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Informatics for a complex world

A research focus of the Informatics Institute

Presenter: Cees de Laat

A complex world

- Large numbers of interacting components: agents, cells, sensors, data, processors, machines, users, …
- Emergent behavior: self-organizing and difficult to anticipate from the knowledge of the individual components' behavior
- Collective intelligence: shared or group intelligence that results from the collaboration and competition of many individuals

A complex world: man-made and natural

- Man-made
  - Cities, Countries, Continents
  - Transportation and communication systems
  - Internet, Google, Wikipedia, YouTube, Twitter, FaceBook, Linked Open Data cloud, …
  - Socio-economic systems
- Natural
  - The immune system
  - Biological networks
  - Climate, weather, earthquakes

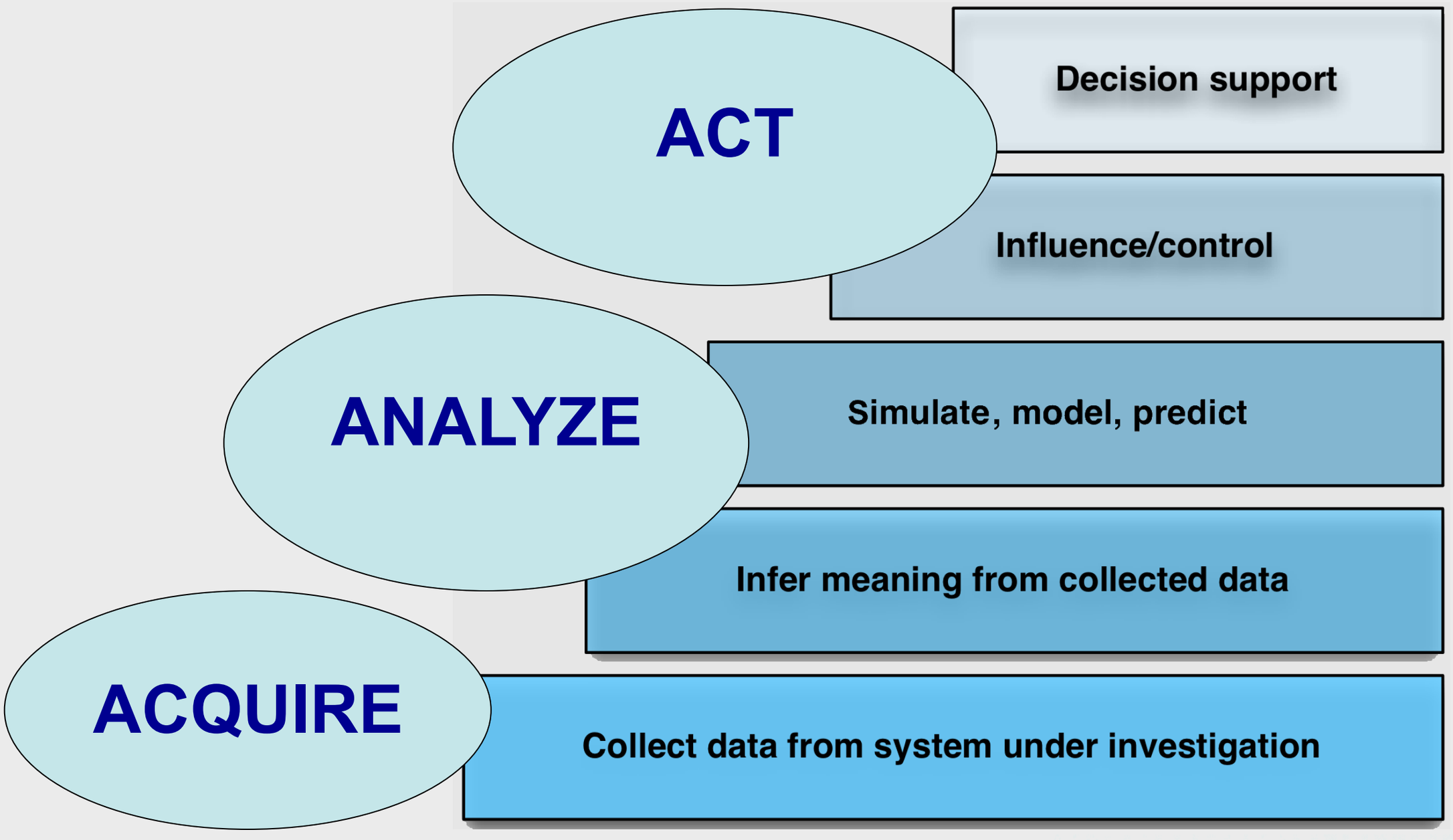
I4CW: Aims

- To understand the behavior of man-made and natural systems in a complex world from the behavior of, and interactions between their components
- Deeply embedded in informatics theoretical, methodological and experimental tradition
- Strongly connected to cross disciplinary and societal links

Research Questions

- What is information?
- What algorithms allow understanding, predicting and controlling information?
- Can we unravel the complexity by computational modeling and simulation?
- Can computers autonomously extract information from data?
- How do people search and use information?
- What is decision making?
- Can we understand and control sustainable data processing environments robustly?
- How to protect the data of an individual, her corresponding integrity and identity, living in a complex digital world?

I4CW: Overall approach



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“Friendship as a health factor”

Spread of obesities, smoking, or happiness as a social virus

Picture from Science
23 January 2009:
Vol. 323 no. 5913
pp. 454-457

Recent papers suggest that aspects of health, such as obesities, smoking, or happiness spread over networks:

1. The Spread of Obesity in a Large Social Network over 32 Years, Nicholas A. Christakis and James H. Fowler, N Engl J Med 2007; 357:370-379
2. The Collective Dynamics of Smoking in a Large Social Network, Nicholas A. Christakis and James H. Fowler, N Engl J Med 2008; 358:2249-2258
3. Dynamic spread of happiness in a large social network: longitudinal analysis over 20 years in the Framingham Heart Study, Fowler, J. H. & Christiakis, N. A. 2008.. *BMJ,* 337.

I4CW Approach

- Mine existing cohorts studies or scientific literature
- From social media
- Through serious online games, like degrotegriepmeting.nl

