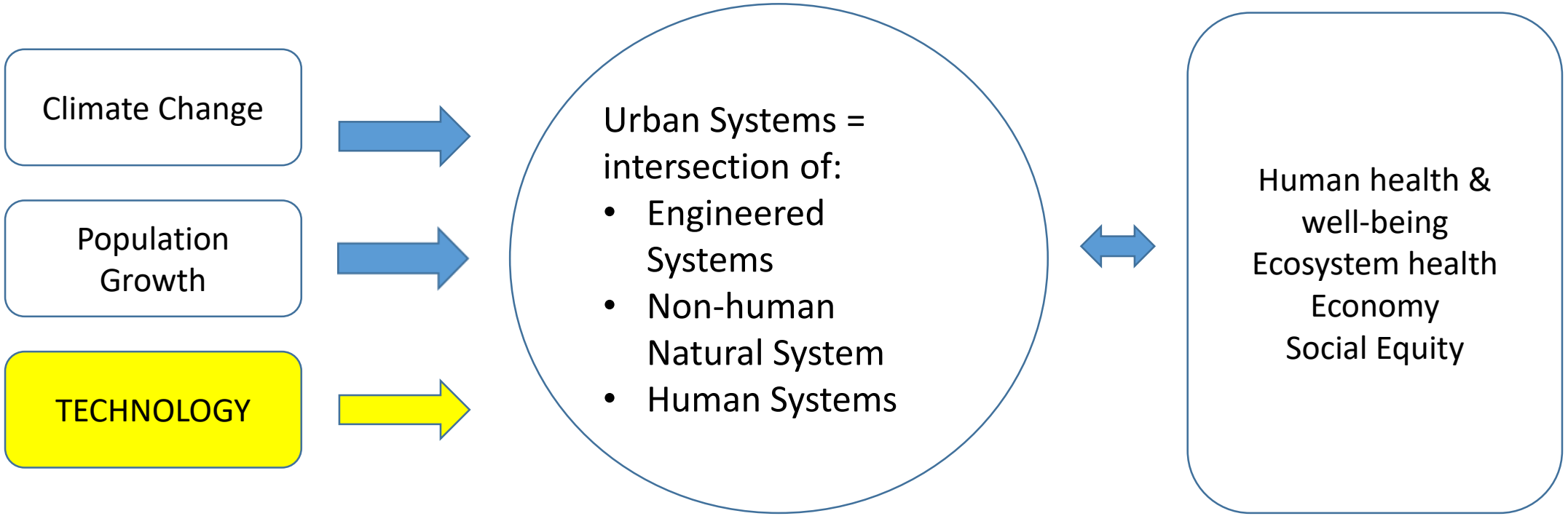
Participatory Modeling and Stakeholder Engagement in Context: “Smart” Technologies, Decisions, and Uncertainty

Antonie J. Jetter
Associate Professor
ajetter@pdx.edu
Department of Engineering and Technology Management
Portland State University


Climate Change
Population Growth
TECHNOLOGY
Urban Systems = intersection of:
• Engineered Systems
• Non-human Natural System
• Human Systems
Human health & well-being
Ecosystem health
Economy
Social Equity

“Smart” Cities

use information and communication technology for data collection, data analysis, and data-based decision-making to

- identify and anticipate citizens’ problems and
- provide services

in order to manage growth, while improving

- quality of life,
- efficiency,
- environmental sustainability,
- and resilience

