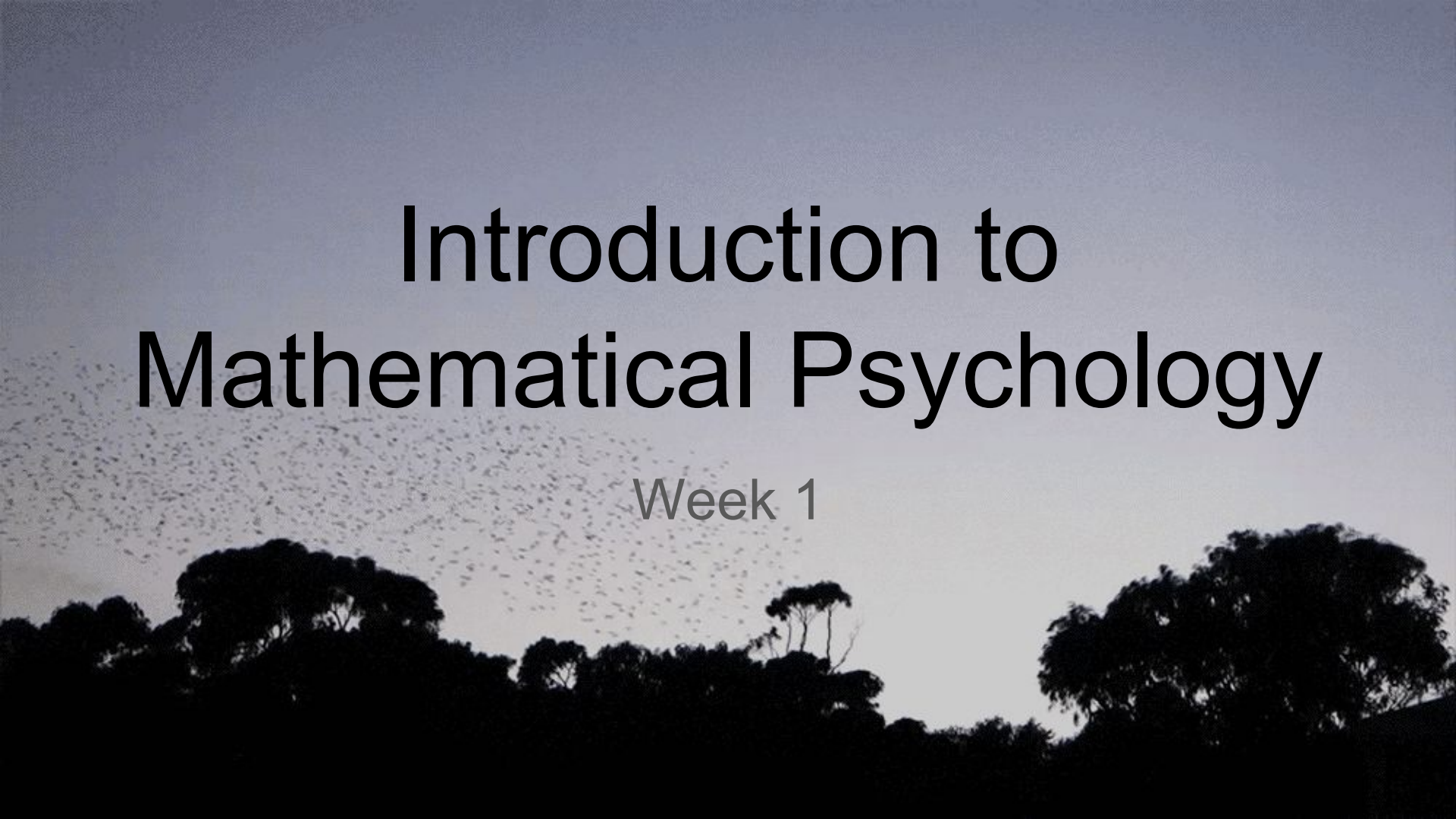


Introduction to Mathematical Psychology

Week 1

Typical Forgetting Curve for Newly L

First learned

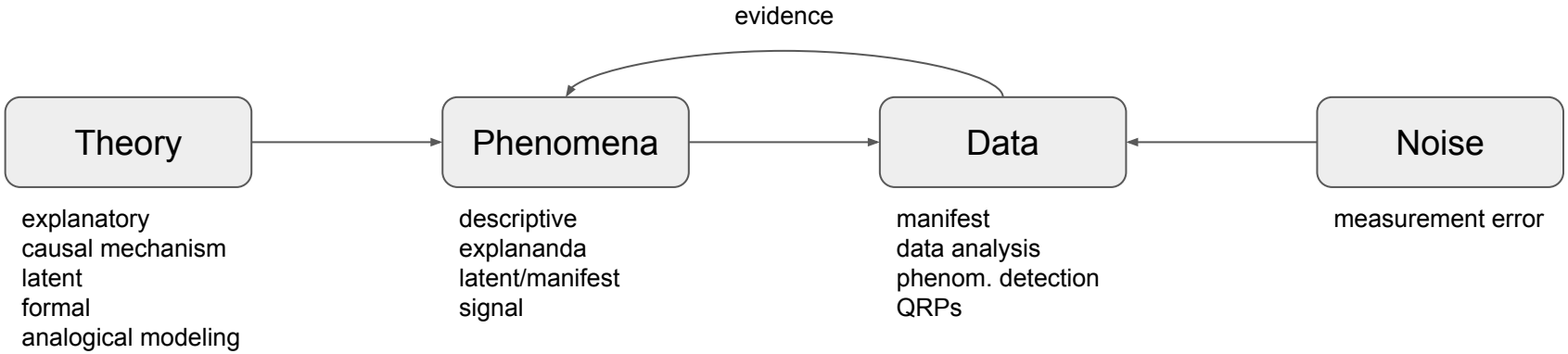
	Classics.	French.	English.	Mathem.	Discrim.	Music.
Classics,	0.87	0.83	0.78	0.70	0.66	0.63
French,	0.83	0.84	0.67	0.67	0.65	0.57
English,	0.78	0.67	0.89	0.64	0.54	0.51
Mathem.,	0.70	0.67	0.64	0.88	0.45	0.51
Discrim.,	0.66	0.65	0.54	0.45	0.40	0.40
Music,	0.63	0.57	0.51	0.51		

4 5 6 7

Days

Altogether, we have a uniformity that is very nearly perfect and far surpasses the conceivable limits of chance coincidence.

Abductive theory of scientific method



Course

Learn the concept of a formal theoretical model, as an aid in understanding cognitive processes; and get familiar with three leading approaches, to understand the basic concepts of math. psychology.

4 weeks / 3 topics / 1 project

Week 1
Alexander Savi
Introduction & growth models in intelligence

Week 3
Han van der Maas
Catastrophe models in psychology

Week 2
Leendert van Maanen
Diffusion models in decision making

Week 4
You
Research project

Schedule

	In class	At home
Mo 4	Introduction & growth models (AS)	Assignment
Th 7	Tutorial growth models (AS)	Assignment
Mo 11	Lecture diffusion models (LvM)	Assignment
Th 14	Tutorial diffusion models (LvM)	Assignment
Mo 18	Lecture catastrophe models (HvdM)	Assignment
Th 21	Tutorial catastrophe models (HvdM)	Assignment
Mo 25	Research project (you)	Research project
Th 28	*Research project (you)*	Research project
	Time 13:00-15:00; location JK B.26 *Time 12:00-14:00; location G S.08*	Slides on www.alexandersavi.nl/teaching/

Grading

Assignments

- Various assignments for each topic
- Pass / fail

Research project

- Pick a topic from the assignments / tutorials
- Extend the topic with an idea of your own
- Write a report or research proposal about it
- Use about 2000 words
- Upload report (pdf) before June 29th, 18:00
- Graded (final grade)