Collect data from system under investigation

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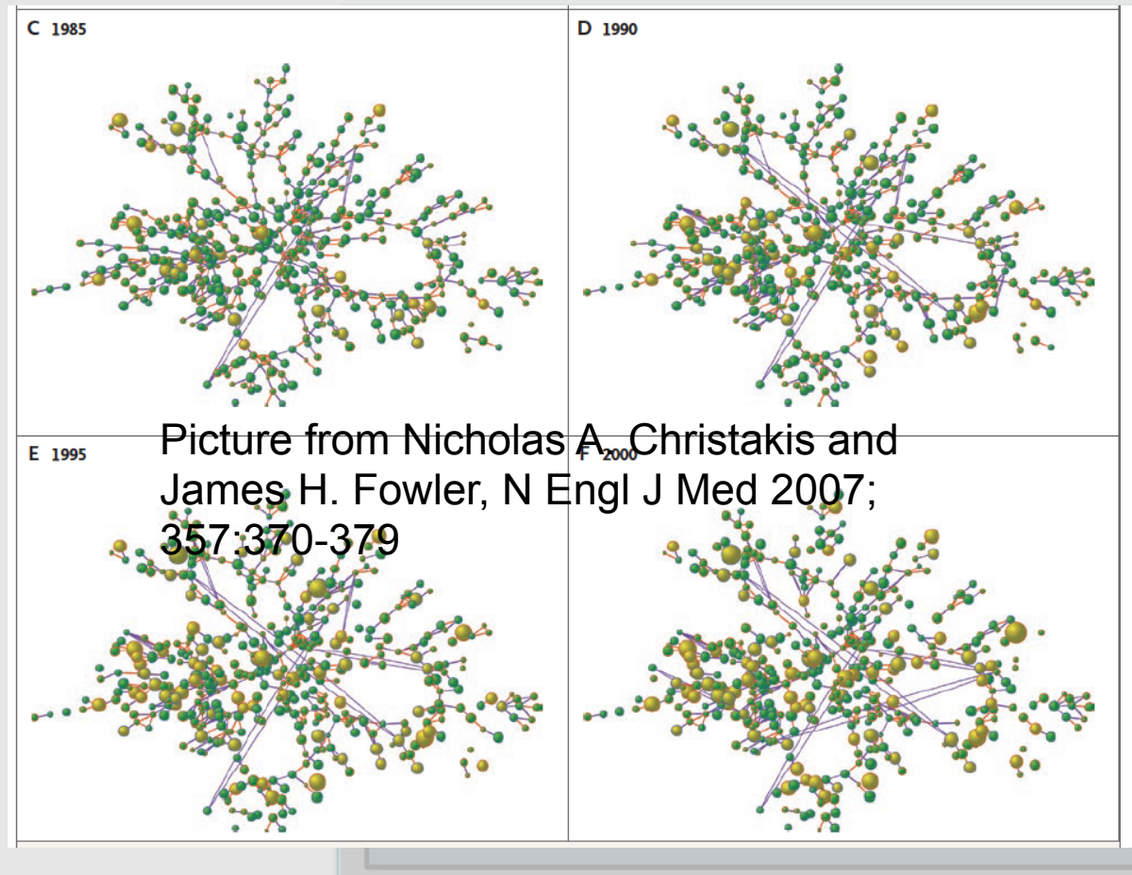
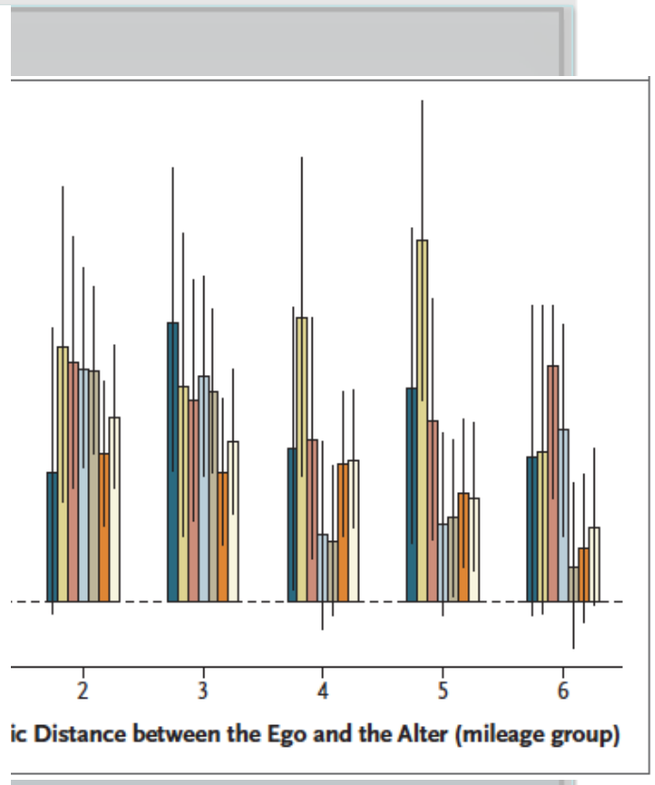
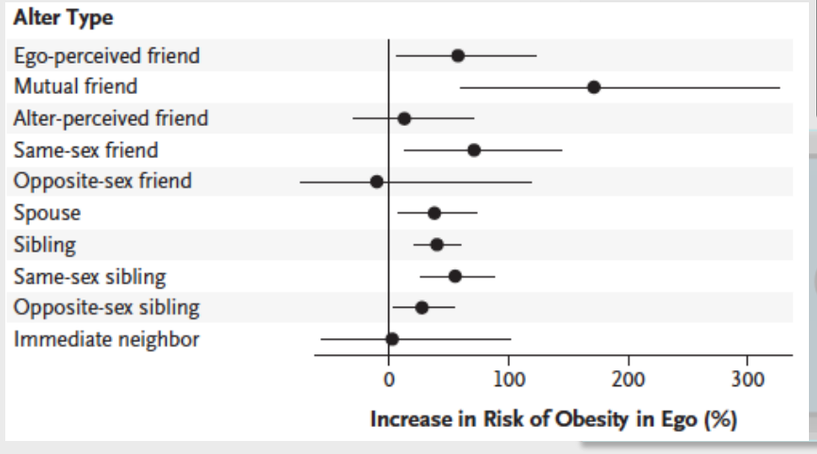
I4CW Approach