Meet Susan…

loves taking care of her two grandchildren

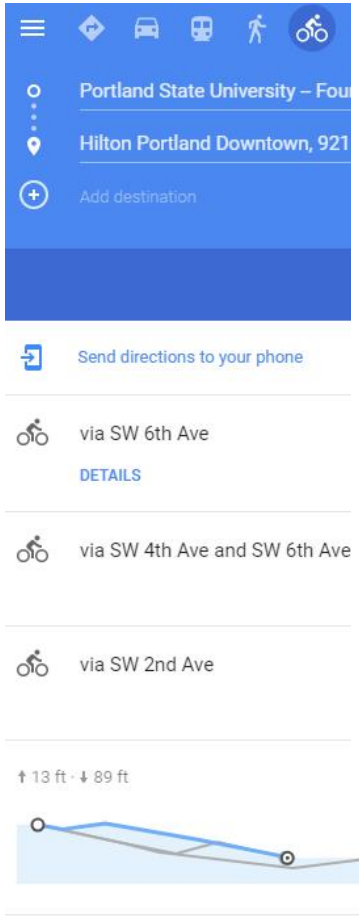
76 years old, retired

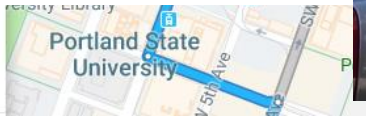
considering a hip replacement

drives but does not own a car anymore

lives on her own but close to her daughter‘s family

Not (entirely) science fiction: ingredients



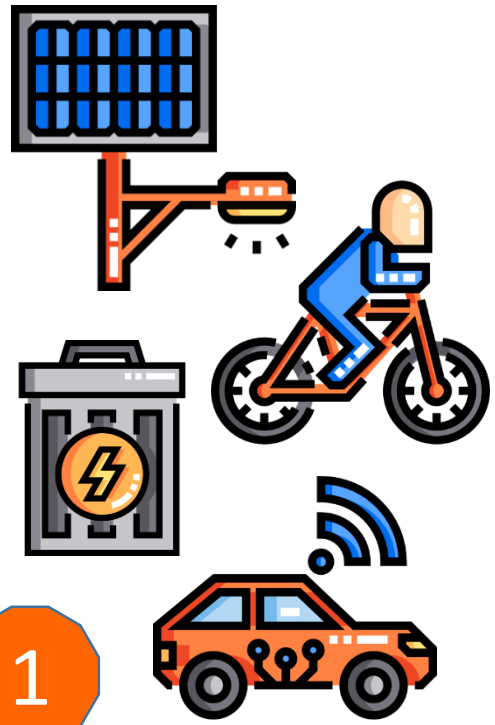


Microsoft's Chinese chatbot won't talk about Tiananmen or Xi Jinping

is to me?" Ask Microsoft's Chinese chatbot
e Dalai Lama and that's how she responds. She
like the 1989 crackdown on Tiananmen
ping or even President-elect Donald Trump.

accessmap

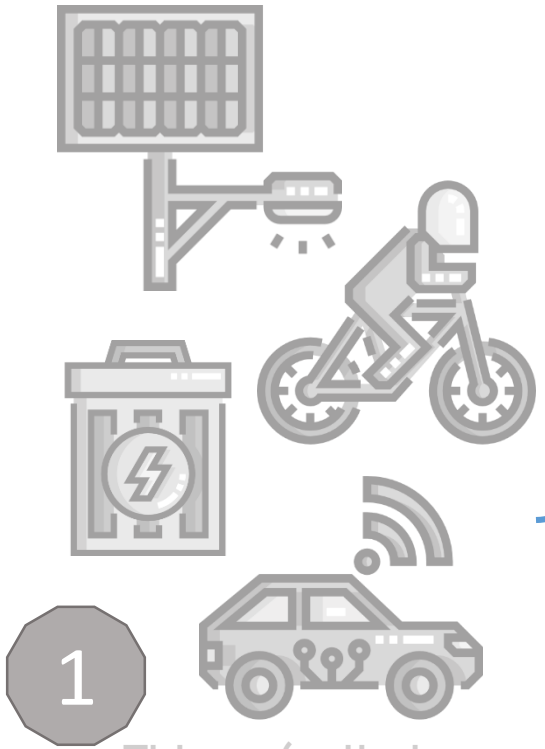
How ?



1

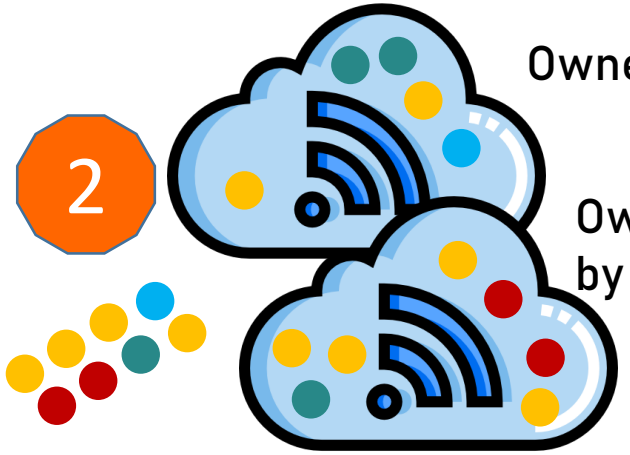
Things (cell phones, cars, thermostats, garbage cans, lamp posts, etc.) collect data

How ?