Growth models in intelligence #1

JOURNAL OF THE ROYAL SOCIETY Interface

rsif.royalsocietypublishing.org

Review

CrossMark click for updates

Cite this article: Perc M. 2014 The Matthew effect in empirical data. *J. R. Soc. Interface* **11**: 20140378.
http://dx.doi.org/10.1098/rsif.2014.0378

Received: 10 April 2014
Accepted: 10 June 2014

The Matthew effect in empirical data

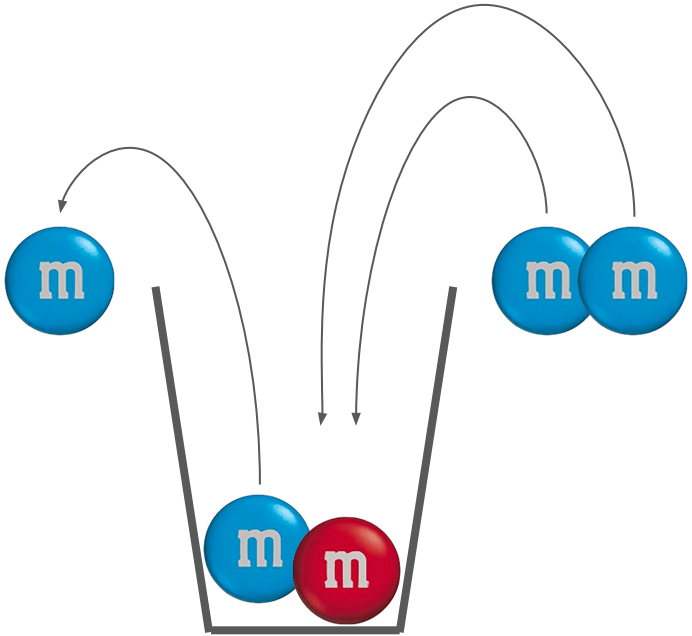
Matjaž Perc

Faculty of Natural Sciences and Mathematics, University of Maribor, Koroška cesta 160, 2000 Maribor, Slovenia

MP, 0000-0002-3087-541X

The Matthew effect describes the phenomenon that in societies, the rich tend to get richer and the potent even more powerful. It is closely related to the concept of preferential attachment in network science, where the more connected nodes are destined to acquire many more links in the future than the auxiliary nodes. Cumulative advantage and success-breads-success also both describe the fact that advantage tends to beget further advantage. The concept is behind the many power laws and scaling behaviour in empirical data, and it is at the heart of self-organization across social and natural sciences. Here, we review the methodology for measuring preferential attachment in empirical data, as well as the observations of the Matthew effect in patterns of scientific collaboration, socio-technical and biological networks, the propagation of citations, the emergence of scientific progress and impact, career longevity, the evolution of common English words and phrases, as well as in education and brain development. We also discuss whether the Matthew effect is due to chance or optimization, for example related to homophily in social systems or efficacy in technological systems, and we outline possible directions for future research.

Pólya's urn



Explore

Parameters

What are they? What is their influence?

Compensation effect

What is it? Can you create it?

Do the smart get smarter? Development of fluid and crystallized intelligence in 3rd grade☆

Ulrich Schroeders [a,*], Stefan Schipolowski [b], Ingo Zettler [c], Jessika Golle [d], Oliver Wilhelm [e]

[a] Department of Educational Science, University of Bamberg, Germany
[b] Institute for Educational Quality Improvement, Humboldt-Universität zu Berlin, Germany
[c] Department of Psychology, University of Copenhagen, Denmark
[d] Hector Research Institute of Education Sciences and Psychology, University of Tübingen, Germany
[e] Department of Psychology and Education, Ulm University, Germany

ARTICLE INFO

Article history:
Received 22 March 2016
Received in revised form 10 August 2016
Accepted 10 August 2016
Available online 21 August 2016