- Network analysis
- Machine learning approaches
- Extract parameters for models



Picture from Nicholas A. Christakis and James H. Fowler, N Engl J Med 2007; 357:370-379





Infer meaning from collected data

Collect data from system under investigation

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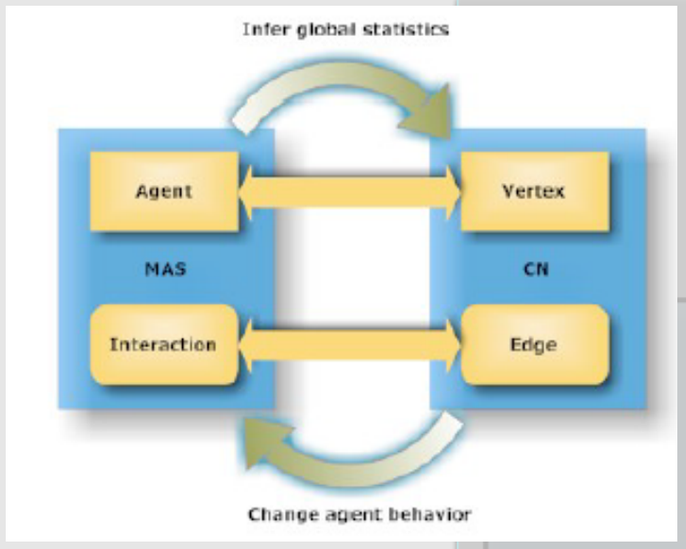
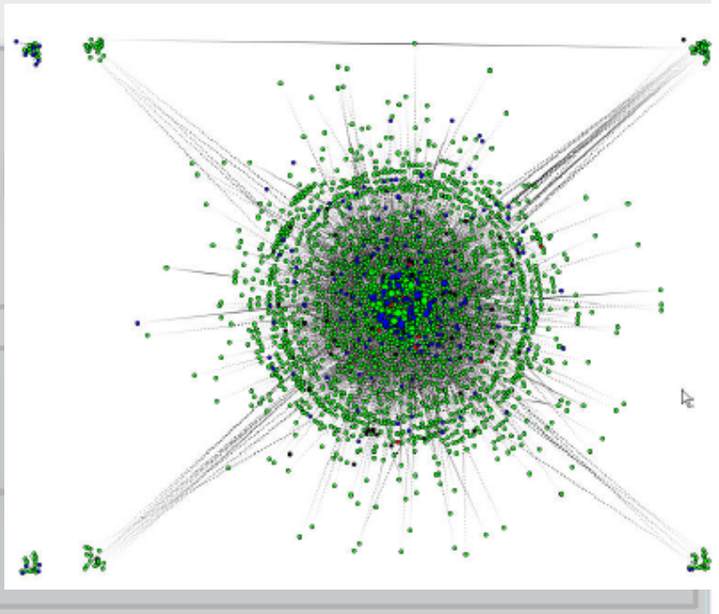
I4CW Approach

