



University of Trento  
Department of Information Engineering  
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# Towards an Adaptation Mechanism for Handling Multiple Failures

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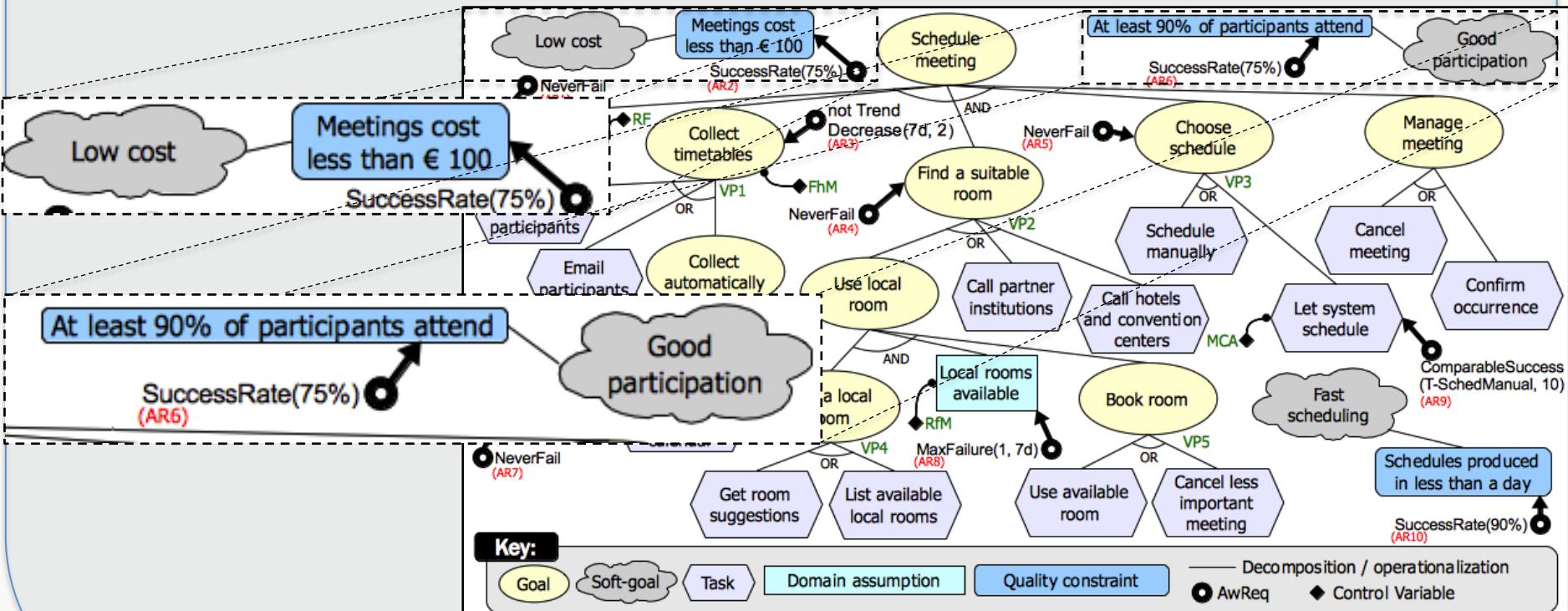
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# Adaptation: The Story So Far

- Past (Vitor's work)
  - Awareness Requirements (AwReq)
  - System Identification
  - Qualitative Adaptation (no mechanism for handling multiple failures)
- Now (My work)
  - New Qualitative Adaptation (with mechanism for handling multiple failures)
  - Working John and Vitor
  - Paper to be submitted to SEAMS'14

# Background: AwReqs

- AwReqs determine the critical requirements. We should be aware of their success/failure.