1

Things (cell phones, cars, thermostats, garbage cans, lamp posts, etc.) collect data



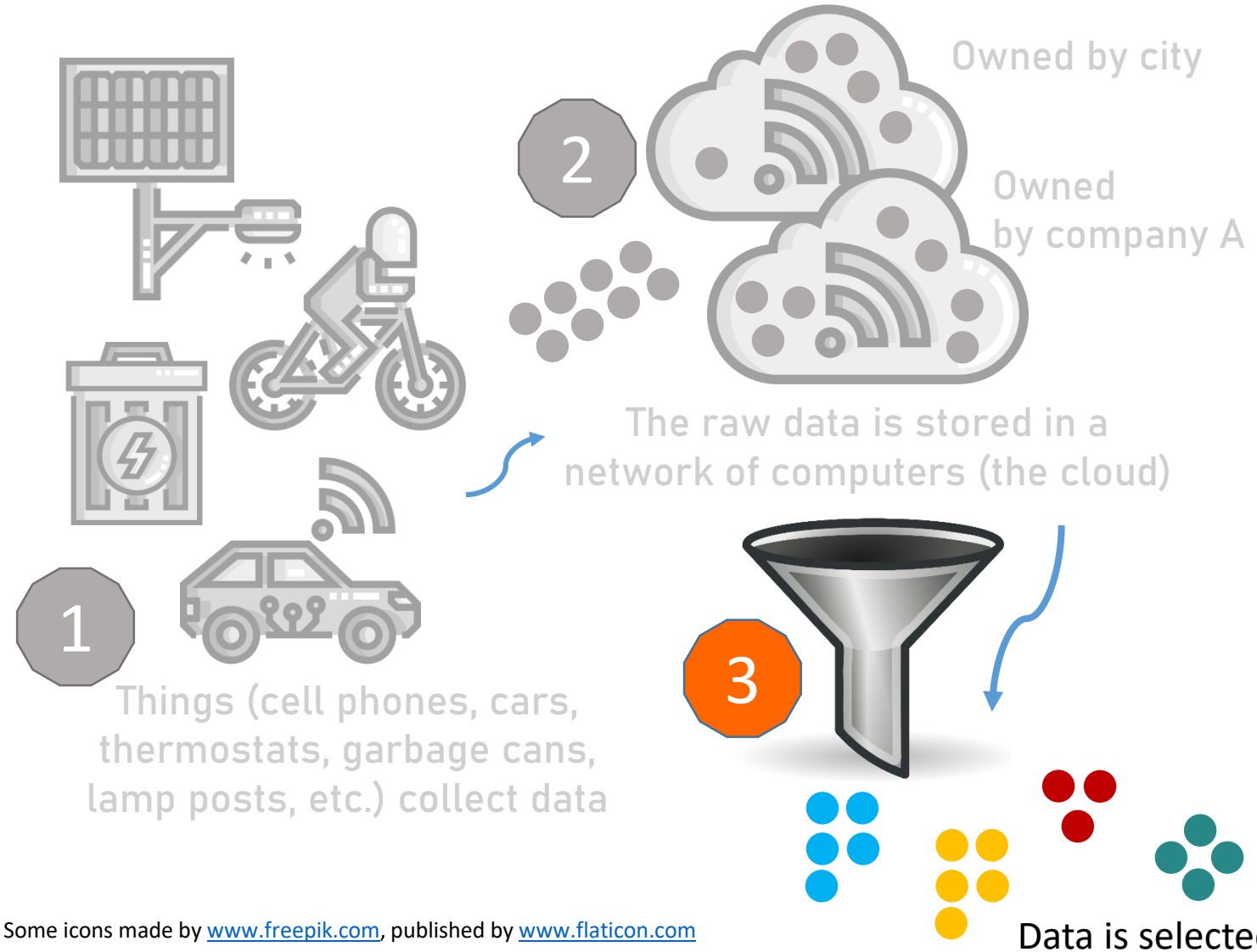
2

Owned by city

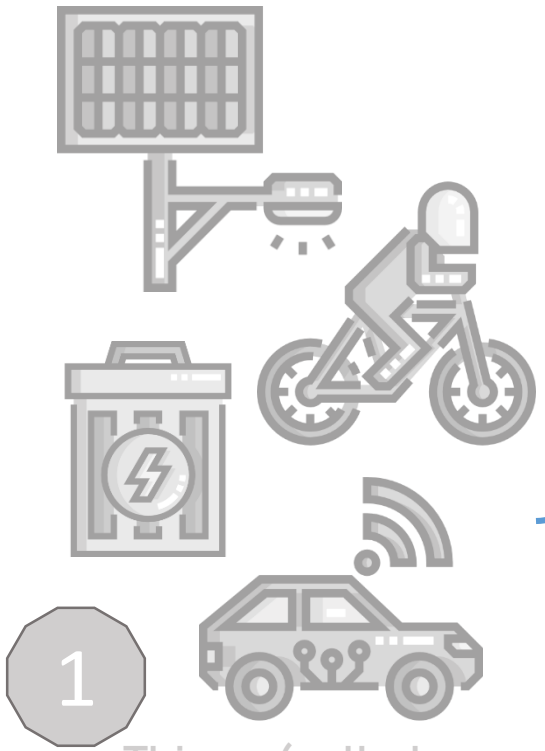
Owned by company A

The raw data is stored in a network of computers (the cloud)

How ?



How ?



1

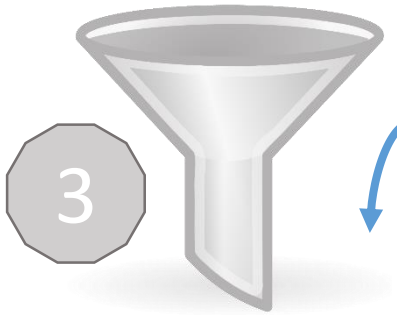
Things (cell phones, cars, thermostats, garbage cans, lamp posts, etc.) collect data

2

Owned by city

Owned by company A

The raw data is stored in a network of computers (the cloud)



3

Data is selected and organized

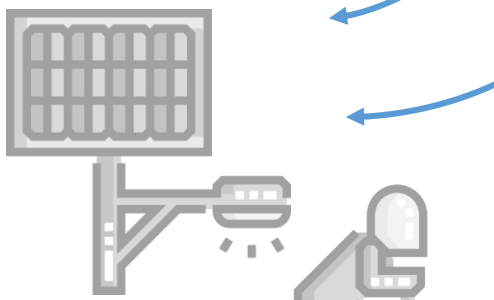
4

What is happening? **Descriptive**	Why is this happening? **Diagnostic**	What will happen? **Predictive**	What do I need to do? **Prescriptive**

Data is processed to answer questions

How ?

Changes to the City



1

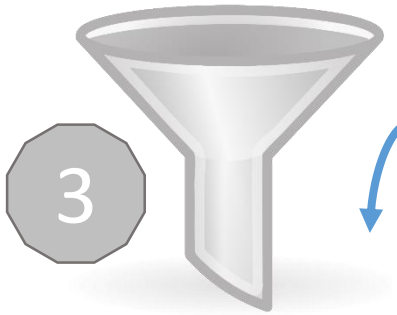
Things (cell phones, cars, thermostats, garbage cans, lamp posts, etc.) collect data

2

Owned by city

Owned by company A

The raw data is stored in a network of computers (the cloud)



3

Data is selected and organized

4

Data is processed to answer questions

5

