Playing God:

Modeling and Simulation in Philosophy Classroom

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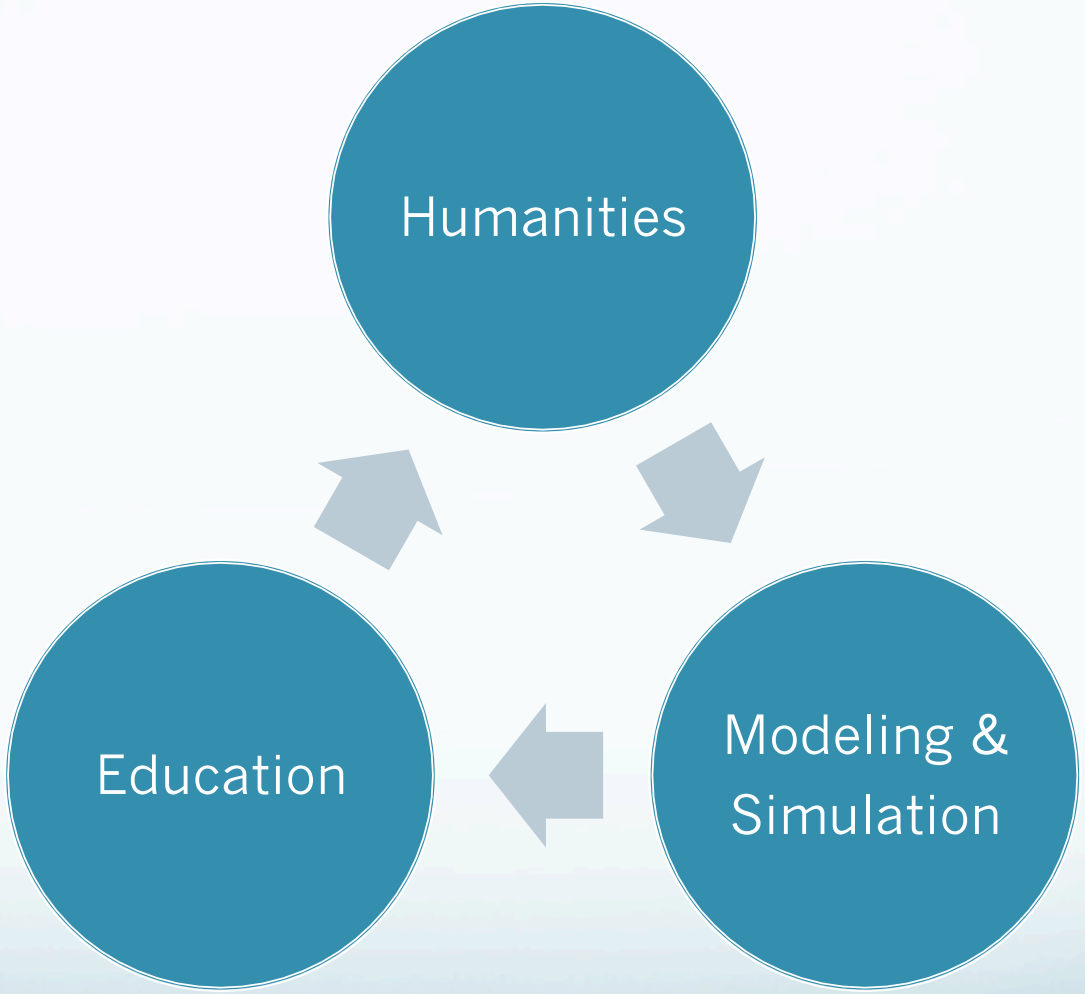
Outline

- Introduction
- The Love Story
- The Art of Modeling
- Spreadsheet as a Platform
- Simulation in Philosophy Classroom
- Conclusion


Humanities
Modeling & Simulation
Education

Digital Humanities & Humanities of the Digital

How the *Cybernetic Turn* enhances research, learning and teaching of humanities?