- Agent based models on social friendship networks

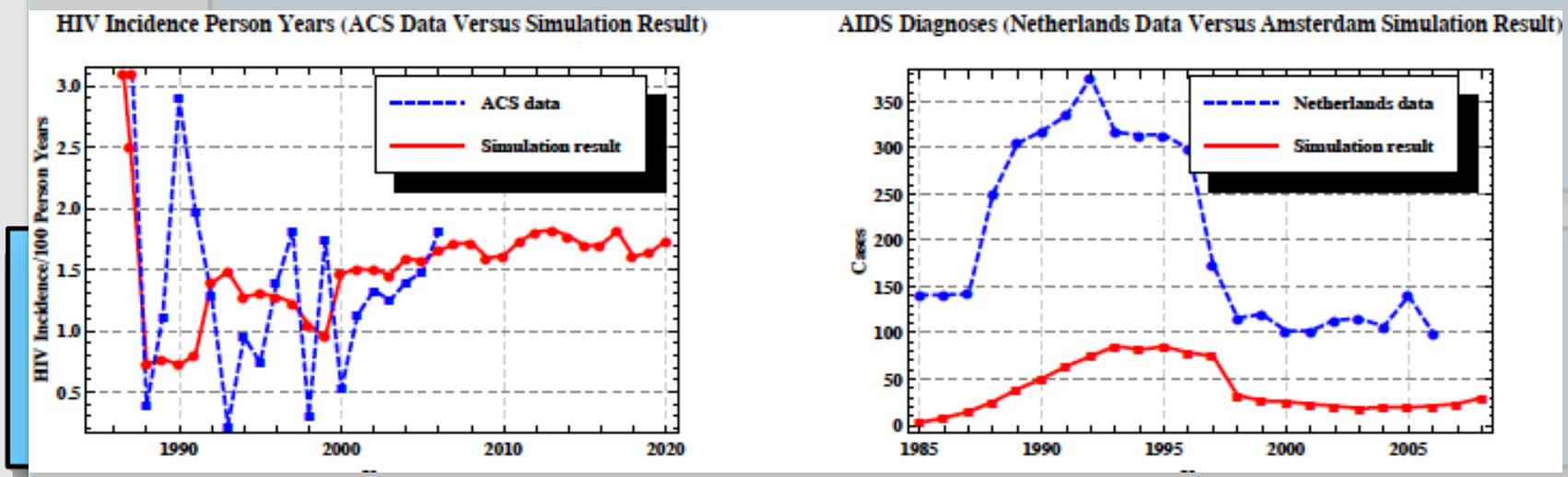




- Spreading of ‘social viruses’ on such networks

- Infection by a ‘social virus’ on such networks

Simulate, model, predict



Pictures from Shan Mei, P.M.A. Sloot, Rick Quax, Yifan Zhu, Weiping Wang, Mathematics and Computers in Simulation, 80, 1018-1030, 2010

I4CW Approach

- Decision support using the whole I4CW chain
- Influence the epidemic by acting on the social network

Decision support

Influence/control

LETTER

doi:10.1038/nature11421

A 61-million-person experiment in social influence and political mobilization

Robert M. Bond[1], Christopher J. Fariss[1], Jason J. Jones[2], Adam D. I. Kramer[3], Cameron Marlow[3], Jaime E. Settle[1] & James H. Fowler[1,4]

Human behaviour is thought to spread through face-to-face social networks, but it is difficult to identify social influence effects in observational studies[9–13], and it is unknown whether online social networks operate in the same way[14–19]. Here we report results from a randomized controlled trial of political mobilization messages

with all users of at least 18 years of
accessed the Facebook website on 2 N
US congressional elections. Users were
message' group, an 'informational mes
The social message group (n = 60,055,