ABSTRACT

There are conflicting theoretical assumptions about the development of general cognitive abilities in childhood: On the one hand, a higher initial level of abilities has been suggested to facilitate ability improvement, for example, prior knowledge fosters the acquisition of new knowledge (*Matthew effect*). On the other hand, it has been argued that school education with its special focus on promoting less able students results in a compensation effect. A third hypothesis is that the development of cognitive abilities is—as an outcome of the opposing effects—overall independent of the initial state. In this study, 1,102 elementary students in 3rd Grade worked

...time points with an interval of five

...related (Matthew vs. compensation effect), we

...(*gf*) and crystallized intelligence (*gc*) as well as cross-lagged

...background (socio-economic status, parental education) and classroom characteristics (teaching

...) in a series of prediction models to explain these changes in *gf* and *gc*. Although several predictors were included, only few had a significant contribution. Several methodological and content-related reasons are discussed to account for the unexpectedly negligible effects found for most of the covariates.

Next Thursday

Make groups of three

Identify a phenomenon

Identify the (type of) data that support the phenomenon

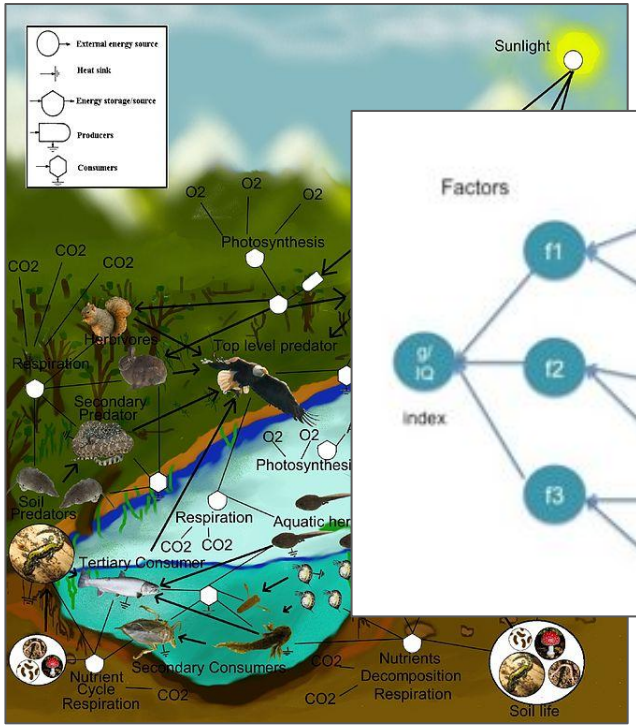
Identify a formal theory that explains the phenomenon

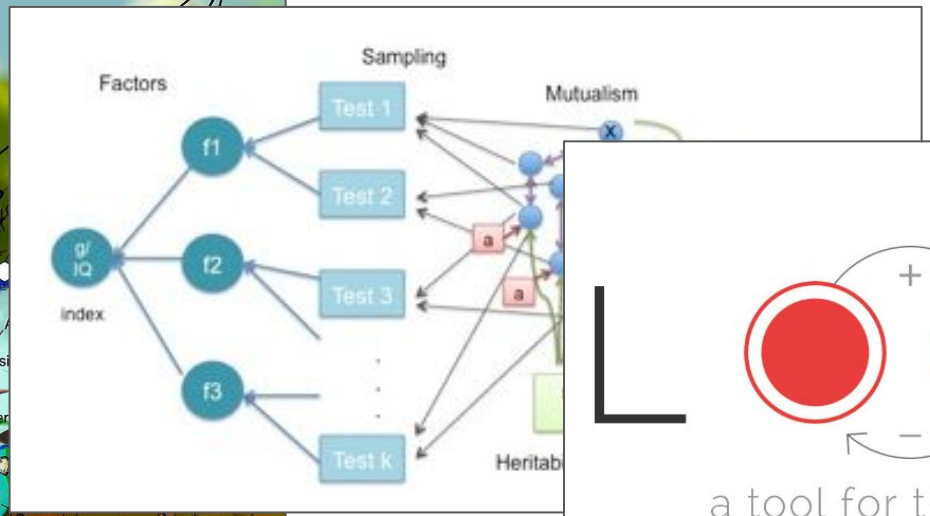
Identify the mechanisms that explain the phenomenon