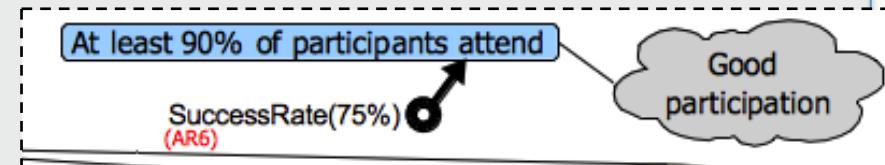
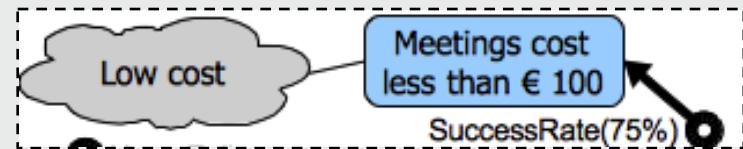
# Background: System Identification

- System Identification:
  - Indicator/Parameter qualitative relations
  - Information to reason over how to reconfigure the system

$order(RF) : listonly \prec short \prec full$	$order(VP2, AR10) : partner \prec hotel \prec local$
$\Delta(AR1/RF) < 0$ (4.16)	$\Delta(AR6/VP1) < 0$
$\Delta(AR2/RfM) < 0$ (4.17)	$\Delta(AR6/VP3) < 0$
$\Delta(AR2/VP2) < 0$ (4.18)	$\Delta(AR7/VPA) \{false \rightarrow true\} < 0$
$\Delta(AR3/FhM) < 0$ (4.19)	$\Delta(AR8/RfM) [0, enough] > 0$
$\Delta(AR4/RfM) > 0$ (4.20)	$\Delta(AR8/VP2) > 0$
$\Delta(AR4/VP2) > 0$ (4.21)	$\Delta(AR9/MCA) > 0$
$\Delta(AR5/MCA) > 0$ (4.22)	$\Delta(AR9/VP3) > 0$
$\Delta(AR5/VP3) < 0$ (4.23)	$\Delta(AR10/RF) < 0$
$\Delta(AR6/RF) > 0$ (4.24)	$\Delta(AR10/FhM) < 0$
$\Delta(AR6/FhM) > 0$ (4.25)	$\Delta(AR10/VP1) > 0$
$\Delta(AR6/VPA) \{false \rightarrow true\} > 0$ (4.26)	$\Delta(AR10/VP2) > 0$
$\Delta(AR6/MCA) < 0$ (4.27)	$\Delta(AR10/VP3) > 0$
$ \Delta(AR2/RfM)  <  \Delta(AR2/VP2) $ $ \Delta(AR4/RfM)  =  \Delta(AR4/VP2) $ $ \Delta(AR4/\{RfM, VP2\})  =  \Delta(AR4/VP2) $ $ \Delta(AR6/VPA)  <  \Delta(AR6/RF)  <  \Delta(AR6/VP3)  <  \Delta(AR6/FhM)  < \dots$ $\dots <  \Delta(AR6/FhM)  <  \Delta(AR6/VP1)  <  \Delta(AR6/MCA) $ $ \Delta(AR8/RfM)  =  \Delta(AR8/VP2) $ $ \Delta(AR8/\{RfM, VP2\})  =  \Delta(AR8/VP2) $ $ \Delta(AR9/MCA)  <  \Delta(AR9/VP3) $ $ \Delta(AR10/RF)  <  \Delta(AR10/VP2)  <  \Delta(AR10/VP3)  < \dots$ $\dots <  \Delta(AR10/VP3)  <  \Delta(AR10/FhM)  <  \Delta(AR10/VP1) $	

