

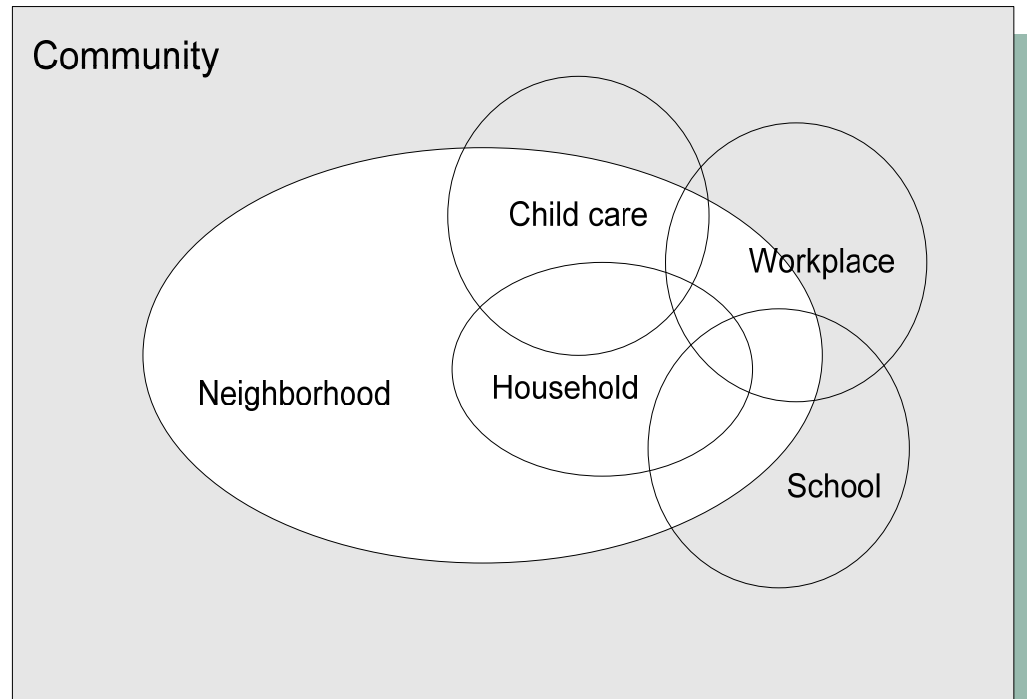


Simulation Modeling using Protégé

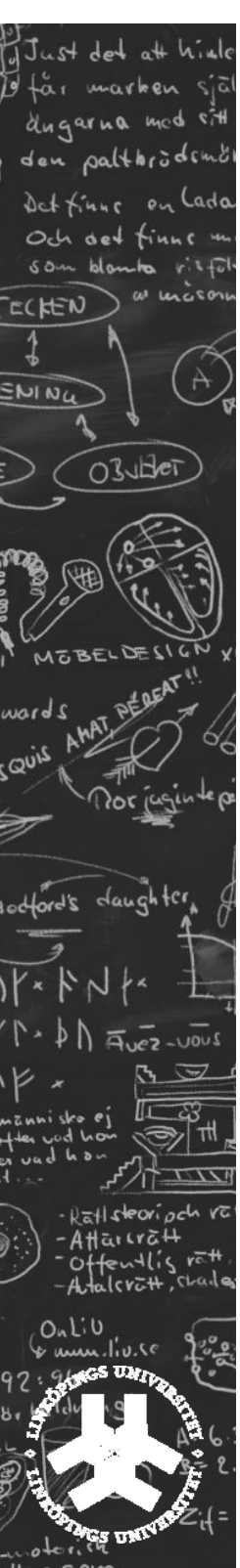
Henrik Eriksson
Magnus Morin
Joakim Ekberg
Johan Jenvald
Toomas Timpka