Education

Constructionism

Awakening the "Bricoleur Spirit"

"The role of the teacher is to create the conditions for invention rather than provide ready-made knowledge."

"Here I am suggesting that in the most fundamental sense, we, as learners, are all *bricoleurs*."

(Seymour Papert)

Modeling
&
Simulation

- A target can be represented as a model
- The model can be simulated
- The simulation is a *dynamic model* of the target

Romeo and Juliet

A Love Story Simulation

Romeo and Juliet

Juliet loves Romeo more when he loves her more

Romeo loves Juliet less when she loves him more

Formally:

$$L_J = s_J L_R$$

$$L_R = -s_R L_J$$

where:

L_J - love of Juliet

L_R - love of Romeo

s_J - Juliet's sensitivity

s_R - Romeo's sensitivity

Love Story Excel Simulation

t	Romeo Love	Juliet Love		Sensitivity of	Sensitivity of Juliet		
1	10	0		0.36	0.3		
2	10	3					

=B2-E2*C2

=C2+B2*F2

Love Story Excel Simulation

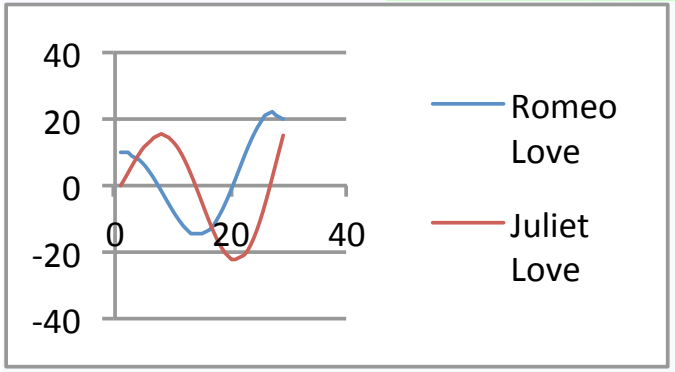
t	Romeo Love	Juliet Love		Sensitivity of Romeo	
1	10	0		0.36	
2	10	3		Sensitivity of Juliet	
3	8.92	6		0.3	
4	6.76	8.676			
5	3.63664	10.704			
6	-0.2168	11.794992			
7	-4.4629971	11.729952			
8	-8.6857798	10.3910529			
9	-12.426559	7.78531891			
10	-15.229274	4.05735125			
11	-16.68992	-0.5114309			
12	-16.505805	-5.5184069			
13	-14.519179	-10.470148			
14	-10.749925	-14.825902			
15	-5.4126004	-18.05088			
16	1.08571621	-19.67466			
17	8.16859367	-19.348945			
18	15.1342138	-16.898367			
19	21.2176258	-12.358103			
20	25.6665427	-5.9928148			

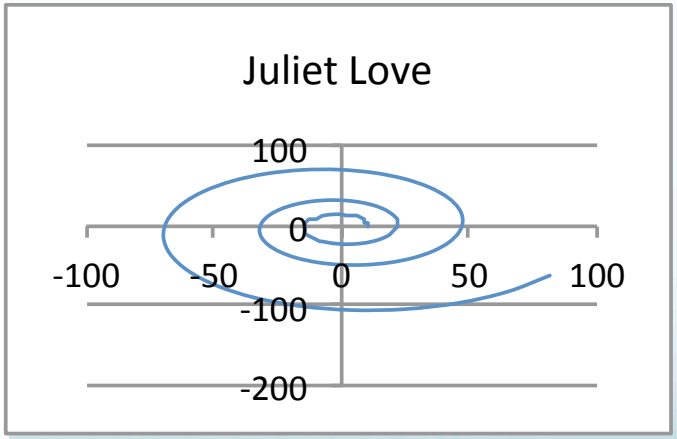
Love Story Excel Simulation

t	Romeo Love	Juliet Love
1	10	0
2	10	3.1
3	9.38	6.2
4	8.14	9.1078
5	6.31844	11.6312
6	3.9922	13.5899164
7	1.27421672	14.8274984
8	-1.69128296	15.2225056
9	-4.73578408	14.6982079
10	-7.67542565	13.2301148
11	-10.3214486	10.8507329
12	-12.4915952	7.65108378
13	-14.0218119	3.77868928
14	-14.7775498	-0.5680724
15	-14.6639353	-5.1491129
16	-13.6341127	-9.6949328
17	-11.6951262	-13.921508
18	-8.91082462	-17.546997
19	-5.40142525	-20.309352
20	-1.33955475	-21.983794