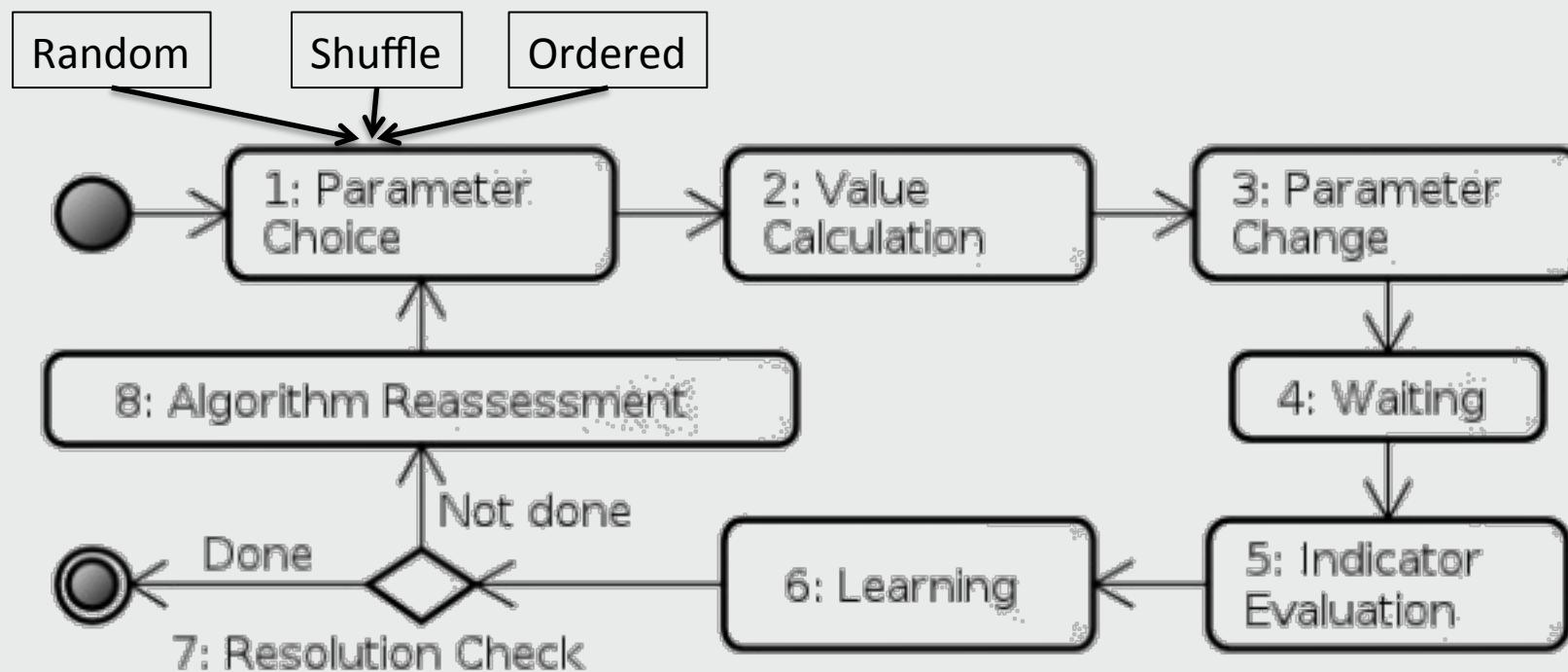
# Examples

- Meeting Scheduler
  - Softgoal: Low Cost
  - QC: Meetings cost less than 100€
  - AwReq AR2: SuccessRate(75%)
  - Parameters:
    - RfM: Rooms for Meetings ↓
    - VP2 @ goal Find Suitable Room ↓
  - Softgoal: Good Participation
  - QC: At least 90% of the participants attend
  - AwReq AR6: SuccessRate(75%)
  - Parameters:
    - RF: Required Fields ↑
    - FhM: From how Many ↑
    - VPA: View Private Appointments ↓
    - MCA: Maximum Conflicts Allowed ↓
    - VP1 @ goal Collect Timetables ↓
    - VP3 @ goal Chose Schedule ↓



# Old Qualia

Adaptation Algorithm:



# But what if???

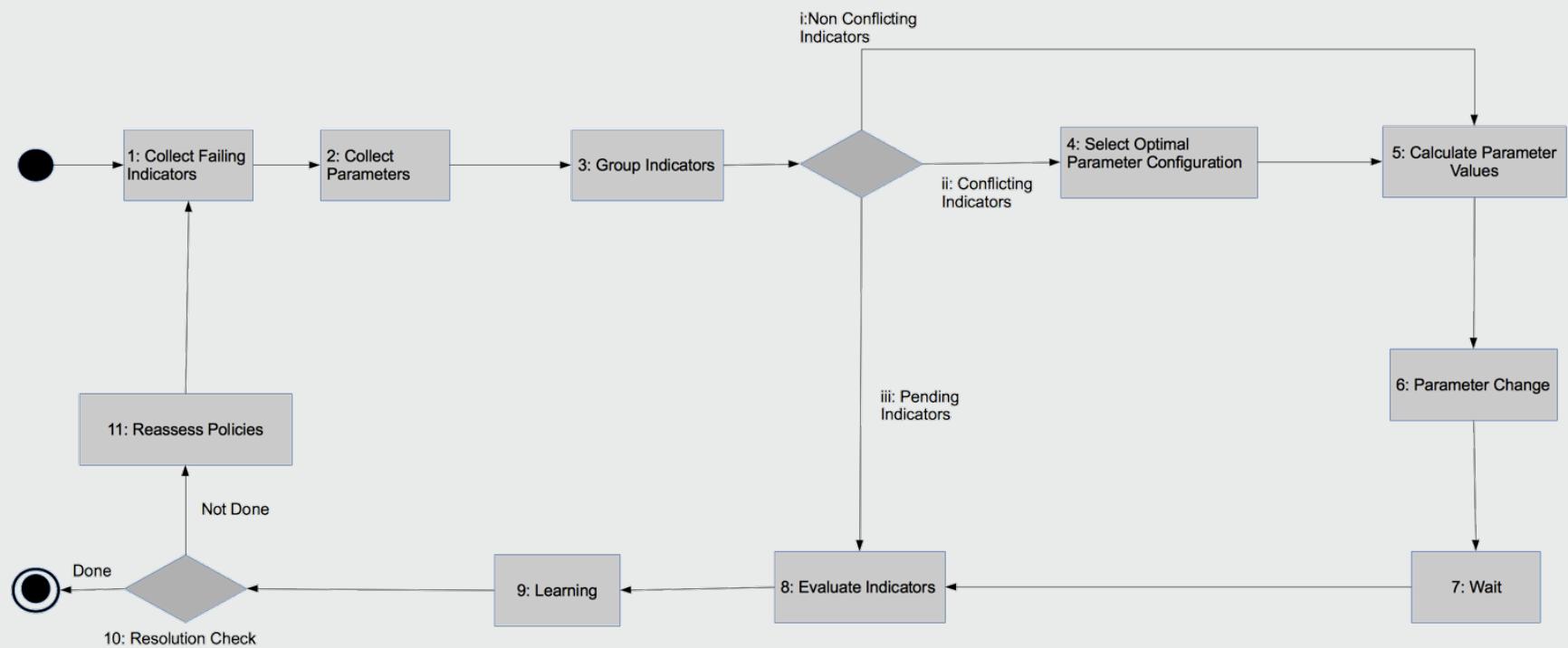
- Many indicators fail at the same time
- Failing indicators get opposite effects from the same parameter (conflicts)
- We know which parameters affect which indicators, but not precisely how much (lack of quantitative information)
- The values we choose lead to overshooting or low settling time (lack of precision)