Collect data from system und

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I4CW Approach

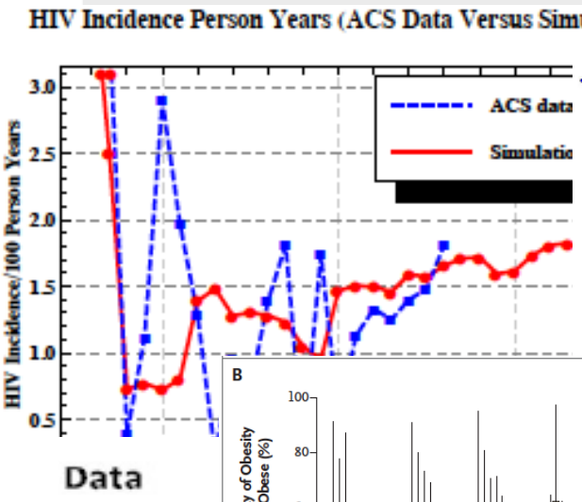
Decision support

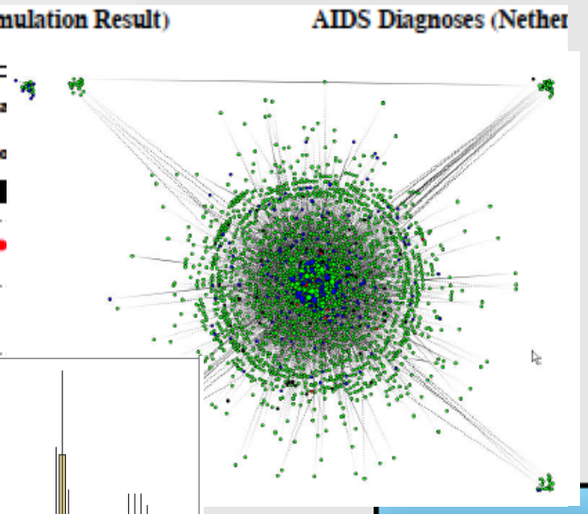
Influence/control

Simulate, model, predict

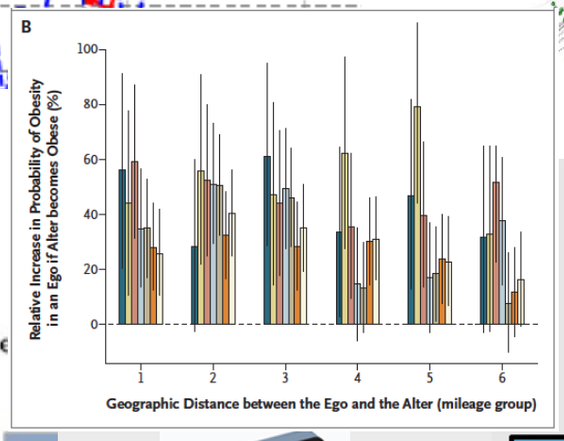
Infer meaning from collected data

Collect data from system under investigation





Data




Clinical Database

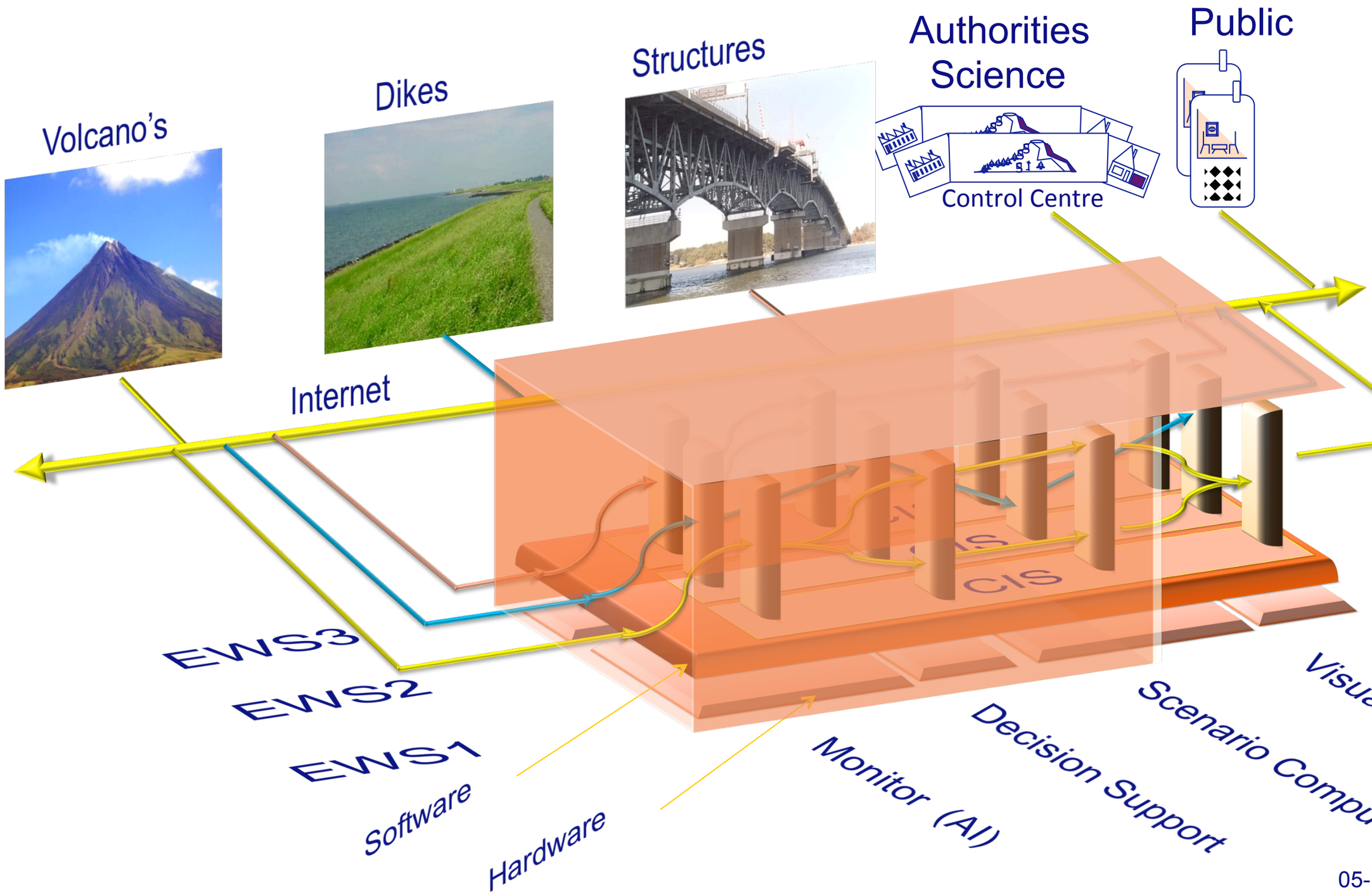

Internet Data Mining


Literature


Questionnaires

IJkdijk - UrbanFlood

UrbanFlood creates an internet based hosting platform for early warning systems … just connect your sensors to the internet ...



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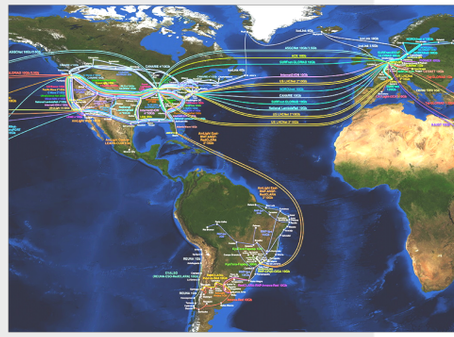
I4CW: Starting strengths

- Systems and Network Engineering (De Laat, Grosso)
  - Complex cyber infrastructure spanning continents
  - Secure, sustainable, robust, collective behavior and control