Sensitivity of Romeo
0.2

Sensitivity of Juliet
0.31





Math Models of Dynamic Systems

- Function of time
- Differential Equation
- Difference Equation

Mathematical Models

Model	Equation
Function of time	$x(t) = Ae^{\nu+t} + Ae^{\nu-t}$
Differential Equation	$m\ddot{x} + c\dot{x} + kx = 0$
Difference Equation	$x_{n+1} = x_n + y_{n-1} - \frac{c}{m}x_{n-1} - \frac{k}{m}y_{n-1}$

Characteristics of Math Models

- **Complexity** – the minimal number of symbols containing the complete information about the model
- **Comprehensibility** – the ability of the model to be understood
- **Constructability**– the ability of the model to be created, constructed

Comparison of Math Models

Model	Simplicity	Comprehensibility	Constructability
Function of time	Low	High	Low
Differential Equation	High	Low	Low
Difference Equation	High	High	High

Complexity of math models

Function of time vs. *Differential Equation*

$$x(t) = Ae^{\nu+t} + Ae^{\nu-t}$$

$$m\ddot{x} + c\dot{x} + kx = 0$$

Exponential gap:

one of the representations is a "derivation" of the other

Comprehensibility of math models

Function of time vs. *Differential Equation*

$$x(t) = Ae^{\nu+t} + Ae^{\nu-t}$$

$$m\ddot{x} + c\dot{x} + kx = 0$$

The Function of time is complex but comprehensible, while the differential equation is simple but non-comprehensible

Question: Is it the intrinsic feature of humans or the result of modernity education?

