Supporting Rich Participatory Mapping for Hybrid and Agent-Based Models: A Collaborative Web-Based Modeling Platform

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Innovations in Collaborative Modeling

2016

Agenda

- Motivations
- Vision
  - ABHM modeling language
  - Collaborative model mapping environment
- Demonstration
- Limitations
- Future Work

Three Modeling Eras

- Consult us, we'll bring you the answer
  - Generalist modelers, dependent end users
- Models built, distributed as "black boxes"
  - Tight constraints:Scenario assumptions&outputs
  - Limited end user understanding of assumptions
  - Slow, exogenous model evolution
- Agile (Collaborative, Adaptive) modeling
  - Interdisciplinary: Model building w/end users
  - Model relatively transparent to non-modelers
  - End user customized outputs
  - End users help evolve model assumptions
  - Model as living document, evolving with learning

Models as Thinking Tools

- Models help us *learn more quickly* by thinking through the implications of our assumptions more
  - Consistently, reliably & rigorously
  - Quickly
  - Thoroughly

  and thereby allow us to put whatever *empirical evidence* we have to better, more complete & effective use in
  - Informing our choices
  - Advancing our understanding (including by refining our models & our choice of data to collect)

Models as Boundary Objects

- When characterized in a transparent fashion, models can serve as a common point of understanding by diverse stakeholders
- Having this common point of understanding permits easier communication and sharing of intervention ideas
- *The modeling approach & software used often has a major impact on capacity for use of models as boundary objects*

A Spectrum of Participation

System Dynamics Models as Boundary Objects

- System Dynamics models have long served as effective boundary objects
- Causal loop diagrams can be understood very quickly by those from most backgrounds
- Stock and flow diagrams can be understood with a bit of guidance
- Often the model is finished following the participatory section

Recent Advances Support Using ABHMs as Boundary Objects

- Recent software advances permit declarative specification of ABHMs -- a focus on *what* is being modeled, less on the how
- Such specifications do support a strong and growing capacity to use ABHMs as boundary objects

ABMs: Long-time Status-Quo

Z:\LinuxHome\Usask\Research\NICH_THIMModel\thim-master\repast\sarah\src\THIM\Person.java - Notepad++ [Administrator]