Models of community structures

- Geographical
- Logistical
- Social
- Cultural

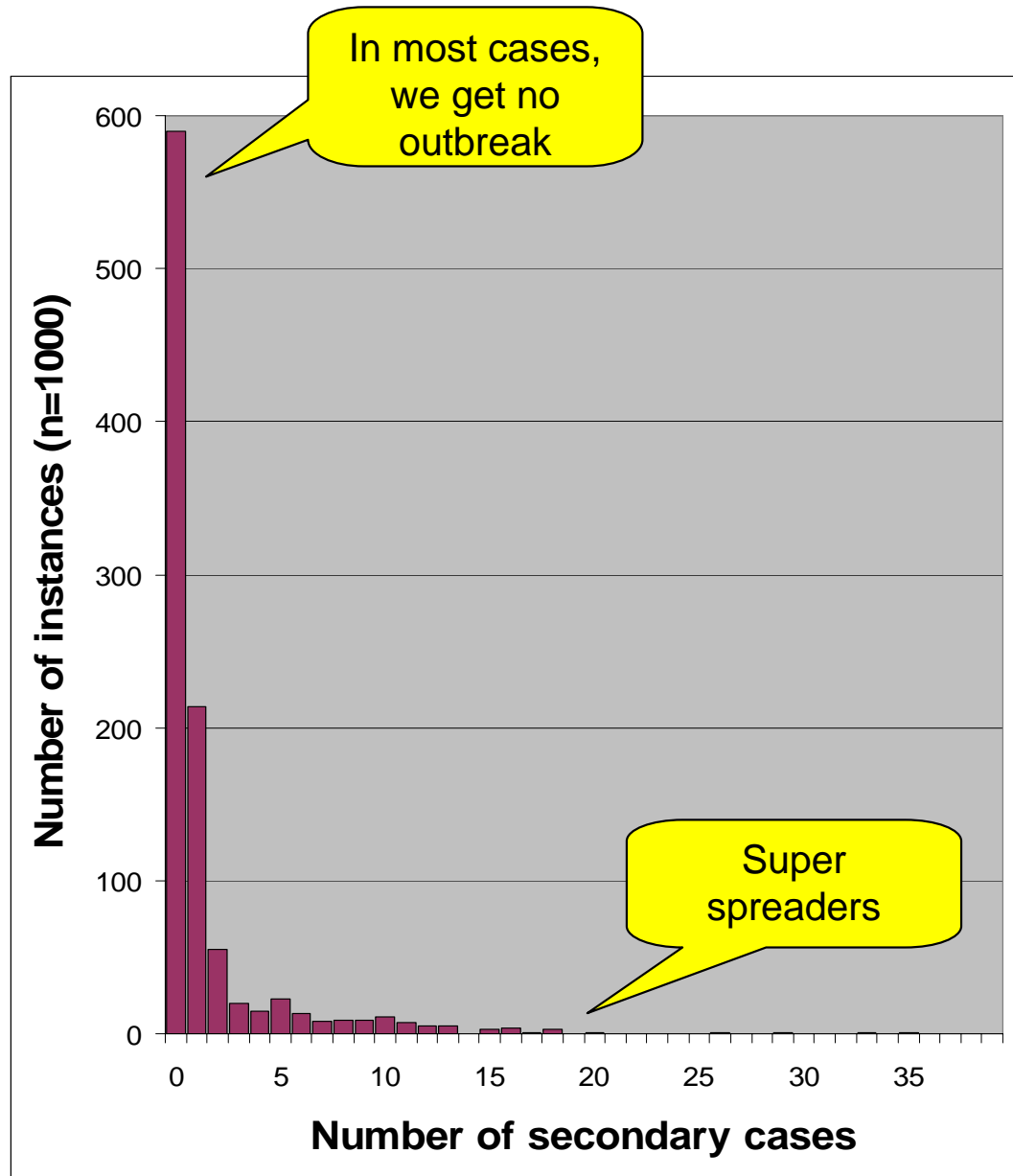


- Mixing-group approach
- People get infected where they meet other people



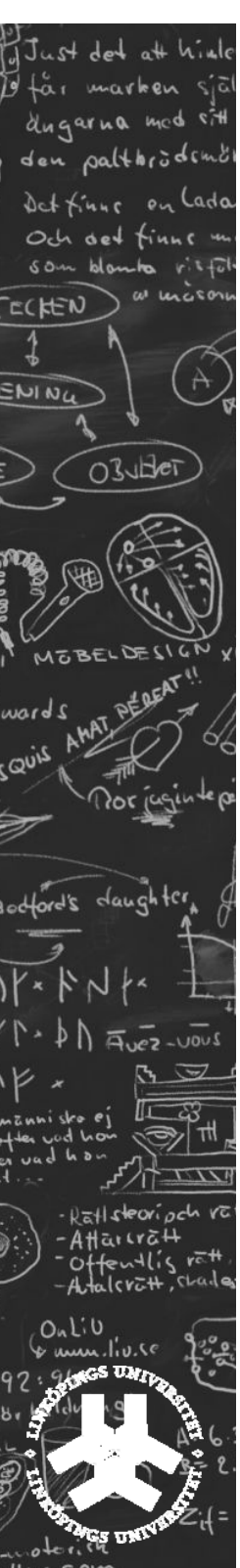
Number of secondary cases (R_0)

Results from 1000 simulation runs:
Frequency of secondary cases

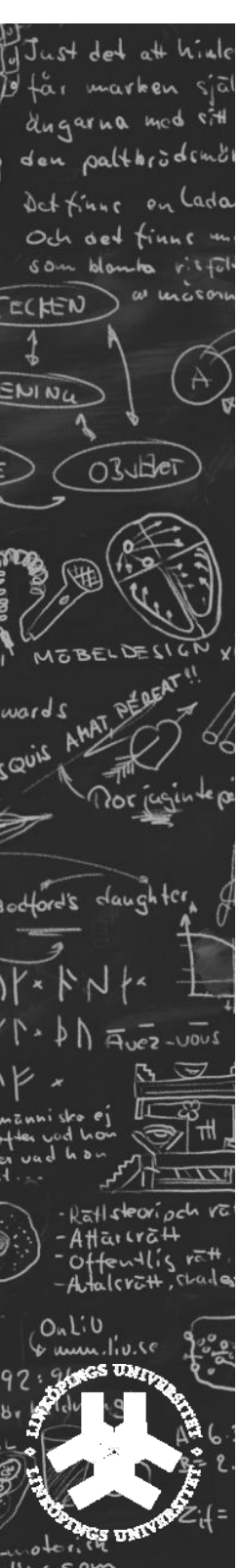
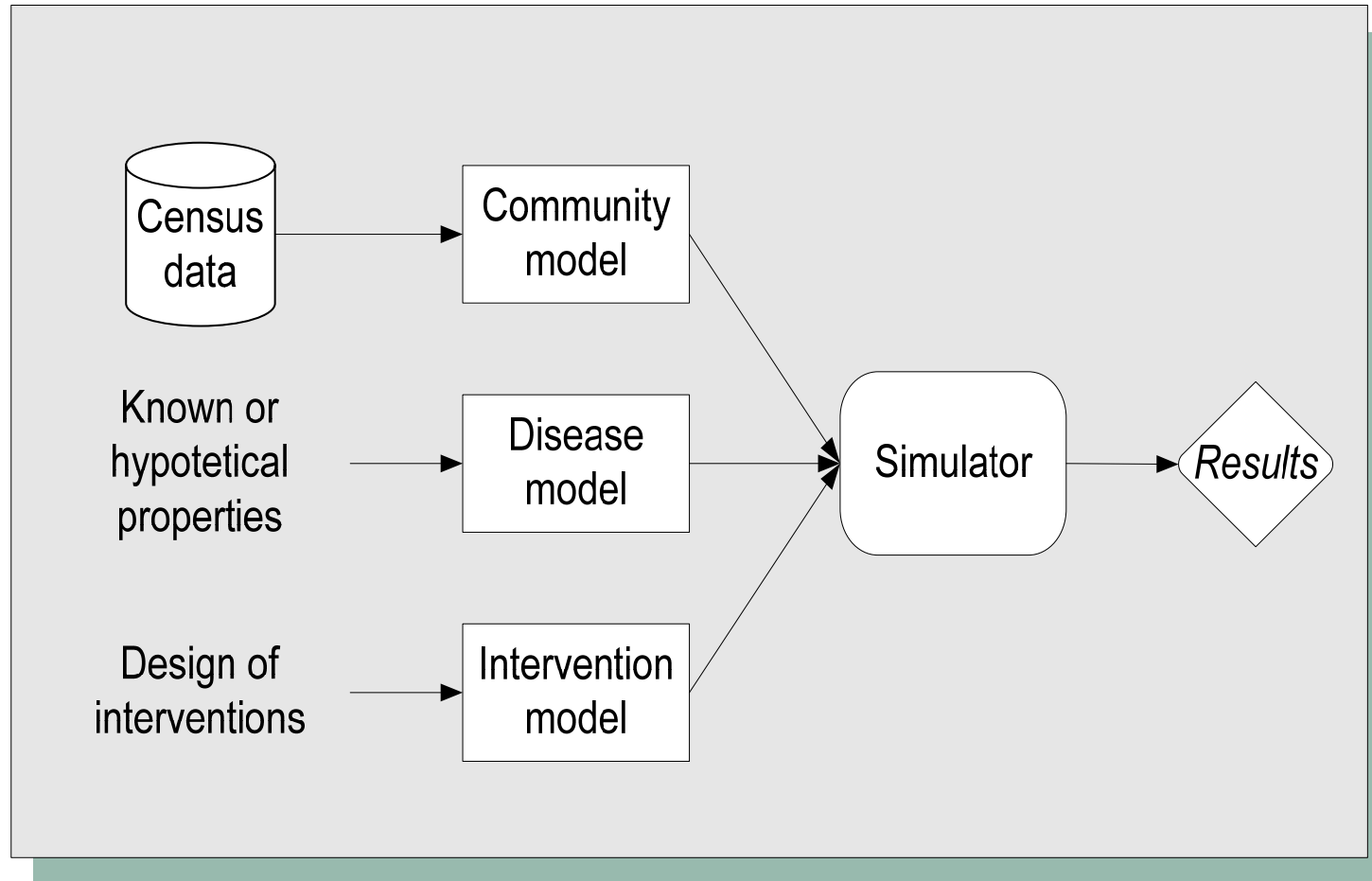