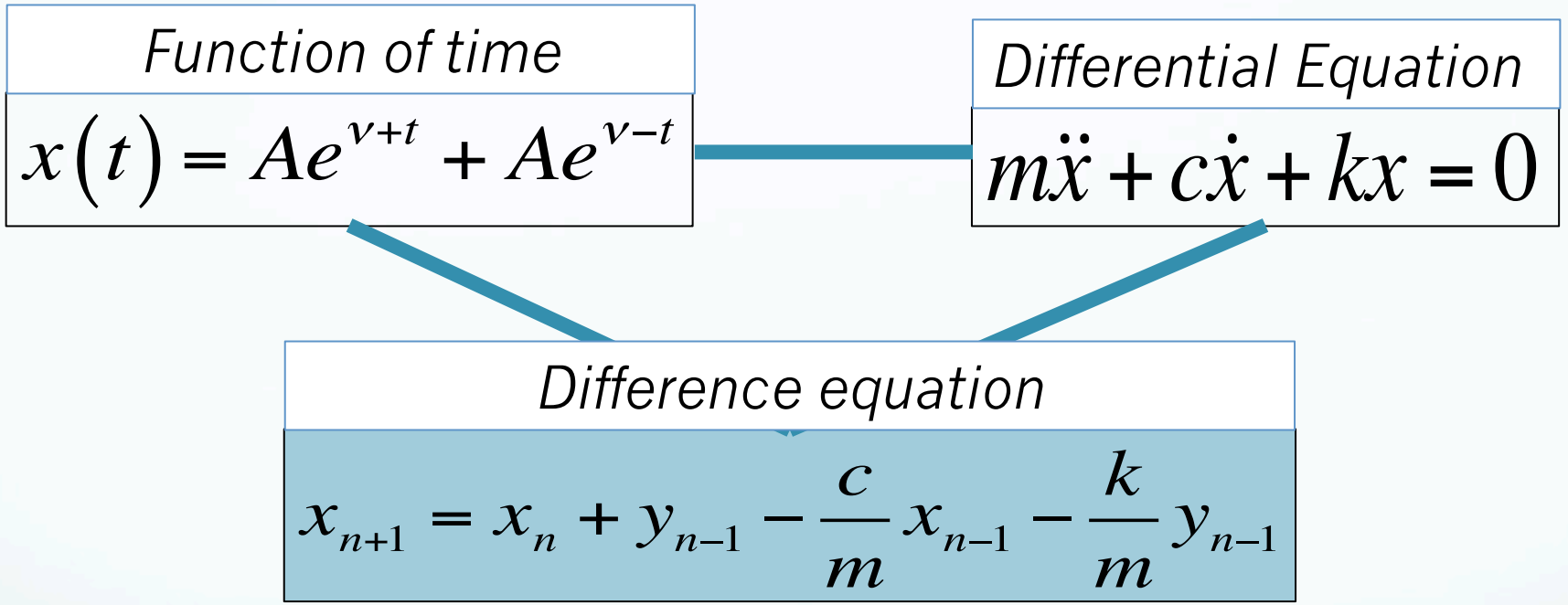
Difference equation

$$x_{n+1} = x_n + y_{n-1} - \frac{c}{m} x_{n-1} - \frac{k}{m} y_{n-1}$$

Difference equation is the function of previous *states* but not a function of time.

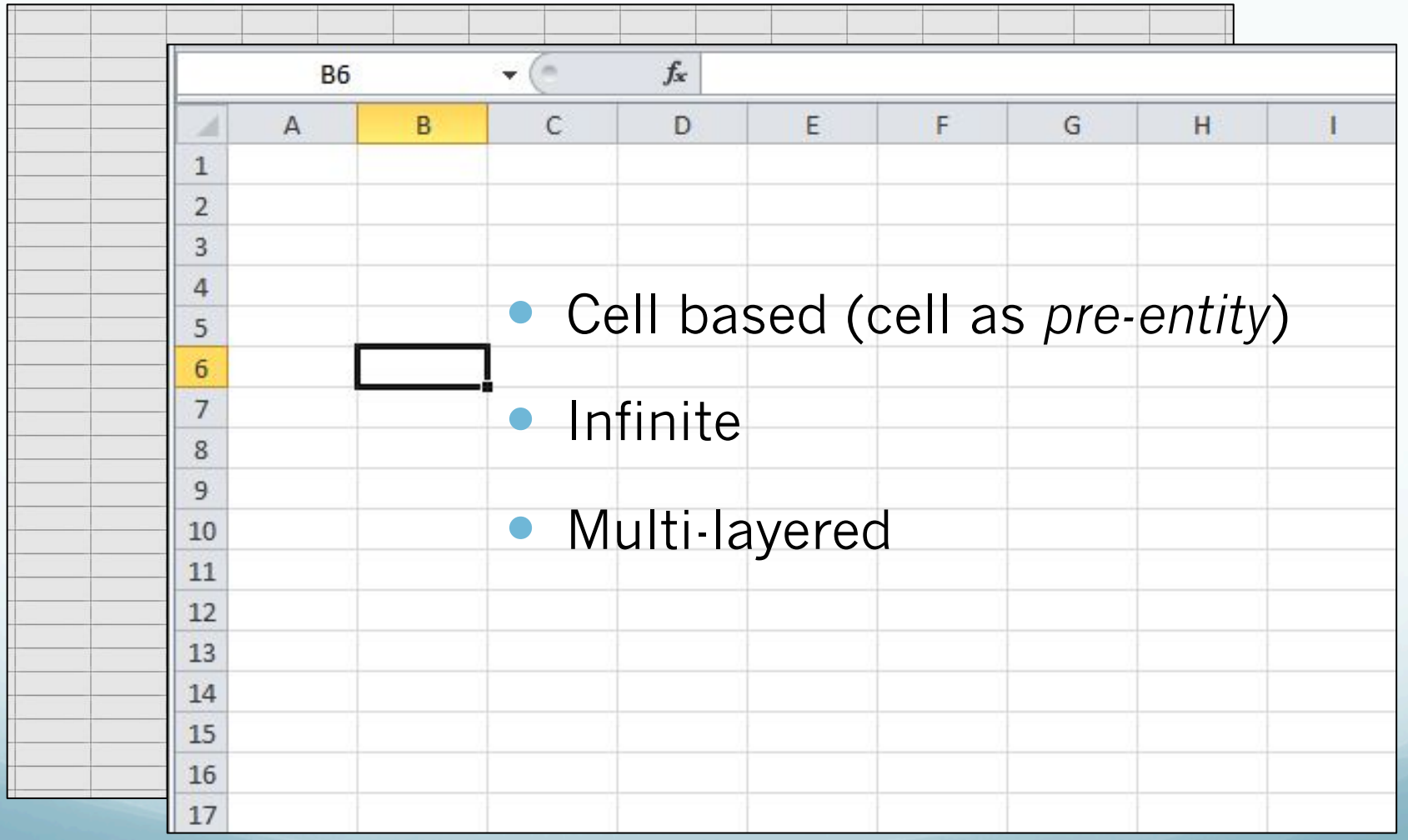
The difference equation can be considered as a simple numerical sequence