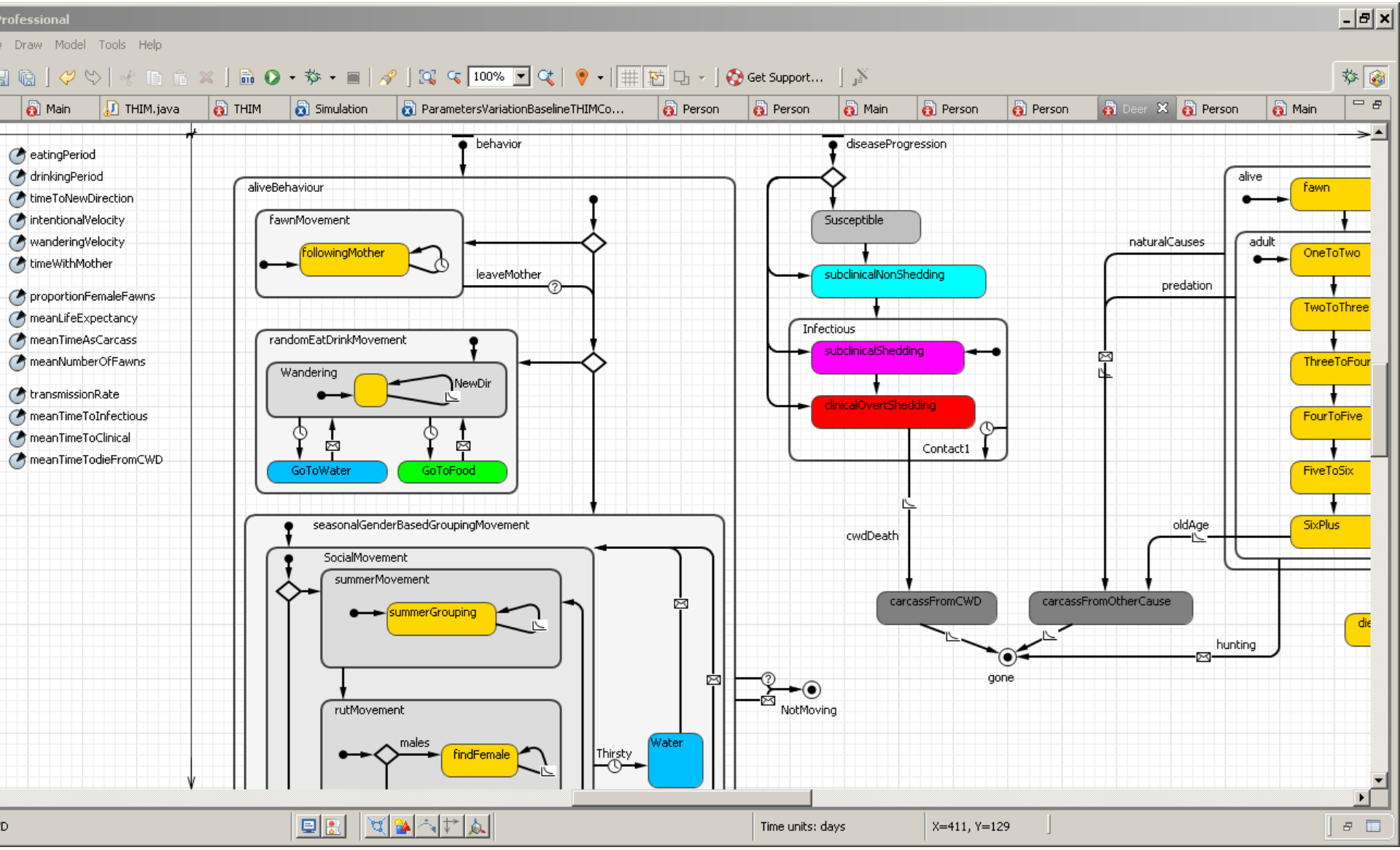
File Edit Search View Encoding Language Settings Macro Run TextFX Plugins Window ?

Movement.mpp | Abstract v1 | scala-output-100000 | new 1 | Person.java

```
316         }
317         if (willMove)
318         {
319             double dBestPropIncDiff = 1.0;
320             Context<?> mainContext = ContextUtils.getParentContext(this.myNeighborhood);
321             Neighborhood nBestNeighborhood = null;
322             for(Context<?> hoodContext : mainContext.getSubContexts())
323             {
324                 Neighborhood hood = (Neighborhood) hoodContext;
325                 if (hood.getAvgIncome() > 0 )
326                 {
327                     dPropIncDiff = Math.abs( this.income - hood.getAvgIncome()) / hood.getAvgIncome();
328                     if ( dPropIncDiff < dBestPropIncDiff)
329                     {
330                         nBestNeighborhood = hood;
331                         dBestPropIncDiff = dPropIncDiff;
332                     }
333                 }
334             }
335             if ( nBestNeighborhood != null && dBestPropIncDiff < stayPropIncDiff )
336             {
337                 this.setMyNeighborhood(nBestNeighborhood);
338             }
339         }
340     }
341
342     public void changeNeighborhood(Neighborhood bestNeighborhood)
343     {
344         if (this.home)
345             {this.home = false;}
346         for (Person child : this.myChildren)
347         {
348             child.myNeighborhood = bestNeighborhood;
349         }
350         this.myNeighborhood = bestNeighborhood;
351     }
```

Java source file | length : 13884 lines : 431 | Ln : 349 Col : 10 Sel : 0 | 0

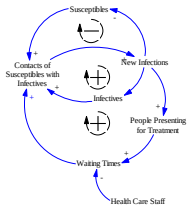
Declarative Languages: Present (AnyLogic)