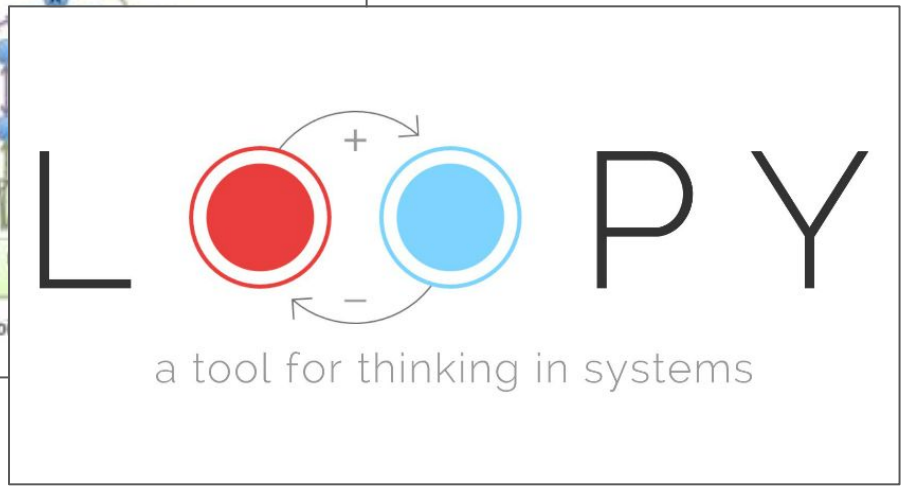
Present it on Thursday

Presentations

Thinking in systems





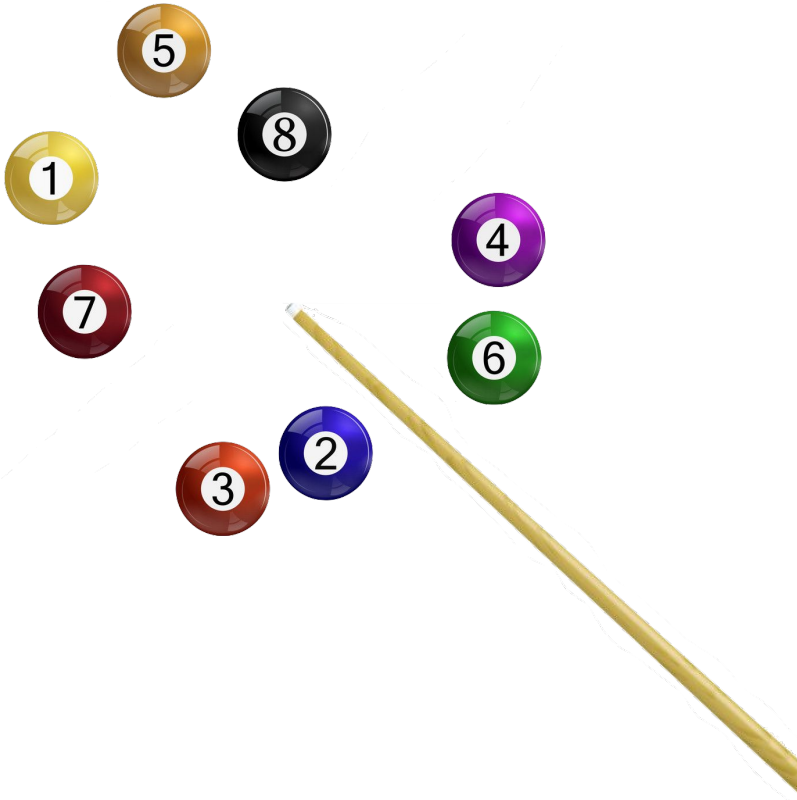


[comorbidity from a network perspective]