Simulator requirements

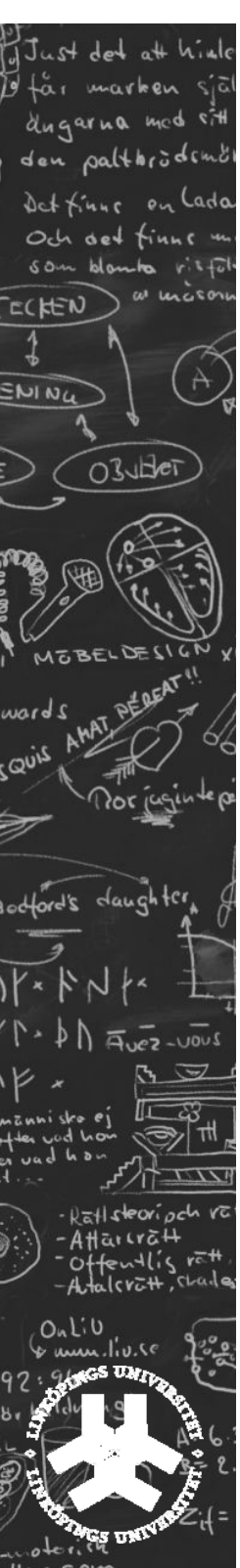
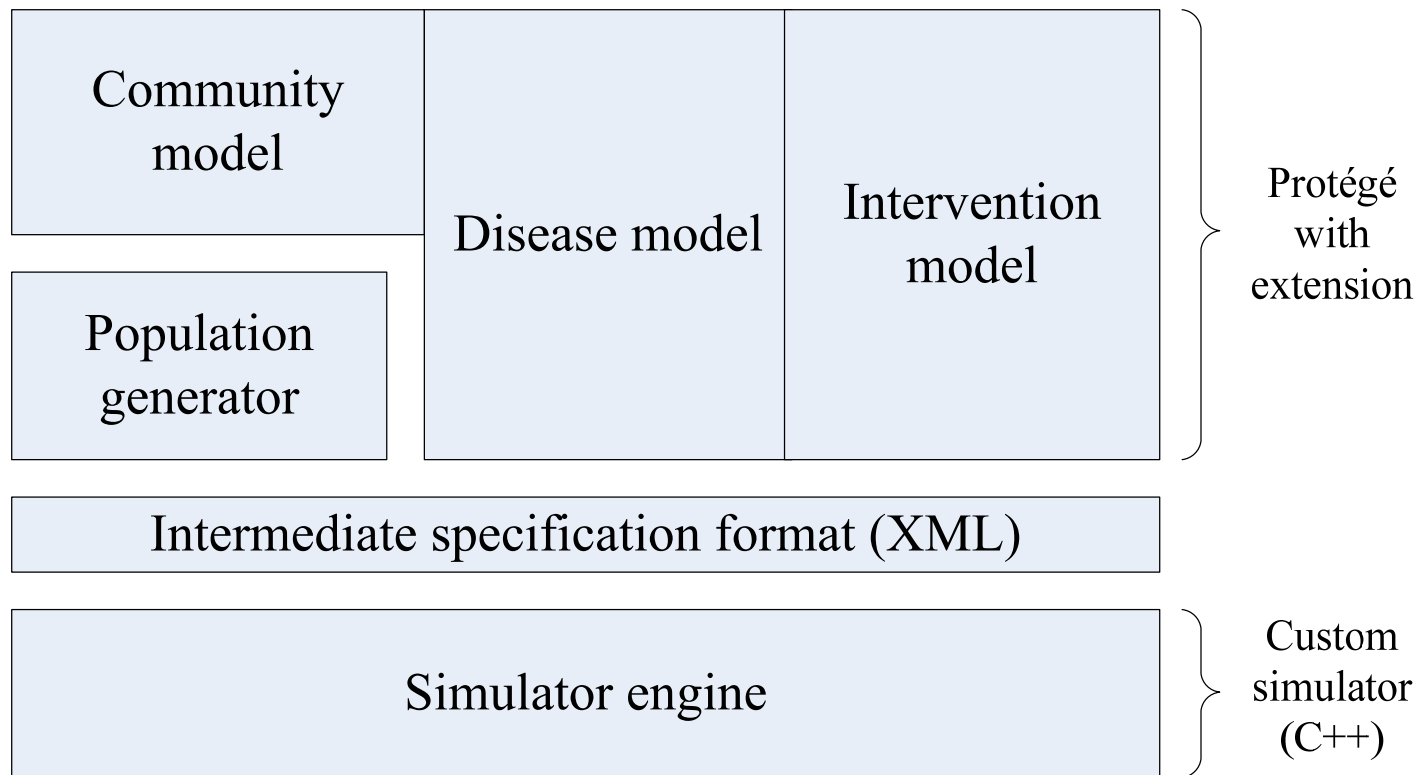
- Fast turn-around time (<24h)
 - Updated simulation as more information become available
- Transparent, user-friendly models
- Pluggable models
 - Interchangeable disease model
 - Alternative community models (e.g., actual and randomized)
- Scalable computational environment
- Visualization