Decisionmakers (e.g. city managers, product users) decide and take action

Software decides and takes action

What is happening? **Descriptive**	Why is this happening? **Diagnostic**	What will happen? **Predictive**	What do I need to do? **Prescriptive**

Some icons made by www.freepik.com, published by www.flaticon.com

Data Analysis

What is happening?
Descriptive

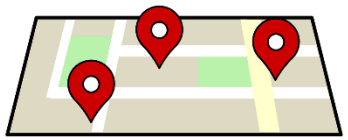
How many street lights are on?
Where do urban heat islands exist?

Data Analysis

What is happening?
Descriptive

How many street lights are on?
Where do urban heat islands exist?

„Show and Tell“



Why is this happening?
Diagnostic

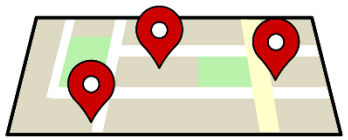
Are elderly people hospitalized because of heat?
Is air pollution caused by businesses or traffic?

„Statistics as we know it“

Data Analysis

What is happening? **Descriptive**	How many street lights are on? Where do urban heat islands exist?
Why is this happening? **Diagnostic**	Are elderly people hospitalized because of heat? Is air pollution caused by businesses or traffic?
What will happen? **Predictive**	Which rail lines will be disrupted in extreme heat? How many people will take the bus next month?