Thinking in systems

Warren Weaver

- simplicity
- disorganized complexity
- organized complexity



Levels of description

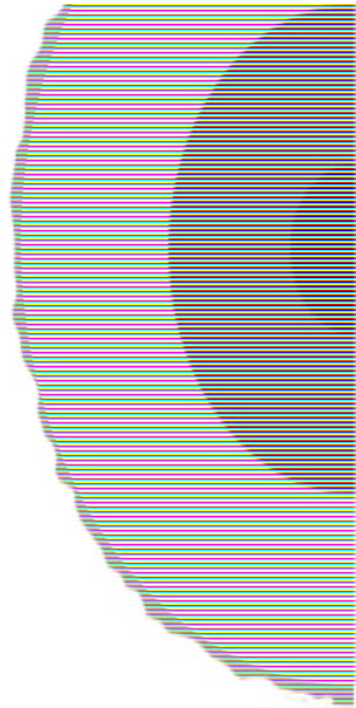
High (“executive summary”)

Low (“technical specifications”)

Levels of analysis

David Marr & Tomaso Poggio

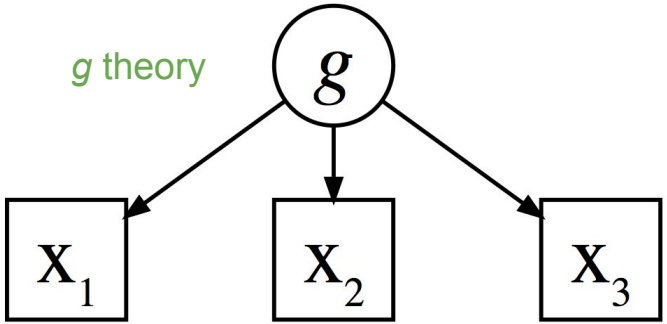
- learning level
- computational level
- algorithmic/representational level
- implementational/physical level



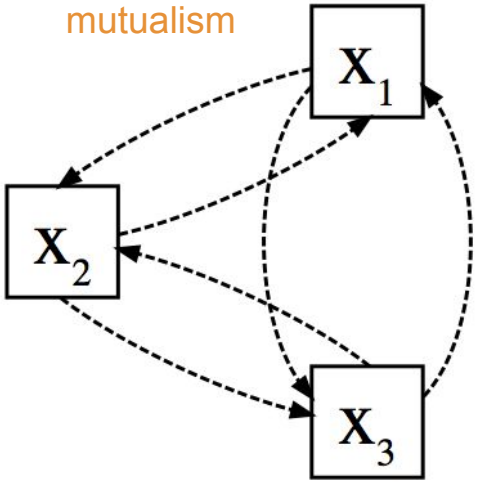
“All models are wrong; some models are useful.” - George Box