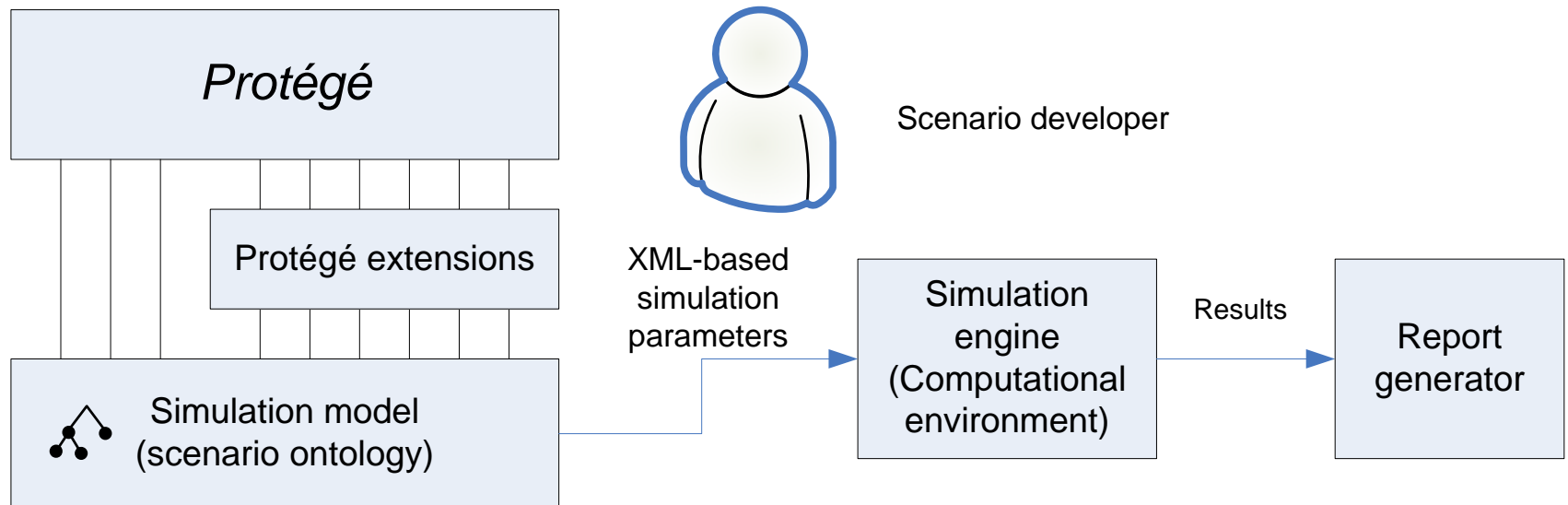
Pandemic modeling and simulation



Simulation environment—architectural layers



Simulation Architecture



Just det att hiale
får mariken sjöt
dingarna med sitt
den paltbröden
det finns en lada
och det finns m
som blanda rieföl
at mäsom

ECHEN
ENINA
OBJET

MÖBELDESIGN

wards
EQUIS AMAT DÉREAT!!
Por jugin de p

Woodford's daughter

Y * K N t x
Y * P N Auez - vous

männi ska ej
fika vad hon
er vad hon

- Rätt teori och rät
- Attärrätt
- Offentlig rätt
- Arärrätt, skada

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Simulation model

The screenshot displays the Protégé 3.3.1 interface for a simulation model. The title bar shows the file path: (file:\C:\cygwin\home\her\SimCode\SimModel\VirSim.pprj, OWL / RDF Files). The menu bar includes File, Edit, Project, OWL, Code, Tools, Window, and Help. The toolbar contains various icons for file operations and navigation.

The interface is divided into three main panes:

- CLASS BROWSER:** Shows the Class Hierarchy for Project: VirSim. The hierarchy includes owl:Thing, Assumption (3), Background (1), Community, CommunityModification (KeepChildrenFromSchool (12), StayIndoors (3)), Disease, Household (1), HouseholdCaseProbability (12), Intervention, InterventionPolicy, MixingGroup, Neighborhood (1), PopulationGenerator, ProbabilityDistribution, Scenario (36), SchoolDistribution (13), SchoolStructure, SchoolType (9), Seeding, SeedingCaseProbability, and SimulationJob (16).
- INSTANCE BROWSER:** Shows the Instance Browser for Class: StayIndoors. It displays Asserted Instances: StayIndoors_Asian, StayIndoors_European, and StayIndoors_Intervention. Below it, the Asserted Types section shows StayIndoors.
- INDIVIDUAL EDITOR:** Shows the Individual Editor for StayIndoors_European (instance of StayIndoors). It includes fields for Name, SameAs, DifferentFrom, and a table for Properties. The Name field contains StayIndoors_European. The AssumptionList section shows Interview_assumption.