„Show and Tell“



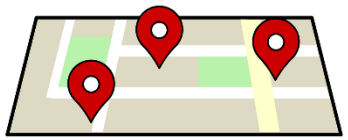
„Statistics as we know it“

„Climate Models“

Data Analysis

What is happening? **Descriptive**	How many street lights are on? Where in Portland is air pollution high?
Why is this happening? **Diagnostic**	Are elderly people hospitalized because of heat? Is air pollution caused by businesses or traffic?
What will happen? **Predictive**	Which rail lines will be disrupted in extreme heat? How many people will take the bus next month?
What do I need to do? **Prescriptive**	Turn on irrigation system in city park X Dispatch a garbage truck on ideal route Y Dispatch police because of aggressive conversations in the park

„Show and Tell“



„Statistics as we know it“

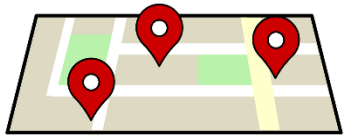
„Climate Models“

„Autonomous Everything“

Data Analysis

What is happening?
Descriptive

„Show and Tell“



Limited data
Straightforward to do
Simple to interpret,
relatively long time to action

Why is this happening?
Diagnostic

„Statistics as we know it“

What will happen?
Predictive

„Climate Models“

What do I need to do?
Prescriptive

„Autonomous Everything“

Complex data
Advanced skills
Hidden layers
Some actions within seconds/minutes

A lot of potential for good

- Many more decisions based on data (vs educated guesses)
- Efficient use of infrastructure + predictive maintenance
- Environmental sustainability
- “One stop shop” for city services, tailored to the needs of individuals
- Improved quality of life, particularly for “forgotten” groups: children, elderly, people with disabilities
- Effective and equitable public safety
- New forms of citizen engagement
- …

Privacy

Everything can provide data…

Do we know what data is collected? Do we really have a choice to “opt out?”

How feasible is it to immediately delete the collected data?

What if the purpose of data collection changes?

Security

Everything is connected…

- Data breaches
- Cyberattacks

What if open data is used
to plan real-world attacks?