Constructability of math models



Only Difference equation is Constructable!

EXCEL – ontologically neutral platform



- Cell based (cell as *pre-entity*)
- Infinite
- Multi-layered

Simulation in philosophy class

- Construction
- Explanation
- Prediction
- Experimentation
- Discovery
- Justification

Construction

- The student is involved in active creation of the scenario
- The process of modeling includes decisions about:
  - The ontology of the scenario, kind of entities relevant for the scenario.
  - Types of description of the “entities” and their properties and interactions
- The student have to be considered as the “creator” or the designer of the simulated world
- The point of view of the “creator” calls for ontological creativity but also for precision and responsibility
- The creator, for a while, is looking on the simulation from the God’s point of view

Explanation

- In the philosophy class, one of the main objectives is to explain and understand the universe around us
- As to the tragic love scenario, the student stands before it in a philosophical puzzlement:
  - Why do things happen this way, as if guided by tragic destiny?
  - Why it happens that Romeo and Juliet, attracted to one another so much, create a lethal relationship?
  - Are they rational free agents?
  - Can Romeo and Juliet be rational free agents and still be captured by a predetermined tragic destiny?
- The love affair poses a riddle but the simulation can be a key for understanding

Prediction

- The simulation can lead to hypotheses predicting the future from the past
- The model can be extrapolated in time, space and other dimensions
- The possibility to generate predictions is a source of novelty, surprise and creativity
- A prediction can be verified, corroborated, refuted and evaluated in multiple dimensions
- The ability to predict is one of the main achievements of sciences and technology
- Combining modeling and simulation in humanities may expand vision of the future

Experimentation

- The simulation is a platform for almost unlimited experimentation. All the variables of the simulation are controllable
- By experimenting with parameters and initial conditions, various scenarios can be simulated
- A number of challenging problems can be explored. For example:
  - Can Juliet or Romeo change their destiny?
  - What is the key for realization of their love?

Discovery

- The simulation is a platform for discovery
- The simulation can be a source of surprises, from discovery of unpredicted phenomena up to discovery of an unnoticed disguised “law”
- Accidental discoveries are the most interesting ones. In the love affair, a kind of cyclic dynamics can be discovered

Justification

- The simulation is a platform for justification of theories and hypotheses
- Finding adequate methods for justification of scientific theories is still an open problem
- Simulation may give a kind of confirmation or refutation of theories

Conclusions

- A new approach for studying humanities is proposed, namely a synthesis oriented learning activity by creating simulations
- The proposed way of creating simulations is based on:
  - Constructionism as an educational paradigm
  - Difference equations as a math model
  - Spreadsheet as an ontologically neutral simulation platform
- Such a way of creating simulations enables the student to study philosophical problems from an unexpected but enriching point of view