A yellow callout bubble points to the Instance Browser pane with the text: **Ontology-based simulation model**

Just det att hiale
fär marcken sjöl
dingarna med sif
den paltbröden
det finns en lada
och det finns m
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a mäsom

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- Rätt teori och re
- Att är rätt
- Offentlig rätt
- Ätalsrätt, skade

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Editing of community definition

◆ Linköping (instance of Community)

INDIVIDUAL EDITOR + - F T

For Individual: ◆ Linköping (instance of Community)

Name SameAs DifferentFrom

Linköping

rdfs:comment

Property	Value	La...
rdfs:comment		

Population 136000

NeighborhoodModel

- ◆ Standard_Neighborhood

BackgroundModel

- ◆ Linköping_Background

SchoolStructureMod

- ◆ Linköping_Schools

HouseholdModel

- ◆ Standard_Household

Just det att hiale
fär marcken sjöl
dugarna med sif
den paltbrödemö
det finne on lada
och det finne m
som blomb rieföl
a mäsom

ECHEN

ENINA

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wards

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Y * K N t x

Y * D N Avez -vous

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fies vad hon
er vad hon

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- Offentlig rätt
- Atalerrätt, chala

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Protégé tab extension for scenario editing

VirSim Protégé 3.3.1 (file:\C:\cygwin\home\her\SimCode\SimModel\VirSim.pprj.OWL / RDF Files)

File Edit Project OWL Code Tools Window Help

OWLClasses Properties Forms Individuals Metadata (unnamed.owl) Scenarios Simulation jobs

SCENARIO BROWSER

For Project: ● VirSim

Scenarios

- ◆ A09_A1B1_European
- ◆ A09_A1B1_Intervention
- ◆ A09_A1B2_Asian
- ◆ A09_A1B2_European
- ◆ A09_A1B2_Intervention
- ◆ A09_A2B1_Asian
- ◆ A09_A2B1_European
- ◆ A09_A2B1_Intervention
- ◆ A09_A2B2_Asian
- ◆ A09_A2B2_European
- ◆ A09_A2B2_Intervention
- ◆ **A09_Baseline**
- ◆ A09_StayIndoors_Asian
- ◆ A09_StayIndoors_European
- ◆ A09_StayIndoors_Intervention
- ◆ A09_StayIndoorsA1B1_Asian
- ◆ A09_StayIndoorsA1B1_European
- ◆ A09_StayIndoorsA1B1_Intervention
- ◆ A09_StayIndoorsA1B2_Asian
- ◆ A09_StayIndoorsA1B2_European
- ◆ A09_StayIndoorsA1B2_Intervention
- ◆ A09_StayIndoorsA2B1_Asian
- ◆ A09_StayIndoorsA2B1_European
- ◆ A09_StayIndoorsA2B1_Intervention
- ◆ A09_StayIndoorsA2B2_Asian
- ◆ A09_StayIndoorsA2B2_European
- ◆ A09_StayIndoorsA2B2_Intervention

SCENARIO INDIVIDUAL

For Instance: ◆ A09_Baseline (instance of Scenario)

Name SameAs DifferentFrom

Name Comment

Name

A09_Baseline

CommunityModel

- ◆ Linköping

DiseaseModel

- ◆ HSN1

InterventionPolicyModel

MappingModel

- ◆ LonginiPopulationGenerator_1

CommunityModificationModel

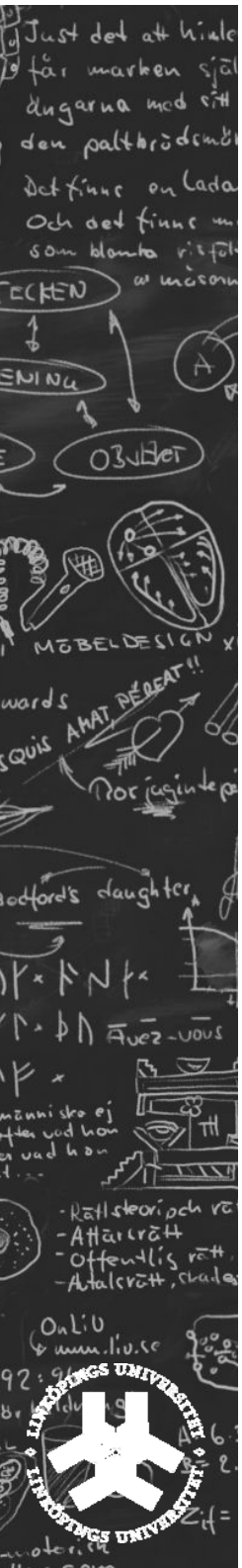
SeedingModel

- ◆ SingleRandomIndexCase

Property	Value	Lang
rdfs:comment		

AssumptionList

Submodels used in the scenario



Protégé tab for simulation job specification

VirSim Protégé 3.3.1 (file:AC:\cygwin\home\her\SimCode\SimModel\VirSim.pprj, OWL / RDF Files)

File Edit Project OWL Code Tools Window Help

OWLClasses Properties Forms Individuals Metadata (unnamed.owl) Scenarios Simulation jobs

SIMULATION JOB BROWSER

For Project: VirSim

Simulation jobs

- A09Job_All
- A09Job_All10
- A09Job_All100
- A09Job_Baseline
- A09Job_Baseline10
- A09Job_Basic
- A09Job_Basic10
- A09Job_Test
- A10Job_Special10
- SimulationJob_1
- SimulationJob_2
- SimulationJob_3
- SimulationJob_4
- SimulationJob_5
- SimulationJob_Longini_2004
- SusJob_Test