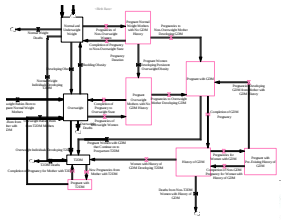


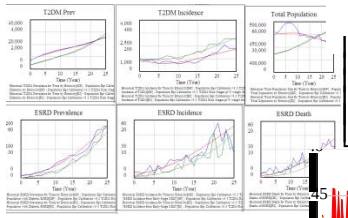
Stages of the ABHM Modeling Process

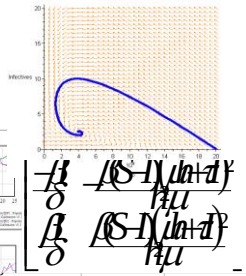
Mental Model

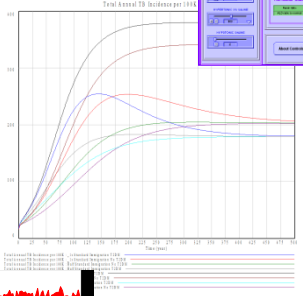
Problem Conceptualization	Qualitative Problem Mapping	Model Formulation	Model Calibration	Model Testing	Policy Evaluation	Knowledge Translation
Model scope/boundary selection. Model time horizon Identification of key variables Reference modes for explanation	Causal loop diagrams Stock & flow diagrams Policy structure diagrams Group model building	Specification of •Parameters •Quantitative causal relations •Decision rules Initial conditions	Reference mode reproduction Matching of intermediate time series Matching of observed data point Constrain to sensible bounds Structural sensitivity analysis	Parameter sensitivity analysis Cross-validation Robustness&extreme case tests Unit checking Problem domain tests Formal analysis	Specification & investigation of intervention scenarios Investigation of hypothetical external conditions Cross-scenario comparisons (CEA)	Learning environments/Microworlds/flight simulators

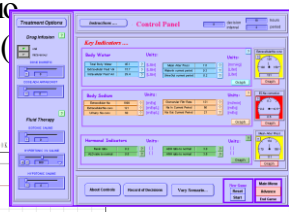


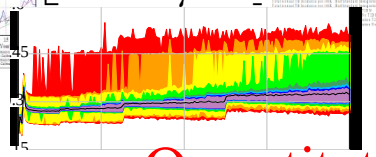












Qualitative &
Semi-quantitative insights

Quantitative insights

Stages of the ABHM Modeling Process

Very limited support available for ABHM model **mapping & conceptualization**

Comparatively strong support available for ABHMs

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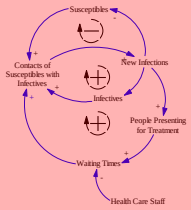

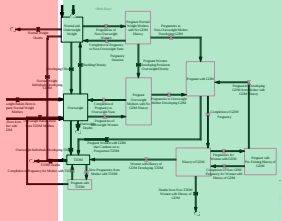

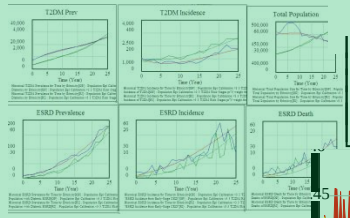

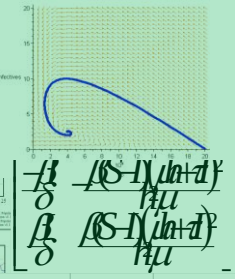

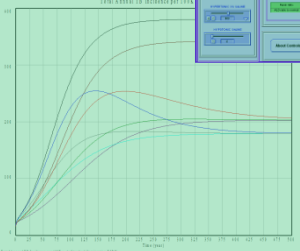

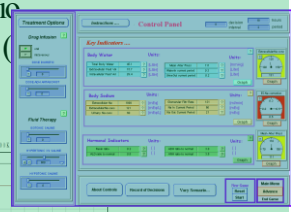

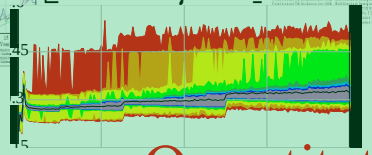

Qualitative & Semi-quantitative insights

Quantitative insights

Challenges with Model Mapping Status Quo: **Content**

- Stock and flow and causal loop diagramming are inadequate to capture agent-based&hybrid features
- Examples of major missing features
  - Separate characteristics of distinct agents
  - Multi-level context
  - Capturing of relevant agent environmental context
    - One or more types of network links
    - Spatial context
  - Structured characterization of existing & dynamics with respect to categorical state