# New Qualia

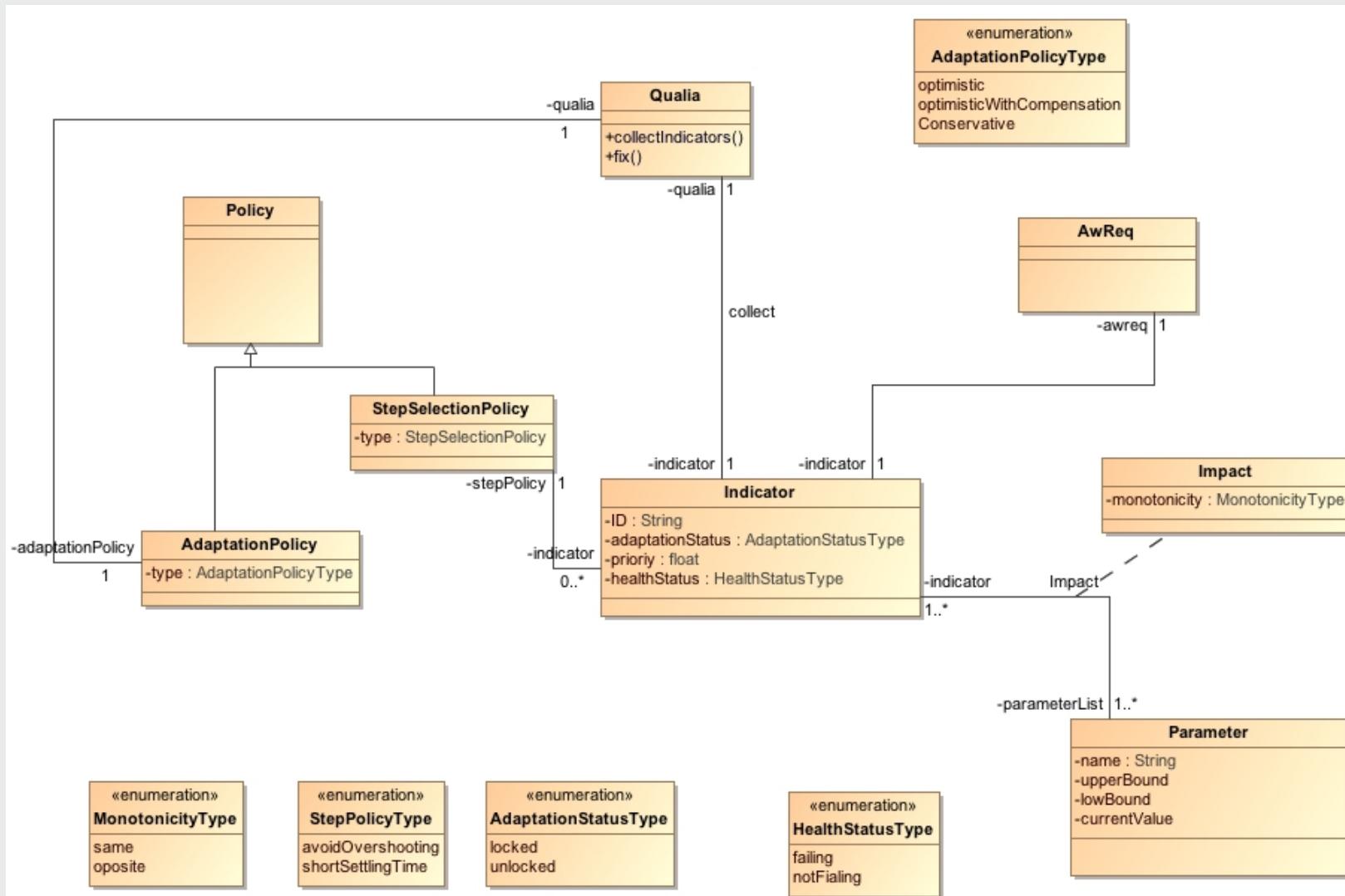
- Resolve conflicts based on preferences and priorities, using Analytic Hierarchy Process (AHP)
- Adaptation policies about the indicator selection
  - Conservative
  - Optimistic with compensation
  - Optimistic
- Adaptation policies for selecting parameters and calculating their values
- Adaptation policies for handling indicators that their resolution time lasts longer than the window of the adaptation cycle
- Policies are implemented in OCL

# New Qualia

## New Adaptation Algorithm



# New Qualia



# Example: Meeting Scheduler

Pairwise comparisons among indicators

	AR1	AR2	AR3	AR4	AR5	AR6	AR7	AR8	AR9	AR10
AR1	1	1	1	1	1	5	1	1	1	1
AR2	1	1	1	0.143	1	1	1	0.333	1	5
AR3	1	1	1	1	1	0.2	1	1	1	1
AR4	1	7	1	1	1	1	1	1	1	1
AR5	1	1	1	1	1	5	1	1	7	7
AR6	0.2	1	1	1	0.2	1	9	1	7	9
AR7	1	1	1	1	1	0.111	1	1	1	1
AR8	1	3	1	1	1	1	1	1	1	1
AR9	1	1	1	1	0.143	0.143	1	1	1	1
AR10	1	0.2	1	1	0.143	0.111	1	1	1	1
SUM	9.2	17.2	10	9.143	7.486	14.565	18	9.333	22	28

Normalized table

	AR1	AR2	AR3	AR4	AR5	AR6	AR7	AR8	AR9	AR10	Priority
AR1	0.109	0.058	0.100	0.109	0.134	0.343	0.056	0.107	0.045	0.036	1.097
AR2	0.109	0.058	0.100	0.016	0.134	0.069	0.056	0.036	0.045	0.179	0.800
AR3	0.109	0.058	0.100	0.109	0.134	0.014	0.056	0.107	0.045	0.036	0.767
AR4	0.109	0.407	0.100	0.109	0.134	0.069	0.056	0.107	0.045	0.036	1.171
AR5	0.109	0.058	0.100	0.109	0.134	0.343	0.056	0.107	0.318	0.250	1.584
AR6	0.022	0.058	0.100	0.109	0.027	0.069	0.500	0.107	0.318	0.321	1.631
AR7	0.109	0.058	0.100	0.109	0.134	0.008	0.056	0.107	0.045	0.036	0.761
AR8	0.109	0.174	0.100	0.109	0.134	0.069	0.056	0.107	0.045	0.036	0.939
AR9	0.109	0.058	0.100	0.109	0.019	0.010	0.056	0.107	0.045	0.036	0.649
AR10	0.109	0.012	0.100	0.109	0.019	0.008	0.056	0.107	0.045	0.036	0.600

