Interactive Timetabling

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Introduction - Timetabling

- Allocation of activities
- Resources
- Various constraints
- Interactivity
  - combination of automated timetabling with user interaction
  - solution is built step by step

Goals

- Generic model
  - to describe timetabling problems
  - motivated by School Timetable Problem
- An interactive algorithm
  - mixture of local search and backtracking based methods
- Implementation in JAVA
  - generic scheduling engine
  - GUI – School Timetable

Motivation – School Timetable

- Activities
  - lectures
- Resources
  - classrooms
  - teachers
  - classes
  - other (special) resources
- Dependencies
  - relations between lectures

The Model

- **Time Slots**
- **Time Preferences**
  - **soft and hard constraints**
- **Activities**
  - **name, duration, time preferences**
  - **sets of needed resources - resource groups**
- **Resources**
  - **name, time preferences**
- **Dependencies**
  - **binary, between two activities**
  - **before, closely before, concurrently**

The (Partial) Solution

- **Every (scheduled) activity has all required resources reserved.**
  - **all from conjunctive, one from disjunctive group**
- **Two (scheduled) activities cannot use the same resource at the same time.**
- **No hard constraint of time preference is violated.**
- **All dependencies are satisfied.**

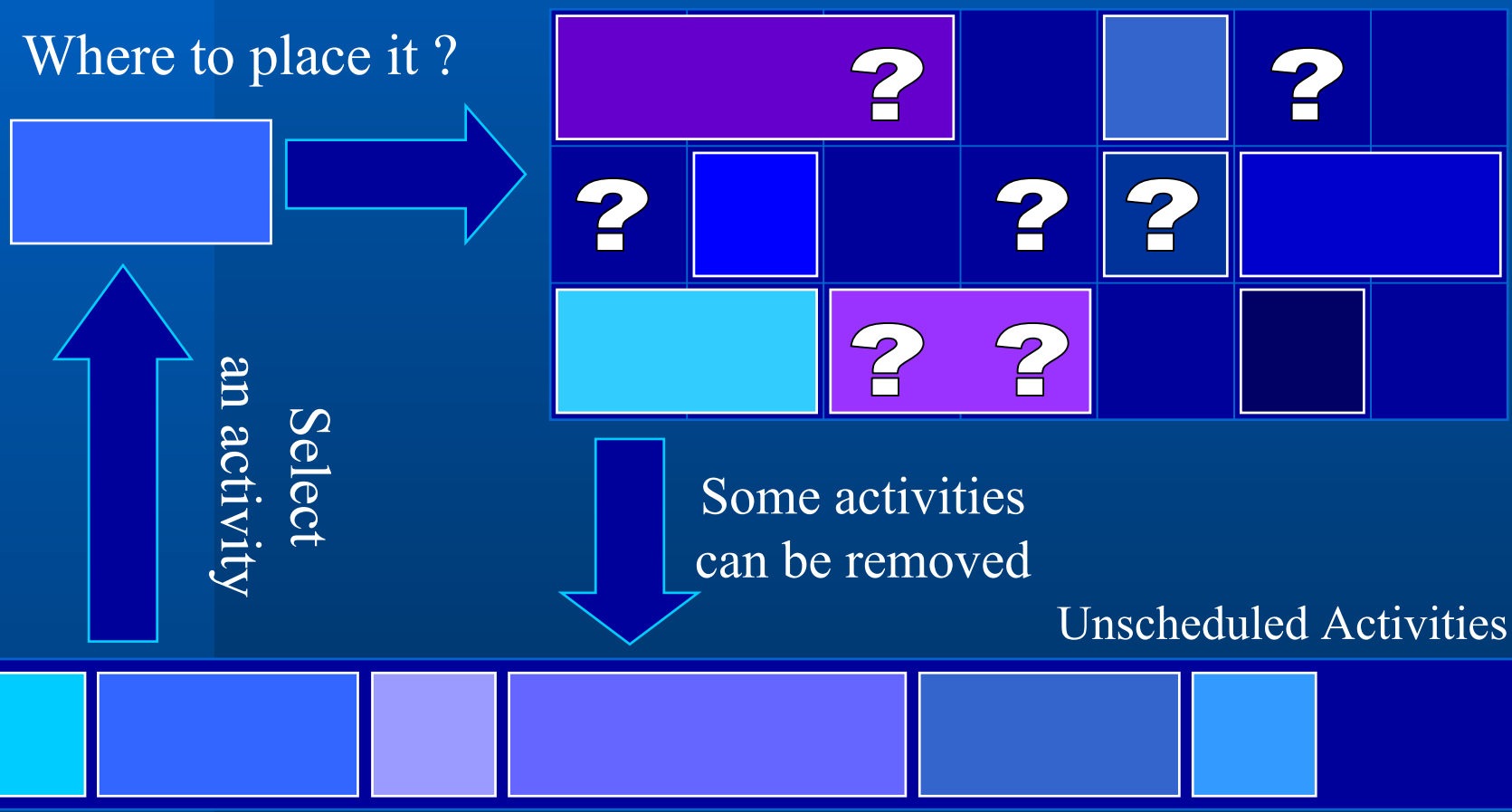
Furthermore:

We want to minimize the number of violated soft constraints.

An Interactive Solver

- **Basic Approaches**
  - local search
  - backtracking based search
- **Interactive Solving Algorithm**
  - forward based search
  - works in iterations
  - extending consistent partial solution
  - interactivity

An Interactive Solver



Activity Selection

- First-fail Principle
- Weighted Sum
  - for each unscheduled activity
  - $val_{activity}=w_1N_{\#Rm}+w_2N_{\#Dep}+w_3N_{\#Plc}+w_4N_{\#PlcNc}$
  - activity with minimal value is selected
- Improvements
  - select randomly 20% of unscheduled activities first

Location Selection

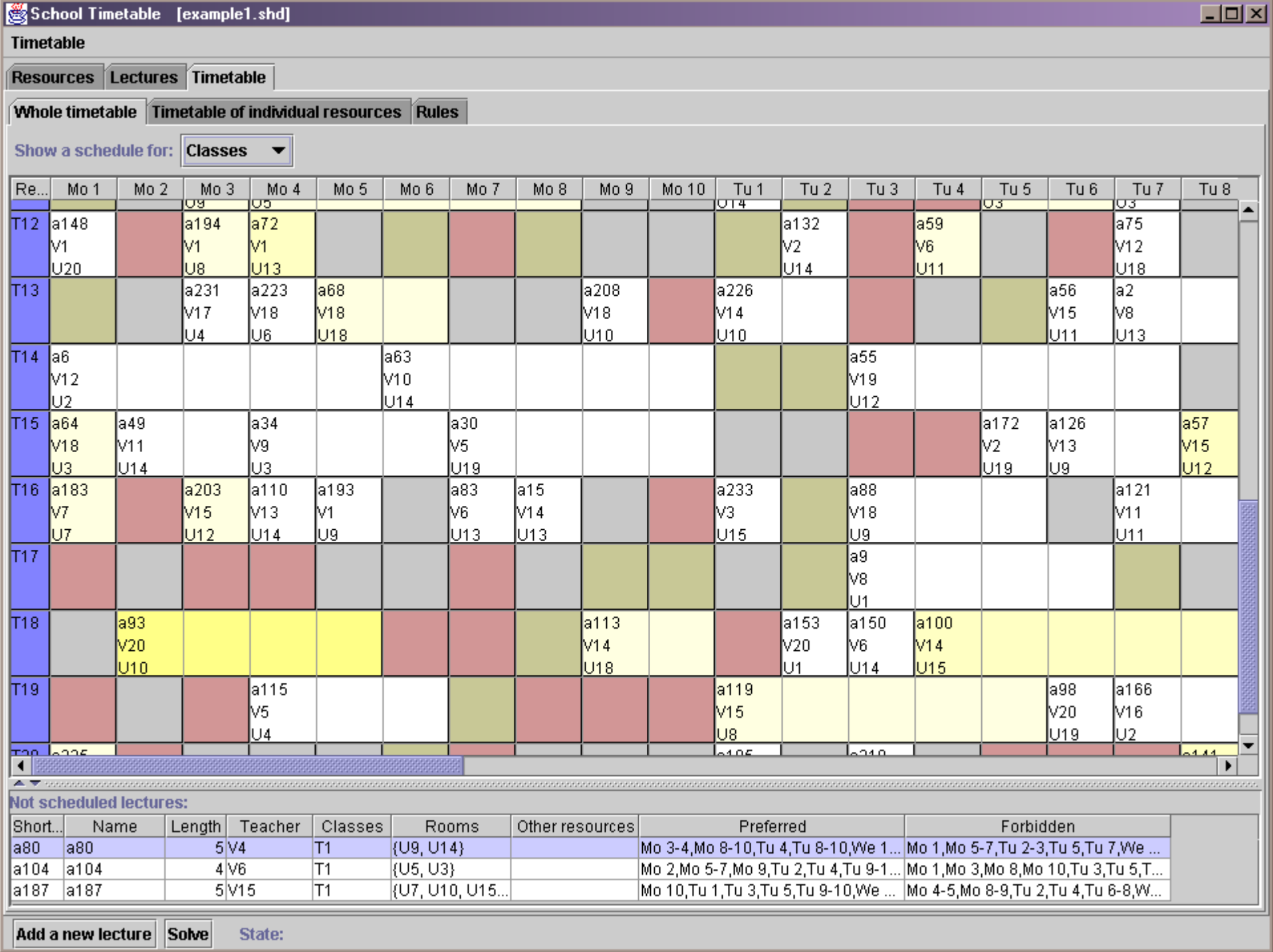
- **Select The Best-Fit Place**
- **Weighted Sum**
  - **for each possible location**
  - $val_{place} = w'_1 N_{\#CnfAct} + w'_2 N_{\#Rep} + w'_3 N_{\#ConfNoRsh} + w'_4 N_{\#Soft} + w'_5 N_{\#DiffPlace} + w'_6 N_{\#User}$
  - **place with minimal value is selected**
- **Improvements**
  - **random selection of the top *N* places**