Growth models in intelligence #2

g theory



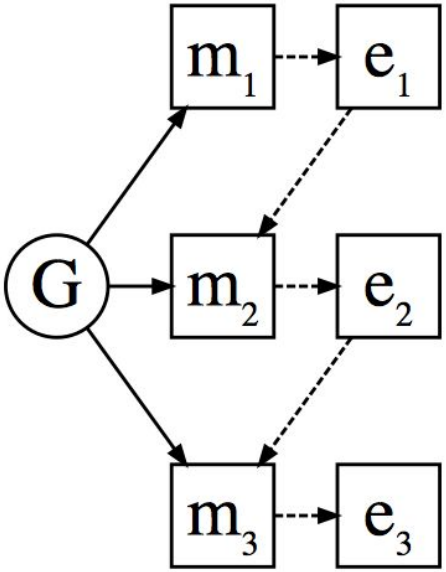
mutualism



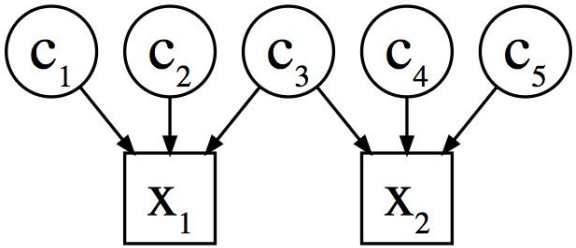
	Classics.	French.	English.	Mathem.	Discrim.	Music.
Classics,	*0.87*	0.83	0.78	0.70	0.66	0.63
French,	0.83	*0.84*	0.67	0.67	0.65	0.57
English,	0.78	0.67	*0.89*	0.64	0.54	0.51
Mathem.,	0.70	0.67	0.64	*0.88*	0.45	0.51
Discrim.,	0.66	0.65	0.54	0.45		0.40
Music,	0.63	0.57	0.51	0.51	0.40	

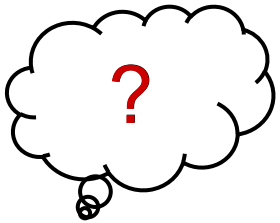
Altogether, we have a uniformity that is very nearly perfect and far surpasses the conceivable limits of chance coincidence.