- Computer Systems Architecture (Pimentel)
  - system-level design methods and techniques - microgrids
  - general-purpose computing platforms
- Intelligent Systems Lab Amsterdam (De Rijke, Welling)
  - Semantic analytics for textual, visual, social, sensory data
  - Search, classify, recommend, predict at very large scale
- Section Computational Science (Sloot, Hoekstra)
  - Theory of complex systems
  - Model and simulate complex systems
- Federated Collaborative Networks (Afsamanesh, Bergstra)
  - Ontology engineering, trust management
  - Creation, operation, and management of VOs.

Universiteit van Amsterdam
Computational Science

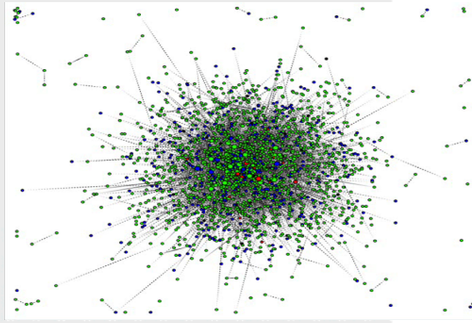
I4CW: Dots on the horizon

- Sustainable robust secure Future Internet
  - Smart Cyber Infrastructure using semantic approach
  - Protect the integrity of the human in digital world