SIMULATION JOB INDIVIDUAL

For Instance: A09Job_All100 (instance of SimulationJob)

Name SameAs DifferentFrom

Name Comment

Name

A09Job_All100

SimulationMode R0

NumberOfCases 1

NumberOfDays 200

SimulationSeed 3400113

NumberOfSimulatorRuns 1000

PopulationSeed 653342432

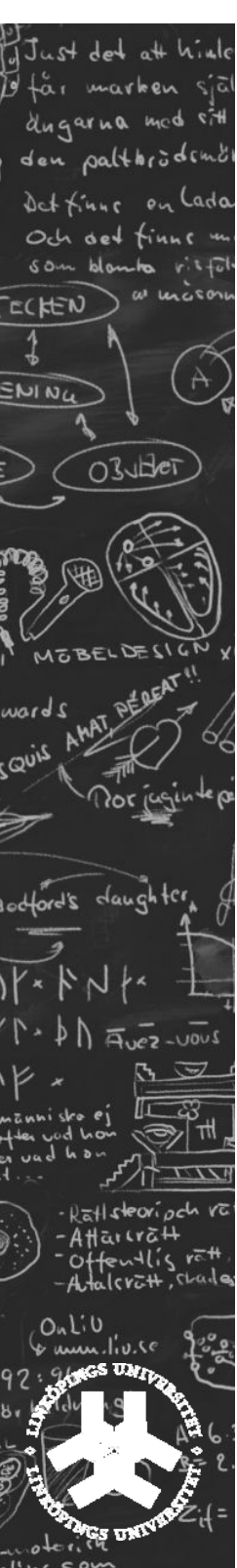
NumberOfGeneratedPopulations 100

ScenarioList

- A09_A2B1_Intervention
- A09_StayIndoorsA2B2_Asian
- A09_StayIndoorsA2B1_Intervention
- A09_StayIndoorsA2B2_European
- A09_StayIndoorsA2B2_Intervention
- A09_StayIndoorsA1B1_Intervention
- A09_A2B1_Asian
- A09_A1B2_Intervention
- A09_A1B1_European
- A09_StayIndoorsA1B1_European
- A09_Baseline
- A09_StayIndoors_Intervention
- A09_A1B2_European
- A09_StayIndoors_Asian
- A09_StayIndoorsA1B1_Asian
- A09_A2B1_European
- A09_A2B2_Intervention
- A09_StayIndoorsA2B1_European
- A09_StayIndoorsA1B2_Intervention
- A09_A1B1_Intervention
- A09_StayIndoorsA2B1_Asian
- A09_A2B2_European
- A09_A1B1_Asian
- A09_StayIndoorsA1B2_Asian
- A09_StayIndoorsA1B2_European
- A09_A2B2_Asian
- A09_A1B2_Asian
- A09_StayIndoors_European

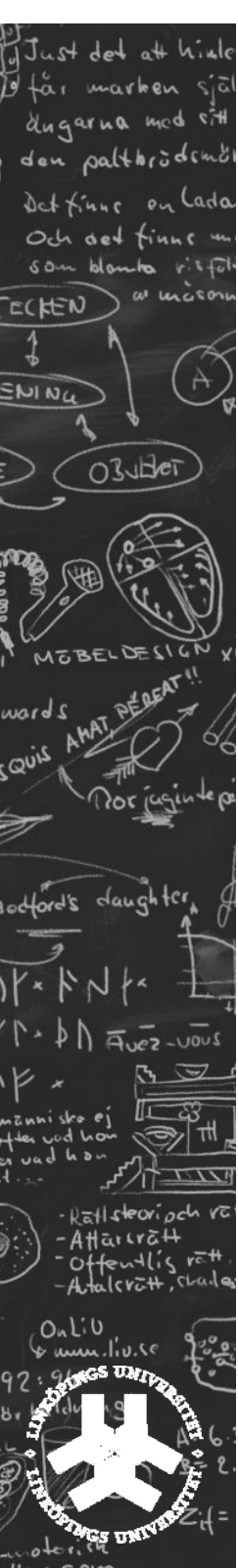
Job parameters

List of scenarios to simulate



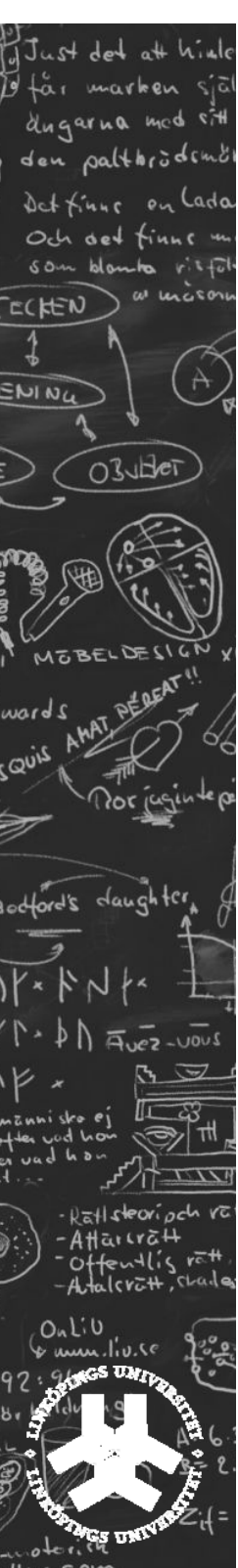
Simulation engine and computational environment

- Requirement
 - Interactive simulation
 - Dynamic scaling
- Problem
 - Supercomputers are fast, but using them takes too long time (job queues)
- Solution
 - Separation of modeling and execution environments
 - Protégé (Java) versus custom simulator (C++)
 - Condor
 - Pool of machines (basic resource)
 - Rent additional machines as needed (Amazon EC2)
 - Web application for managing simulation nodes and simulation jobs
 - Google Web Toolkit (GWT)