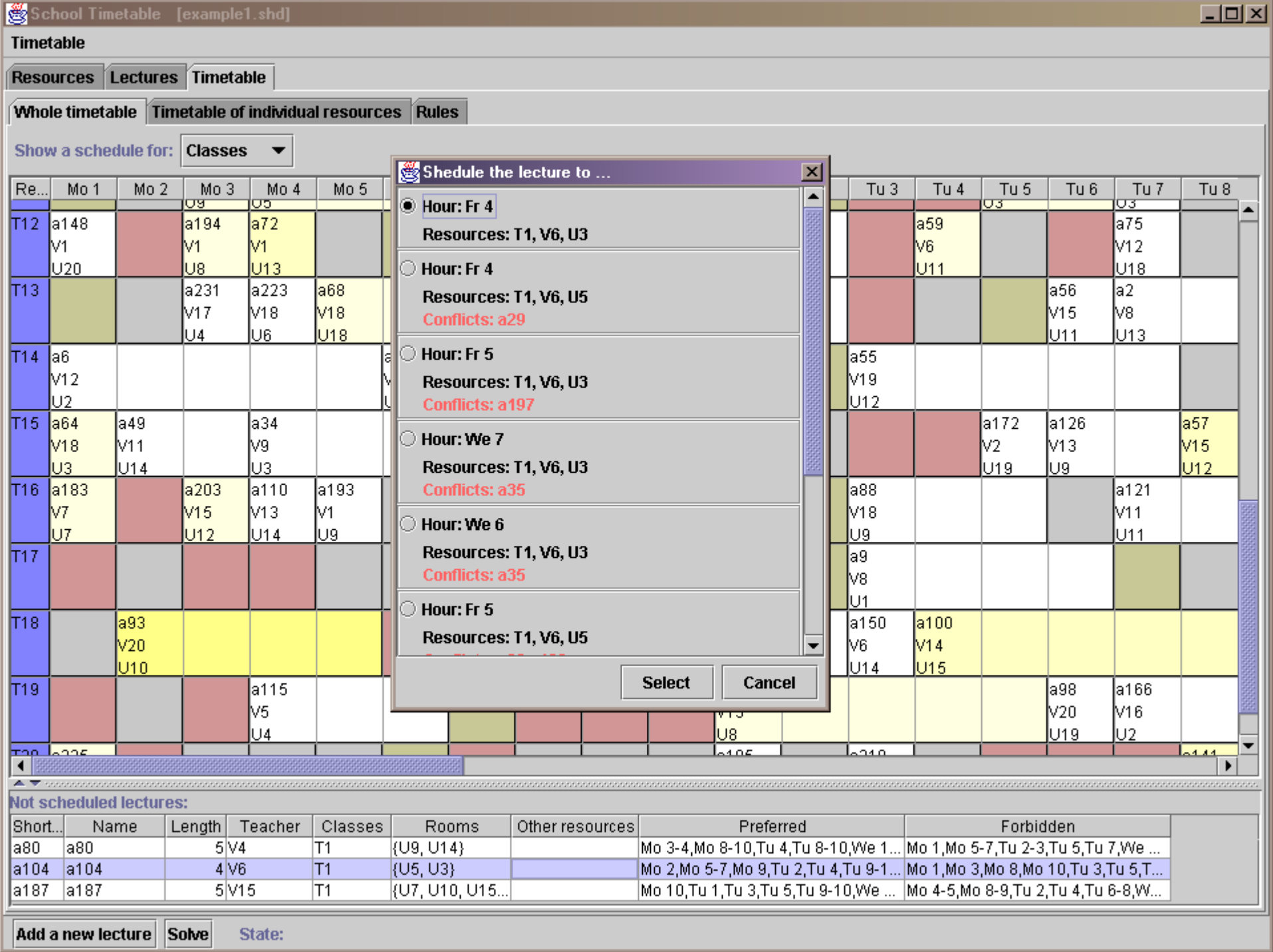
Note:

Scheduling of an activity can cause another activities removal.

Demonstration

- **School Timetable Program**
  - **extension of a generic solver**
  - **written in JAVA**
  - **GUI**

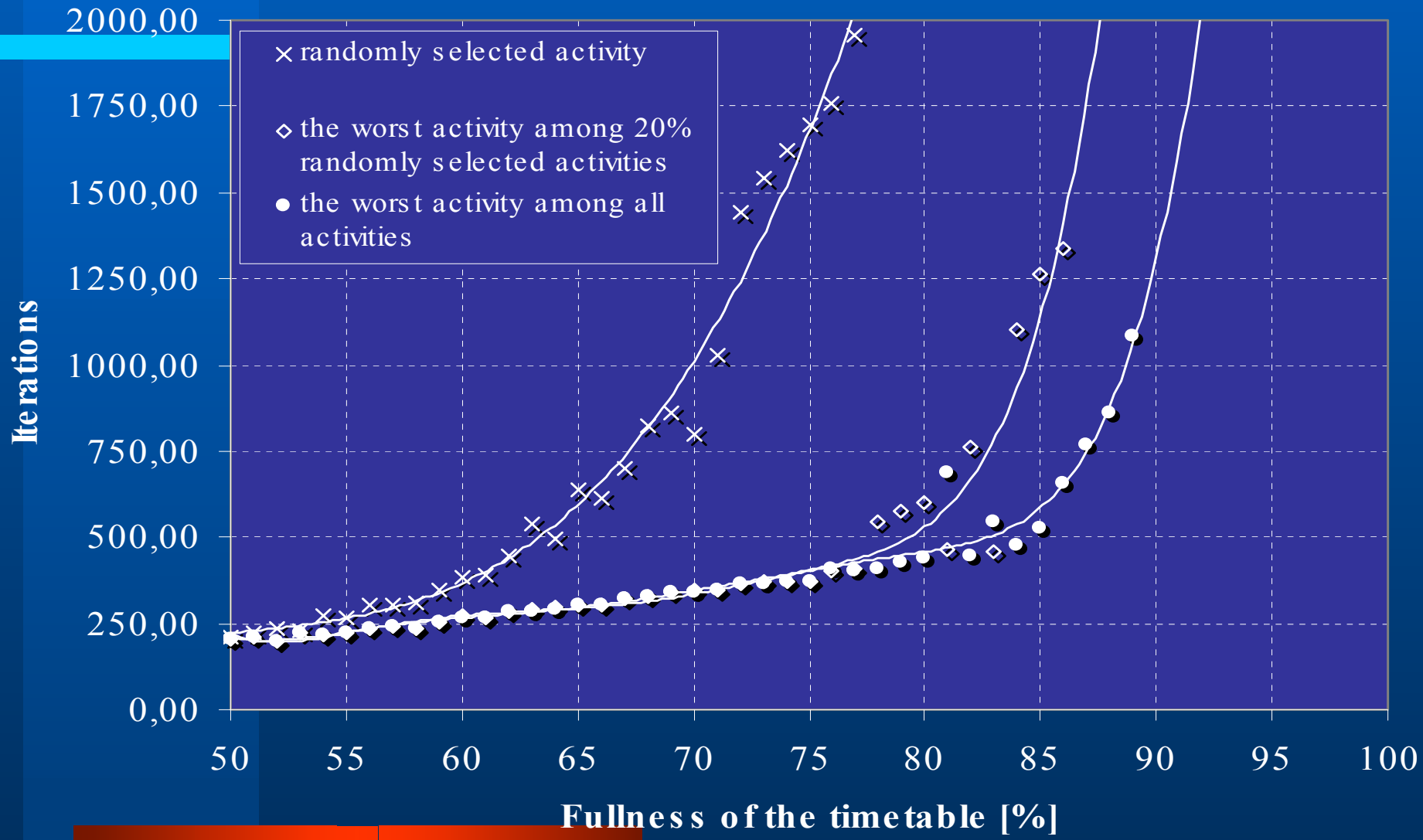

School Timetable [example1.shd]
Timetable
Resources
Lectures
Timetable
Whole timetable
Timetable of individual resources
Rules
Show a schedule for:
Classes
Re...
Mo 1
Mo 2
Mo 3
Mo 4
Mo 5
Mo 6
Mo 7
Mo 8
Mo 9
Mo 10
Tu 1
Tu 2
Tu 3
Tu 4
Tu 5
Tu 6
Tu 7
Tu 8
T12
a148 V1 U20
a194 V1 U8
a72 V1 U13
a132 V2 U14
a59 V6 U11
a75 V12 U18
T13
a231 V17 U4
a223 V18 U6
a68 V18 U18
a208 V18 U10
a226 V14 U10
a56 V15 U11
a2 V8 U13
T14
a6 V12 U2
a63 V10 U14
a55 V19 U12
T15
a64 V18 U3
a49 V11 U14
a34 V9 U3
a30 V5 U19
a172 V2 U19
a126 V13 U9
a57 V15 U12
T16
a183 V7 U7
a203 V15 U12
a110 V13 U14
a193 V1 U9
a83 V6 U13
a15 V14 U13
a233 V3 U15
a88 V18 U9
a121 V11 U11
T17
a9 V8 U1
T18
a93 V20 U10
a113 V14 U18
a153 V20 U1
a150 V6 U14
a100 V14 U15
T19
a115 V5 U4
a119 V15 U8
a98 V20 U19
a166 V16 U2
Not scheduled lectures:
Short...
Name
Length
Teacher
Classes
Rooms