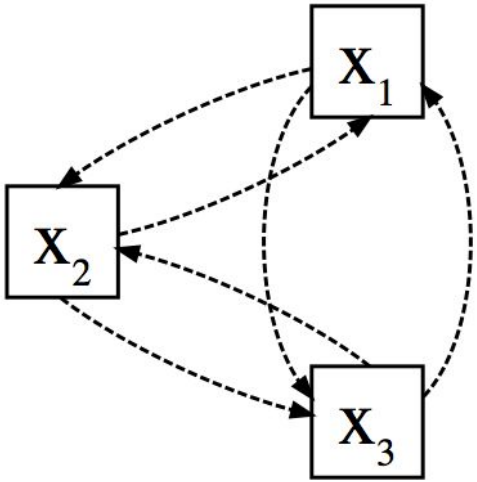
multiplier effect

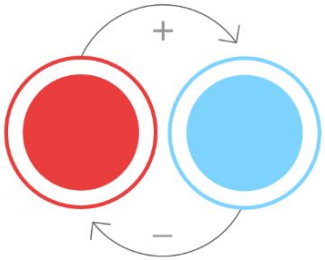


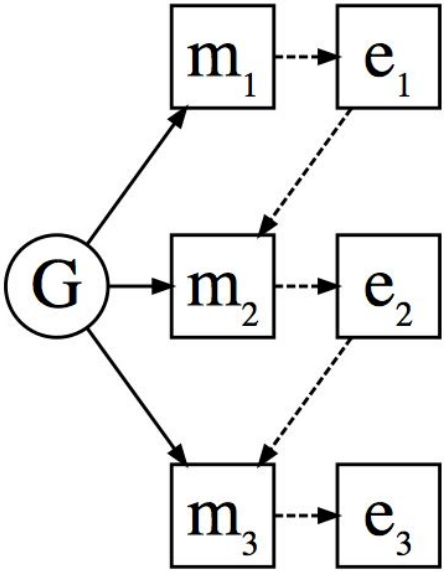
sampling



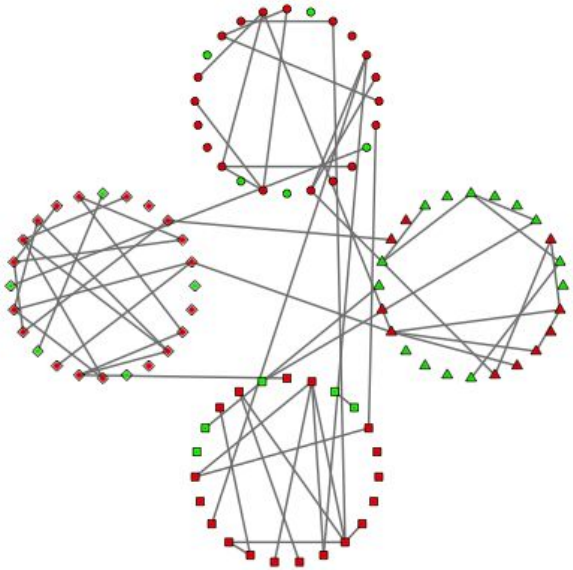


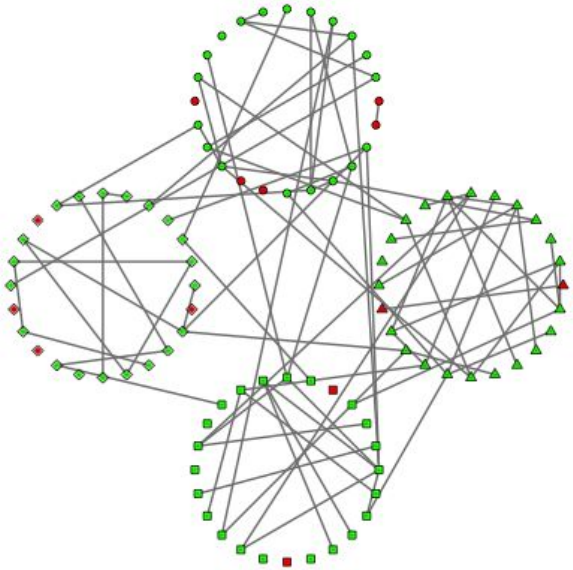

X1
X2
X3


+
−

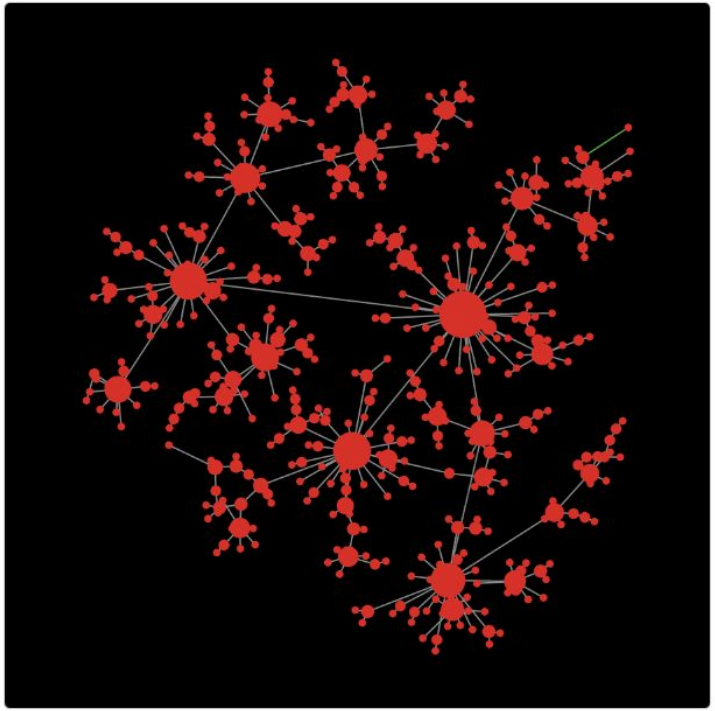

m1
e1
G
m2
e2
m3
e3

Idiographic theory





Preferential attachment



Explore

What patterns do you observe?

What is the mechanism?

What do the degree distributions tell you?

What is special about the degree distribution?

How does it relate to Pólya's urn?

Can it be used in our idiographic theory?

Resources

Abductive theory of scientific method
Brian D. Haig / Jan-Willem Romeijn

Understanding modeling
Joshua M. Epstein / David Marr & Tomaso Poggio / Warren Weaver / (Leo Breiman)

Software
Loopy / NetLogo + Tutorial

Models
Pólya urn model / Mutualism model / Multiplier effect models / (Network models)

Learn about complexity science
Complexity explorer / Herbert A. Simon

Comments / feedback

We're here to facilitate your learning experience

Any comments or feedback?

Tell us during the course

You can do so anonymously on www.alexandersavi.nl/teaching/

Week 2

Diffusion models in decision making, with Leendert van Maanen