Challenges with Model Mapping Status Quo: **Process**

- Limited to co-located individuals
- Hard to scale effectively to large participant pools
  - Privileged record keeper : power structure issues
  - Difficulty seeing a projected diagram
  - Constrained access to physical representation
- Difficulty in communicating to audiences with multiple languages
- Justification/stories are lost
- Commonly reliance on hand-built diagrams

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VISION: SOFTWARE SUPPORTING COLLABORATIVE MAPPING WITH ABHM SPECIFIC LANGUAGE

Central Elements of an Agent & Hybrid Qualitative Modeling Language

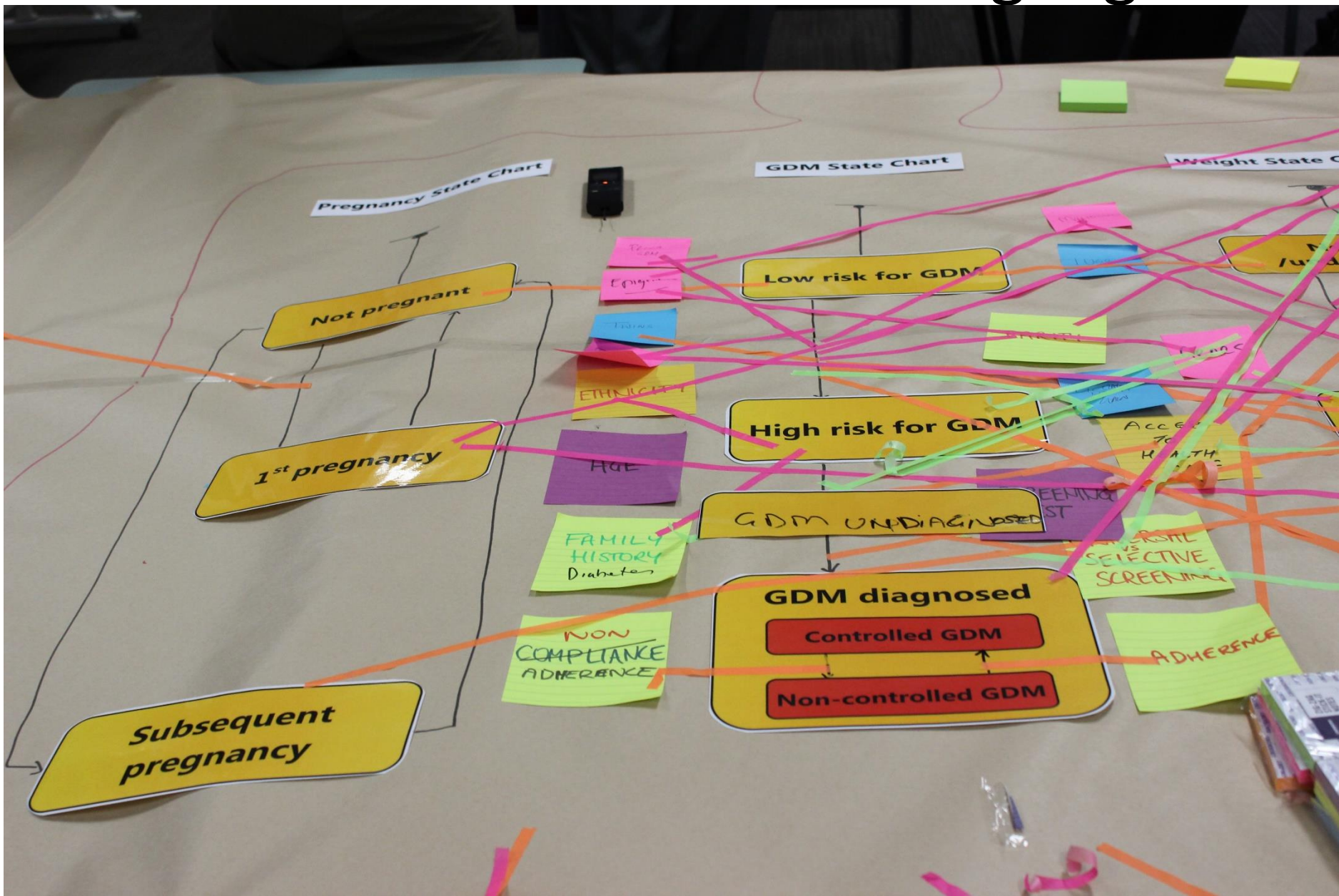
- Agent
- Connections (with polarity)
- Parameters
- Elements of State
  - Stocks & flows
  - Statecharts (state, actions, rules)
    - States
    - Transitions
    - Branches
    - Final state
  - Generic variable
- Interventions
- Environment
  - Networks
  - Geographic context
  - Spatial context
- Flexible use of connections
- Decisions
- Indication of feedback loops
- Text annotations