Ethics and Equity

Dilemmas

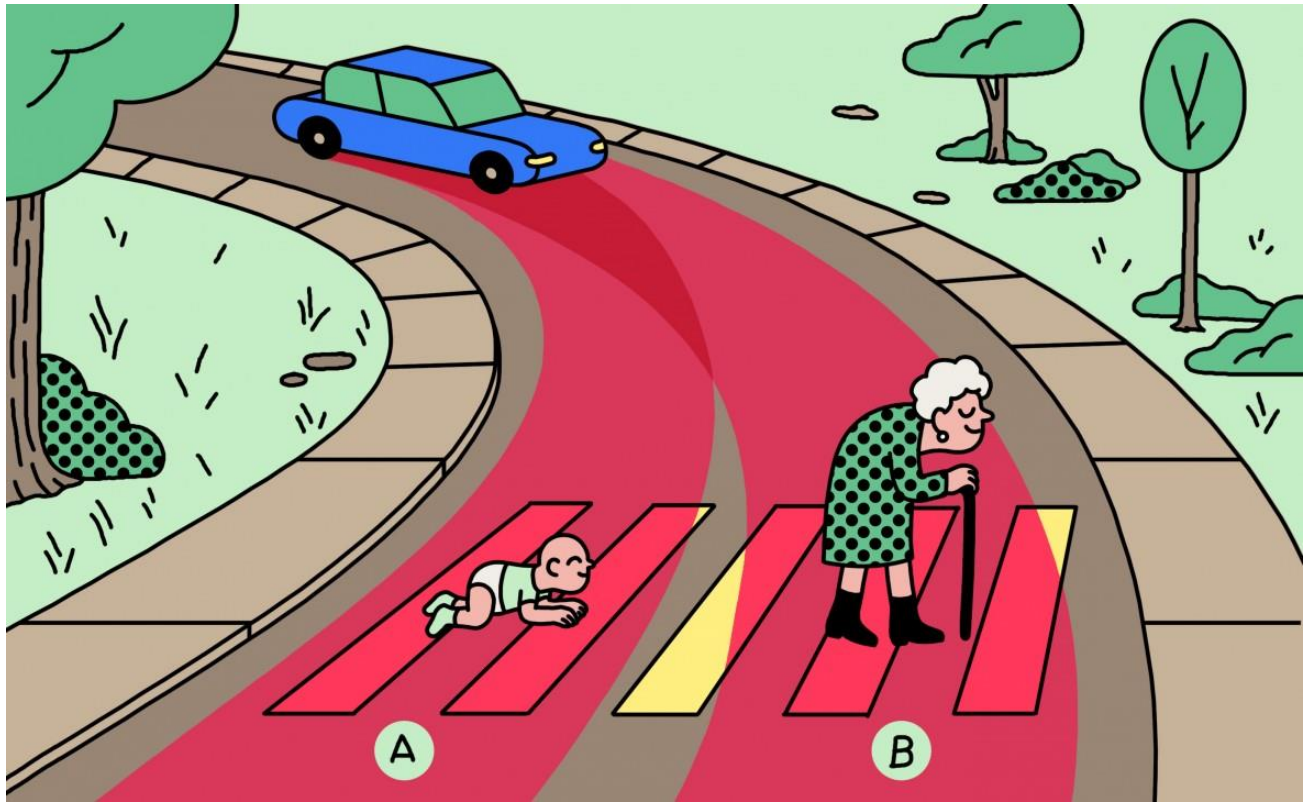
Displacement

Who gets smart technology (first)?

People who can analyze data will have their voices heard

Some data technologies are black boxes to humans

Data on biased practices can perpetuate practices



Source: MIT Technology Review

How ethical are “nudges”?

Data helps understand how changes impact human behavior

but

personalized, technology-facilitated “nudges” influence human behavior at very large scales