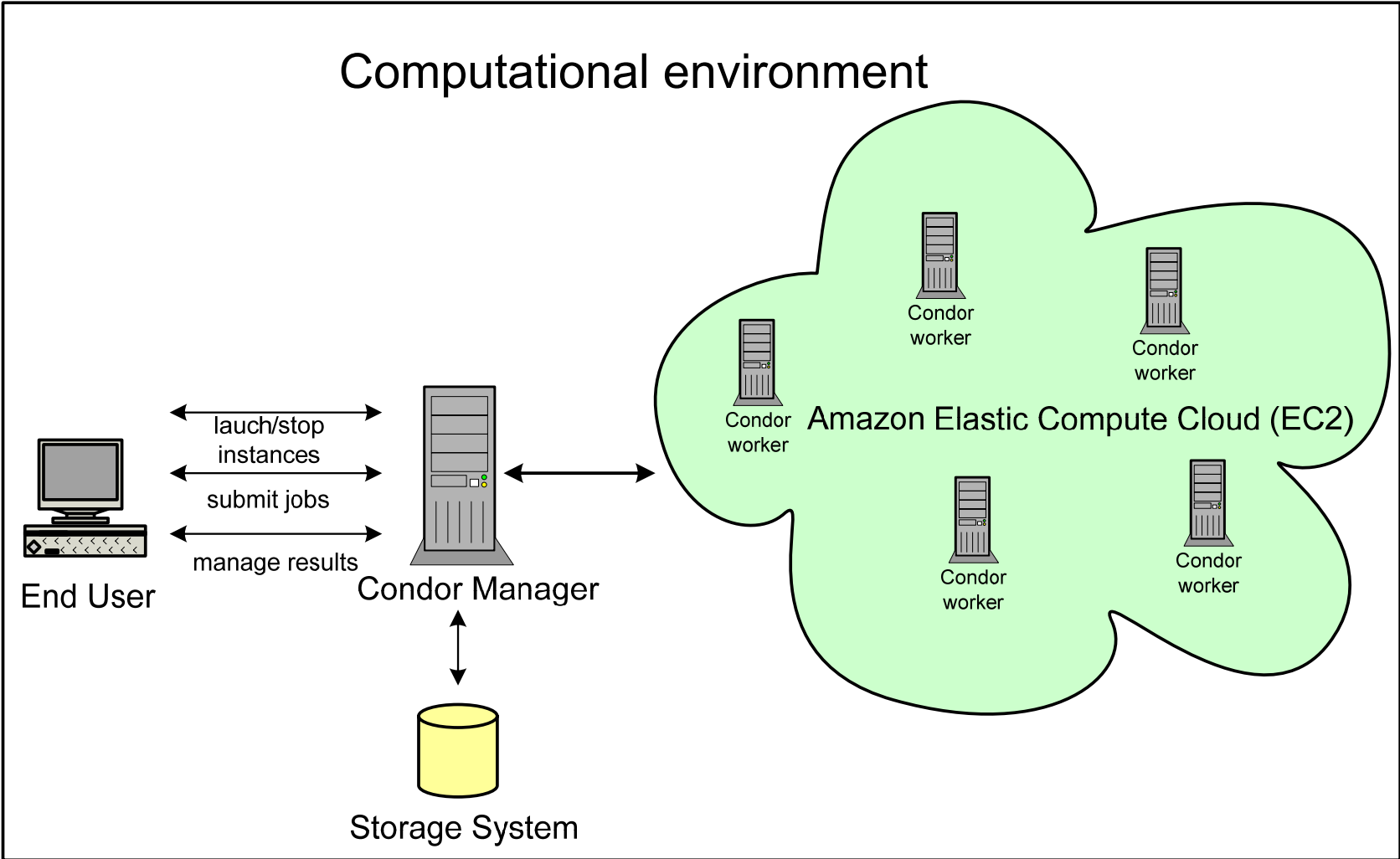


Computational environment

- The Condor platform
 - System for managing clusters of dedicated compute nodes
 - Workload management system for compute-intensive jobs
 - Batch system with a job queueing mechanism, scheduling, resource monitoring and management, etc.
 - Matching of resource requests (jobs) with resource offers (machines)
 - Developed by University of Wisconsin-Madison (UW-Madison)
- Condor components/actors
 - Condor manager
 - Collects information about the pool of machines
 - Manages the job queue
 - Dispatches tasks to workers
 - Condor workers
 - Machines that execute tasks
 - Storage system
 - Storage of input and output data



Computational environment (cont.)



Just det att hi...
fär marcken sjö...
dugarna med s...
den paltbröden...
det finns en lada...
och det finns m...
som blanda r...
at m...
EKEN
ENINA
O3UBer
MÖBELDESIGN
wards
EQUIS AMAT BÉREAT!!
Por j...
oodford's daughter
Y * K N t
P * D N Auez - vous
F *
männi sko ej
f... vad hon
er vad hon
- Rätt sk... och r...
- Att... rätt
- Offentlig rätt
- A... rätt, sk...
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92: 9...
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Web interface for Amazon EC2 management

The screenshot displays the Amazon EC2 management console. At the top, there are navigation tabs for HOME, AMAZON EC2, CONDOR, and SIMULATOR. The main content area is divided into two sections: 'AMI list' and 'Instance list'. The 'AMI list' section contains a table with one entry: ami-fc9d188, located at ec2-debworker.ida/debWorker.manifest.xml, in an available state, owned by 918301612798, and with private visibility. A yellow callout bubble points to this table with the text 'Bootable images (with Condor)'. To the right of the AMI list is a 'Run selected' button. The 'Instance list' section contains a table with one entry: reservation r-77c9ce03, using AMI ami-fc9d188, in a running state, with instance ID i-aba3a4df, public DNS ec2-79-125-40-194.eu-west-1, private DNS ip-10-226-39-65.eu-west-1, launched on 2009-05-14T09:02:47.000Z, and of type c1.medium. A yellow callout bubble points to this table with the text 'Running machines'. To the right of the Instance list are three buttons: 'Stop selected', 'Stop all', and 'Reboot selected'.