Other resources
Preferred
Forbidden
a80 a80 5 V4 T1 {U9, U14} Mo 3-4,Mo 8-10,Tu 4,Tu 8-10,We 1... Mo 1,Mo 5-7,Tu 2-3,Tu 5,Tu 7,We ...
a104 a104 4 V6 T1 {U5, U3} Mo 2,Mo 5-7,Mo 9,Tu 2,Tu 4,Tu 9-1... Mo 1,Mo 3,Mo 8,Mo 10,Tu 3,Tu 5,T...
a187 a187 5 V15 T1 {U7, U10, U15... Mo 10,Tu 1,Tu 3,Tu 5,Tu 9-10,We ... Mo 4-5,Mo 8-9,Tu 2,Tu 4,Tu 6-8,W...
Add a new lecture
Solve
State:


School Timetable [example1.shd]
Timetable
Resources
Lectures
Timetable
Whole timetable
Timetable of individual resources
Rules
Show a schedule for:
Classes
Shedule the lecture to ...
Hour: Fr 4
Resources: T1, V6, U3
Hour: Fr 4
Resources: T1, V6, U5
Conflicts: a29
Hour: Fr 5
Resources: T1, V6, U3
Conflicts: a197
Hour: We 7
Resources: T1, V6, U3
Conflicts: a35
Hour: We 6
Resources: T1, V6, U3
Conflicts: a35
Hour: Fr 5
Resources: T1, V6, U5
Select
Cancel
Re...
Mo 1
Mo 2
Mo 3
Mo 4
Mo 5
Tu 3
Tu 4
Tu 5
Tu 6
Tu 7
Tu 8
T12
T13
T14
T15
T16
T17
T18
T19
Not scheduled lectures:
Short...
Name
Length
Teacher
Classes
Rooms
Other resources
Preferred
Forbidden
a80
a104
a187
Add a new lecture
Solve
State:

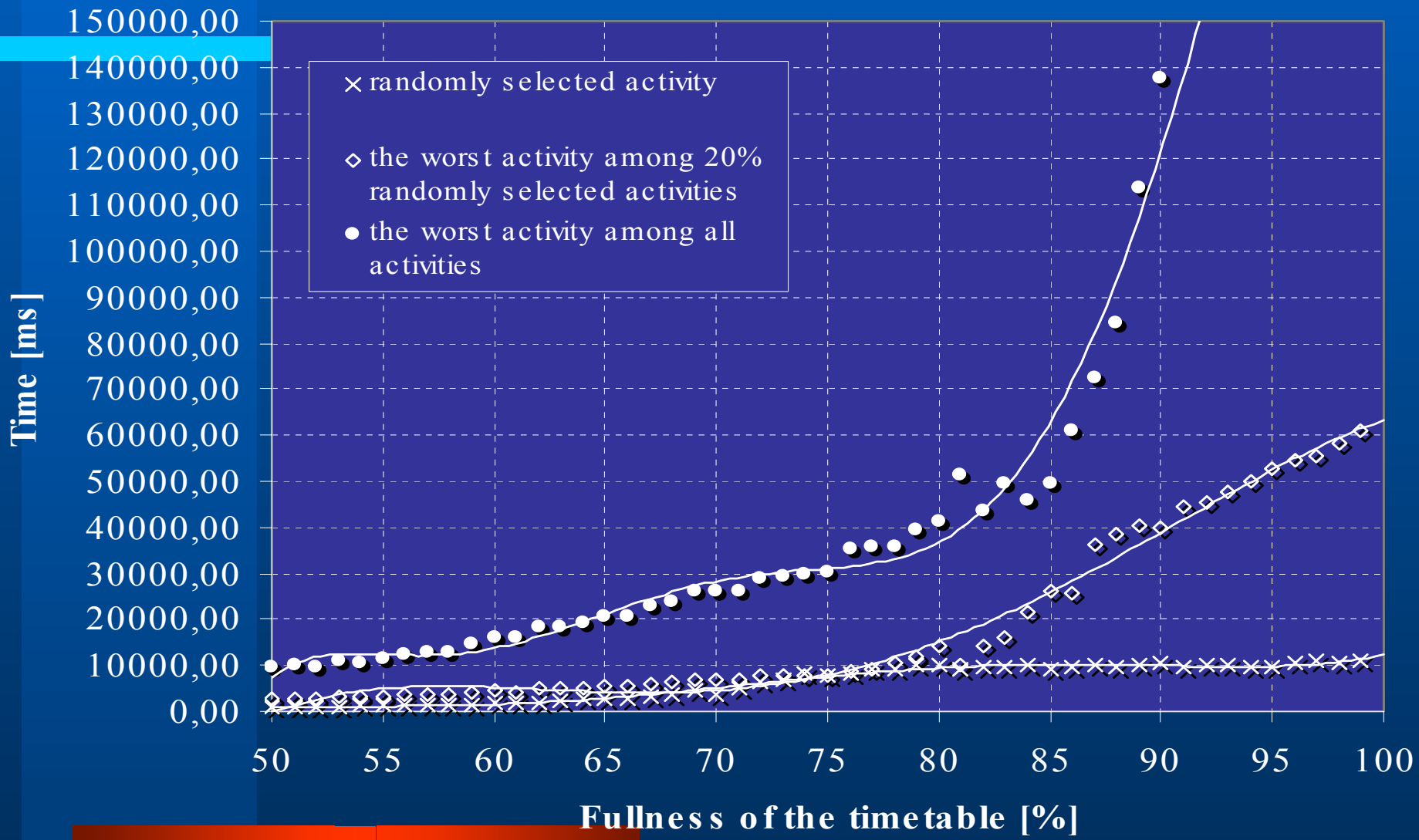
Conclusions and Future Work

- Some results are in the paper
  - comparison of activity selection methods
- Extension of presented algorithm to other constraint satisfaction problems

Comparison of the number of iterations for three basic variable selection criteria



Comparison of the time for three basic variable selection criteria



Comparison of the number of scheduled activities for three basic variable selection criteria