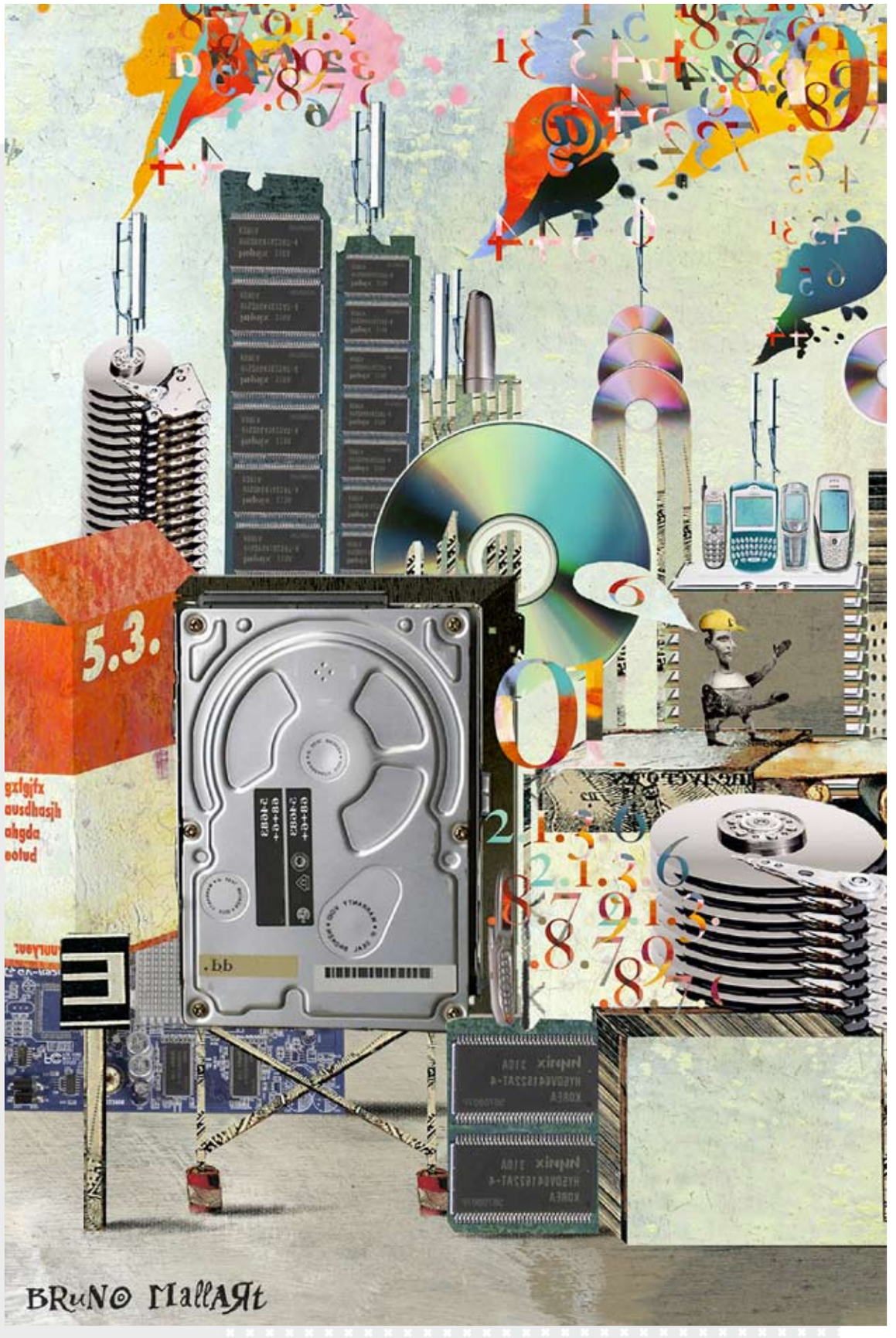
- Self-learning interpretation of complex data streams
  - Unsupervised, real-time
  - Complement with cognitive signals

- Information theory of complex systems
  - Is multi-scale an emergent aspect of Complex Systems?
  - Can we predict and control Complex System Behaviour?



Take Away Message: A-A-A

- Acquire
- Analyze
- Act



Kunnen we onze informatiesystemen nog beheersen?
Ref: De nederlandse Wetenschapsagenda.


data
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I4CW
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Amsterdam
priority
processing
University
behavior
societal
modeling
opportunities
groups
Science
sustainable
complexity
making
society
informatics
online
social
Complex
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program
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