AMI-ID	Location	State	Owner	Visibility
ami-fc9d188	ec2-debworker.ida/debWorker.manifest.xml	available	918301612798	Private

Reservation-ID	AMI	State	Instance-ID	Public DNS	Private DNS	Launch time	Type
r-77c9ce03	ami-fc9d188	running	i-aba3a4df	ec2-79-125-40-194.eu-west-1	ip-10-226-39-65.eu-west-1	2009-05-14T09:02:47.000Z	c1.medium



Condor job queue

Two jobs running

Queue list - condor_q

ClusterId	ProcId	Status	Args	RemoteHost	JobPrio	RunTime	Submitted
197	0	Running	run1_A09_A2B1_Intervention-1.xml.tar.l	slot2@ec2-79-125-40-194.eu	0	0:00:09	5/14 11:02:47
197	1	Running	run1_A09_A2B1_Intervention-2.xml.tar.l	slot1@ec2-79-125-40-194.eu	0	0:00:09	5/14 11:02:47
197	2	Idle	run1_A09_A2B1_Intervention-3.xml.tar.l		0	0:00:00	5/14 11:02:47
197	3	Idle	run1_A09_A2B1_Intervention-4.xml.tar.l		0	0:00:00	5/14 11:02:47
197	4	Idle	run1_A09_A2B1_Intervention-5.xml.tar.l		0	0:00:00	5/14 11:02:47
197	5	Idle	run1_A09_A2B1_Intervention-6.xml.tar.l		0	0:00:00	5/14 11:02:47
197	6	Idle	run1_A09_A2B1_Intervention-7.xml.tar.l		0	0:00:00	5/14 11:02:47
197	7	Idle	run1_A09_A2B1_Intervention-8.xml.tar.l		0	0:00:00	5/14 11:02:47
197	8	Idle	run1_A09_A2B1_Intervention-9.xml.tar.l		0	0:00:00	5/14 11:02:47
197	9	Idle	run1_A09_A2B1_Intervention-10.xml.tar		0	0:00:00	5/14 11:02:47
197	10	Idle	run1_A09_A1B2_Intervention-1.xml.tar.l		0	0:00:00	5/14 11:02:47
197	11	Idle	run1_A09_A1B2_Intervention-2.xml.tar.l		0	0:00:00	5/14 11:02:47
197	12	Idle	run1_A09_A1B2_Intervention-3.xml.tar.l		0	0:00:00	5/14 11:02:47
197	13	Idle	run1_A09_A1B2_Intervention-4.xml.tar.l		0	0:00:00	5/14 11:02:47
197	14	Idle	run1_A09_A1B2_Intervention-5.xml.tar.l		0	0:00:00	5/14 11:02:47
197	15	Idle	run1_A09_A1B2_Intervention-6.xml.tar.l		0	0:00:00	5/14 11:02:47
197	16	Idle	run1_A09_A1B2_Intervention-7.xml.tar.l		0	0:00:00	5/14 11:02:47
197	17	Idle	run1_A09_A1B2_Intervention-8.xml.tar.l		0	0:00:00	5/14 11:02:47
197	18	Idle	run1_A09_A1B2_Intervention-9.xml.tar.l		0	0:00:00	5/14 11:02:47
197	19	Idle	run1_A09_A1B2_Intervention-10.xml.tar		0	0:00:00	5/14 11:02:47

Page 1 of 12 Displaying 1 - 25 of 280

Just det att hiale
fär marcken sjö
dugarna med sif
den paltbrödemö
det finne on lada
Och det finne m
som blanta rieföl
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QUIS AMAT REAT!!

Por jgunde p

oodford's daughter

Y * K N t x

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F x

männi stro ej
fies vad hon
er vad hon

- Rätt teori och r
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Simulation results

New and completed jobs

HOME AMAZON EC2 CONDOR SIMULATOR

JOB list

Job ID	Job name	Size	Status	Progress
1	AMIA2009-All	28	Completed	100%
2	AMIA2009-All-10	280	New	0%
3	AMIA2009-All-100	2800	New	0%
4	simpro	3	Completed	100%

Refresh
Submit selected
Add Job

Scenarios list

Name	Average R0	Standard Deviation of R0
test1_A09_A1B2_European	1.587	0.000
test1_A09_A1B1_Asian	1.717	0.000
test1_A09_A1B1_European	1.986	0.000
test1_A09_A1B1_Intervention	1.584	0.000
test1_A09_A1B2_Asian	1.462	0.000
test1_A09_StayIndoorsA1B1_European	0.987	0.000
test1_A09_StayIndoorsA1B1_Intervention	0.302	0.000
test1_A09_StayIndoorsA1B2_Asian	1.272	0.000
test1_A09_StayIndoorsA1B2_European	0.870	0.000
test1_A09_StayIndoorsA1B2_Intervention	0.307	0.000
test1_A09_StayIndoorsA2B1_Asian	0.665	0.000
test1_A09_A1B2_Intervention	1.372	0.000

Results overview

Just det att hiale
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dugarna med sitt
den paltbrödeb
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och det finns m
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at mäsom

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ENINA
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MÖBELDESIGN
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SQUIS AMAT DÉREAT!!
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er vad hon

- Rätt teori och r
- Att är rätt
- Offentlig rätt
- A taler rätt, stala

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Discussion and Conclusion

■ Summary

- Simulation of influenza outbreaks benefits from a clear separation of modeling and implementation
- Ontologies provide a suitable representation scheme for such epidemiological models
- Ontology management during a factual pandemic outbreak is supported by the maintenance of a scenario library with a collection of instances representing the scenarios

■ Implementation

- Modeling and simulation environment based on ontology models in Protégé
- Corresponding cloud-based execution environment

■ Continued work

- Improved flexibility of simulator engine
- Submitting simulation jobs from Protégé
- Controlling Amazon EC2 and Condor from Protégé
- Visualization of results

