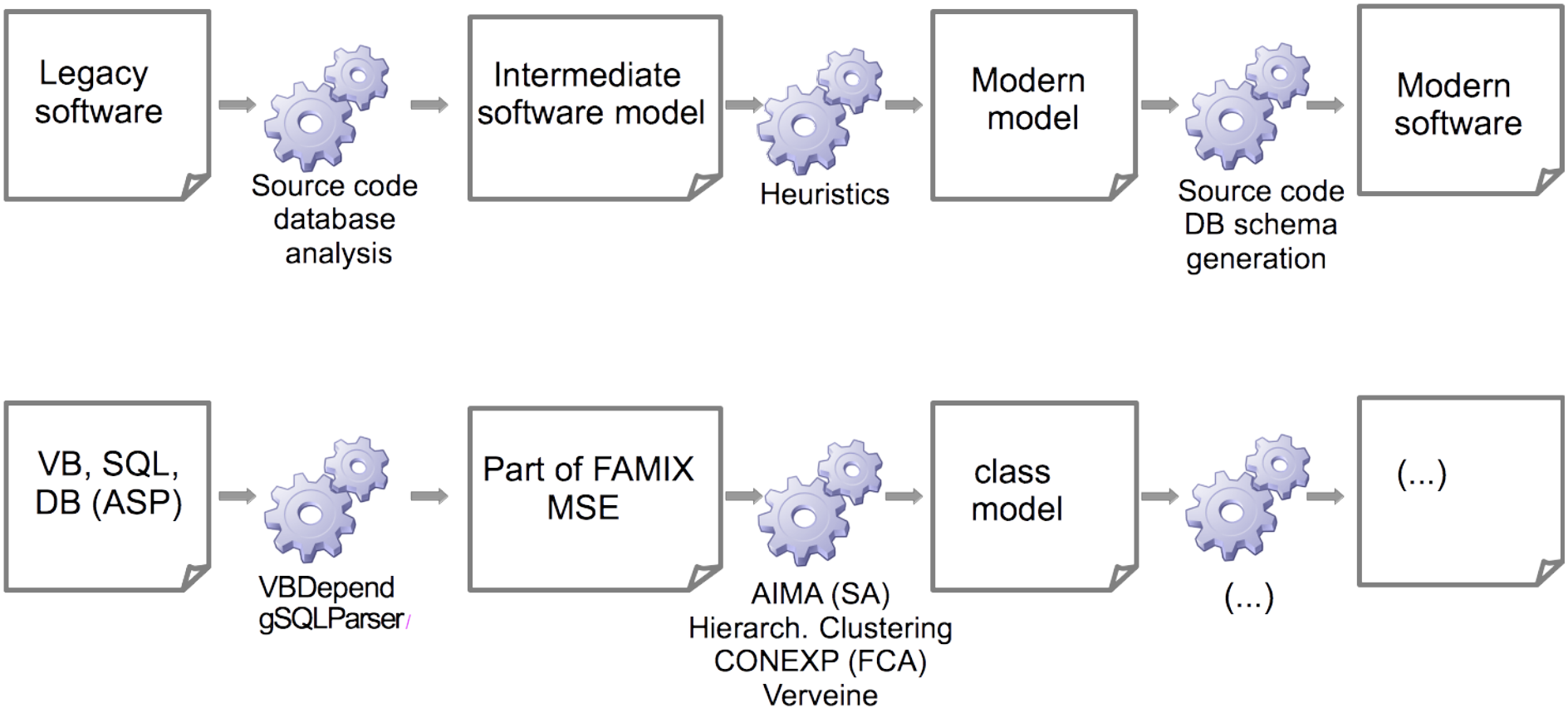
Expected input data: tables, columns, functions, access, invocation
Tools:

- FAMIX / MSE format, Verveine (http://www.moosetechnology.org/docs/famix)
- VBdepend (http://www.vbdepend.com)
- GSP (http://www.sqlparser.com)

Missing:

- VBdepend and GSP not free (trial versions were used)
- database representation in FAMIX
- analyzing VB functions where parameters are the SQL function and its parameters
- merge VB analysis result and SQL analysis result

The instantiated process



[Sahraoui et al., 1999] FCA++

- FCA: data *is accessed by* routine
- select concepts by decreasing routine number and increasing data number
- classes are given by data part of the concepts
- merge concepts that have more in common than not in common
- assign functions to classes when they refer or modify them

In current project:

- data are columns of the database tables
- routines are functions that directly have access to columns

Tools:

- Concept Explorer (http://conexp.sourceforge.net)
- specific code for creating Formal Context and exploit the concept lattice

[van Deursen and Kuipers, 1999] Dendogram

Hierarchical clustering on data similarly accessed by functions

- Create a CRUD matrix: data $\times$ functions
- calculate a distance matrix between data based on CRUD matrix
- build a dendogram based on distance and a chosen cut point
- assign functions to classes when they refer or modify only one class

Tools:

- Entirely implemented

[Glavas and Fertalj, 2011]

Meta-heuristics

- focus in the project: Simulated annealing
- solution: a set of candidate classes composed of data and functions
- fitness functions: software metrics (coupling, cohesion)

Tools:

- AIMA framework (implements *Peter Norvig And Stuart Russell's "Artificial Intelligence - A Modern Approach 3rd Edition."*) (http://code.google.com/p/aima-java/)
- specific Java code to connect to MSE files

Application size

Software size (the smallest)

- two databases: 45 tables
- SQL+ VB code:
  - smallest software: 346 functions, 26042 LOC

Results on TR software (smallest - 45 tables)

FCA++

	attributes			methods		
#class	#min	#max	#av	#min	#max	#av
74	2	165	10	0	30	8

Dendogram-11

	attributes			methods		
#class	#min	#max	#av	#max	#min	#av
20	1	36	12.8	0	12	2.5

Analysis

FCA++

- many classes
- post-treatment creates many duplications
- attributes poorly distributed
- merging method is too strict
+ all methods are assigned

Dendogram

+ reasonable class number (correspond to connected tables)
- few assigned methods

Simulated annealing

- difficulty to understand weighting in metrics
- impossible to reproduce results of the paper on the included example

Conclusion

- not so easy to reproduce paper results
- no good results of FCA++ approach due to post-treatment
- limited results of dendogram approach for method assigment

→ Dendogram results have been chosen by the company for detailed study

Perspectives

- Change FCA++ post-treatment
- Add better method assigment to Dendogram
- Finalize Simulated Annealing
- Apply identifier analysis to tables/variables/columns names
- Use database schema
- Use MMI and interactions
- what about associations?

Thank you!

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