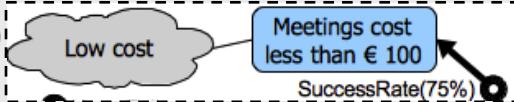
Priority list

AR6	1.631
AR5	1.584
AR4	1.171
AR1	1.097
AR8	0.939
AR2	0.800
AR3	0.767
AR7	0.761
AR9	0.649
AR10	0.600

# Example: Meeting Scheduler

3 failures at the same time:

- AwReq AR2: SuccessRate(75%)



- Parameters:
  - RfM: Rooms for Meetings ↓
  - VP2 @ goal Find Suitable Room ↓(exhausted)

- AwReq AR6: SuccessRate(75%)

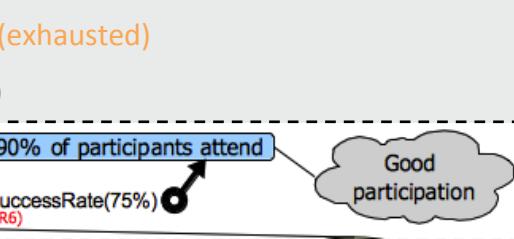
- Parameters:

- RF: Required Fields ↑
- FhM: From how Many ↑
- VPA: View Private Appointments ↓
- MCA: Maximum Conflicts Allowed ↓
- VP1 @ goal Collect Timetables ↓
- VP3 @ goal Chose Schedule ↓

- AwReq AR10: SuccessRate(90%)

- Parameters:

- VP1 @ goal Collect Timetables ↑
- VP2 @ goal Find Suitable Room ↑(exhausted)
- VP3 @ goal Chose Schedule ↑
- RF: Required Fields ↓
- FhM: From how Many ↓



2 potential conflicts

AR2 vs AR10

and

AR6 vs AR10

Conflict Resolution

Priority(AR2)> Priority(AR10)

Priority(AR6)> Priority(AR10)

so...

Abort(AR10)

Conservative Policy

Decreasing RfM harms AR4

Priority(AR4)> Priority(AR2)

so...

Abort(AR2)

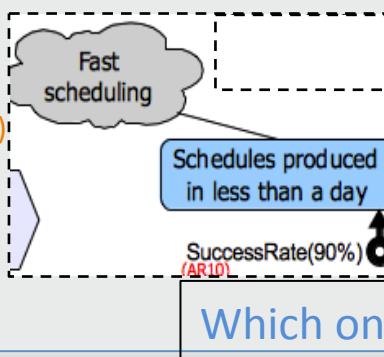
Optimistic with Compensation

no compensation available

Optimistic

Decrease(RfM)

Increase(RF) or Decrease(VPA  
or MCA or VP1 or VP3)



Which one to choose?

# Example: Meeting Scheduler

- Step Selection Policies:
  - Avoid Overshooting: choose the available parameter that according to the SysId ordering has the smallest impact
  - Short Settling Time: choose the available parameter that according to the SysId ordering has the greatest impact

e.g. for AR6:  $|\Delta(\text{AR6/VPA})| < |\Delta(\text{AR6/RF})| < |\Delta(\text{AR6/VP3})| < |\Delta(\text{AR6/FhM})| < \dots < |\Delta(\text{AR6/VP1})| < |\Delta(\text{AR6/MCA})|$

- If the policy is Avoid Overshooting we decrease VPA (  $\Delta(\text{AR6/VPA}) < 0$  )
- If the policy is Short Settling Time we decrease MCA (  $\Delta(\text{AR6/MCA}) < 0$  )

# Next Steps

## For SEAMS'14

- Implement the policies in OCL
- Run scenarios with the Meeting Scheduler case study
- Evaluate the new algorithm

## For later...

- Collect execution logs and derive quantitative relations between parameters and indicators
- Apply quantitative optimization

# Conclusions

The new adaptation mechanism is able to:

- Execute runtime optimization for requirement conflicts based on preferences and priorities
- Handle multiple failures
- Enhance the precision of the qualitative adaptation process

# Thank You!

## Questions?