MANUAL USE OF OUR ABHM LANGUAGE

Manual Use of the ABHM Language 1

Manual Use of the ABHM Language 2

Manual Use of the ABHM Language 3



Manual Use of the ABHM Language 4

Challenges of hand-built diagrams

- Messy
- Changes burdensome
- Sometimes unreliable
- Limited confines of space

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Collaborative Software Vision for ABHM Mapping

- “Google docs/Office365” for ABHM mapping
- Easy way for multiple distributed users to collaborate while building up ABHM diagram
- Simple sharing mechanism
- Accessible by multiple types of devices
- Small, simple feature set
- Scalable with users
- Performant

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DEMONSTRATION

Accessing the System

- To follow along viewing the presentation
  - Go to http://tinyurl.com/ICM2016ViewCL
  - Press “Authenticate” button
  - Watch
- To create a presentation
  - Go to http://tinyurl.com/ICM2016CreateCL
  - Press “Authenticate” button (if you didn’t above)
  - Add variables, etc.

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Limitations

- Views only synched when complete item being altered
- Missing items from tool set
  - State entry points
  - Events
- Lack of hierarchical “hiding” mechanisms
- Aesthetically limited diagrammatic conventions (e.g., for flows)

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Features Seeking to Add

- Multilingual toggle/superposition
- Option of recording explanatory metadata
  - Link creation: Justification/stories
  - Link browsing & modification: Recording of multi-way discussion
- Pointing
- “Auditing” to record who changed what and at what time
- Possible combination with collaborative causal loop diagramming tool
- Expansion to support simulation

Conclusions

- Traditional causal loop & stock / flow diagramming methods offer a poor fit for ABHM mapping
- Traditional diagramming methods for participatory modeling offer significant limitations
- We have created an OSS collaborative modeling tool supporting simultaneous, interactive causal loop diagramming by physically distributed or co-located participants using multiple device categories
- Despite limitations, early experience suggests great potential for such collaborative software

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- Garrett Hansen
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  - Jordan Wong
  - Chin Wang Lau
  - Angela Stankowski
  - Darvin Zhang
- Carl Gutwin

Intermediate Agent-Based Modeling Bootcamp & Incubator 2016 (Aug. 22-27)

- Detailed "hands-on" coverage of building, calibrating & using agent-based & hybrid health models
- Diverse health application case studies
- Instructor & TA assistance in building up models customized to participant's interest
- Dozens of example health models, step-by-step exercises building health ABHMs
- Discussion of modeling process best practices
- Coverage of sensitivity analysis, calibration, debugging
- Detailed tutorials on computational essentials
- modelingtutorials@cs.usask.ca