2005
2013


SERENDIPITY

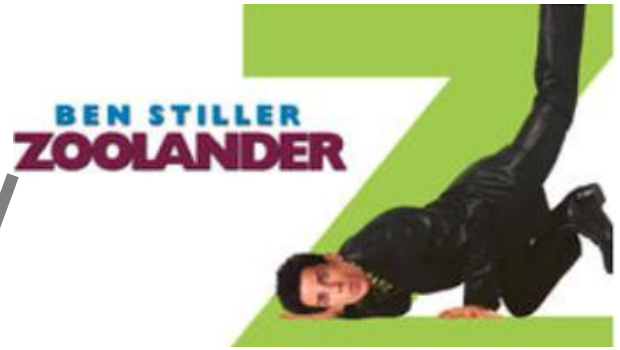

Eternal Sunshine
of the spotless mind


While You
Were Sleeping


GOOD WILL HUNTING

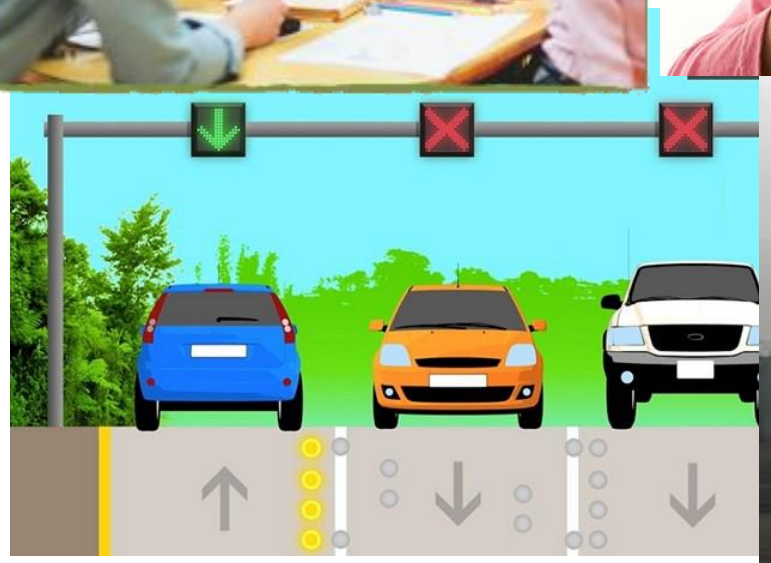

GOOD WILL HUNTING


NETFLIX
ARRESTED
DEVELOPMENT

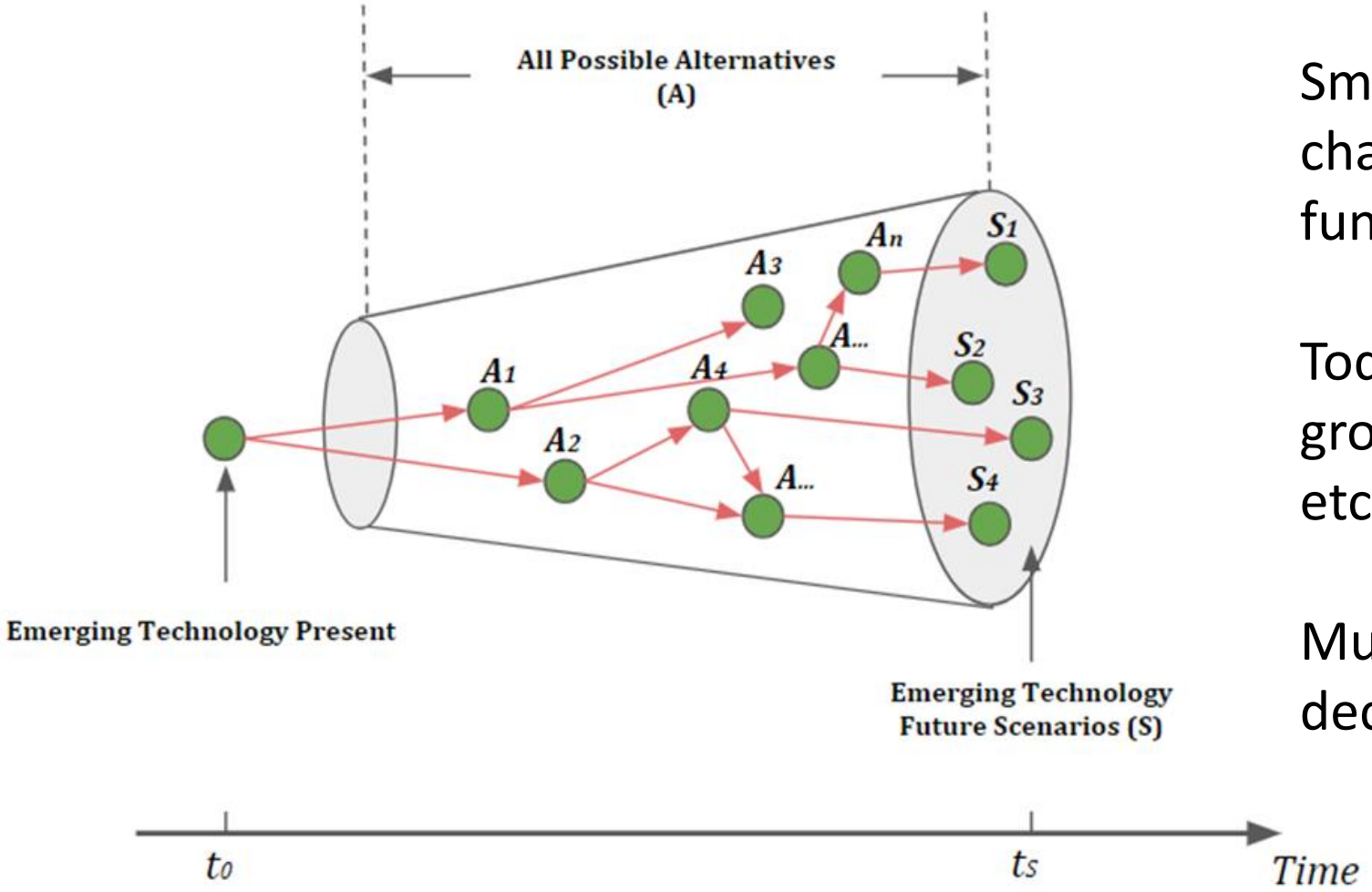

BEN STILLER
ZOOLANDER


ANGER
MANAGEMENT

Humane design & rate of change?



Uncertainty about the Future



Smart City technology can change the rules of the game in fundamental ways

Today's assumptions about growth, impacts, data quality, etc. might be wrong

Much will depend on today's decisions

Type of Uncertainty	Participatory Modeling Response
State Uncertainty • Variable is known but value is unknown	State Uncertainty • Run model for multiple possible values and observe what happens
Effect Uncertainty • Variable is known but impact is unknown	Effect Uncertainty • Run model with variable and see what behavior emerges
Response Uncertainty • Lack of response options and uncertainty about the consequences of the chosen response	Response Uncertainty • Identify leverage points (through modeling) and innovate solutions
UnkUnks (Blind Spots)	UnkUnks (Blind Spots) • Diversity of perspectives

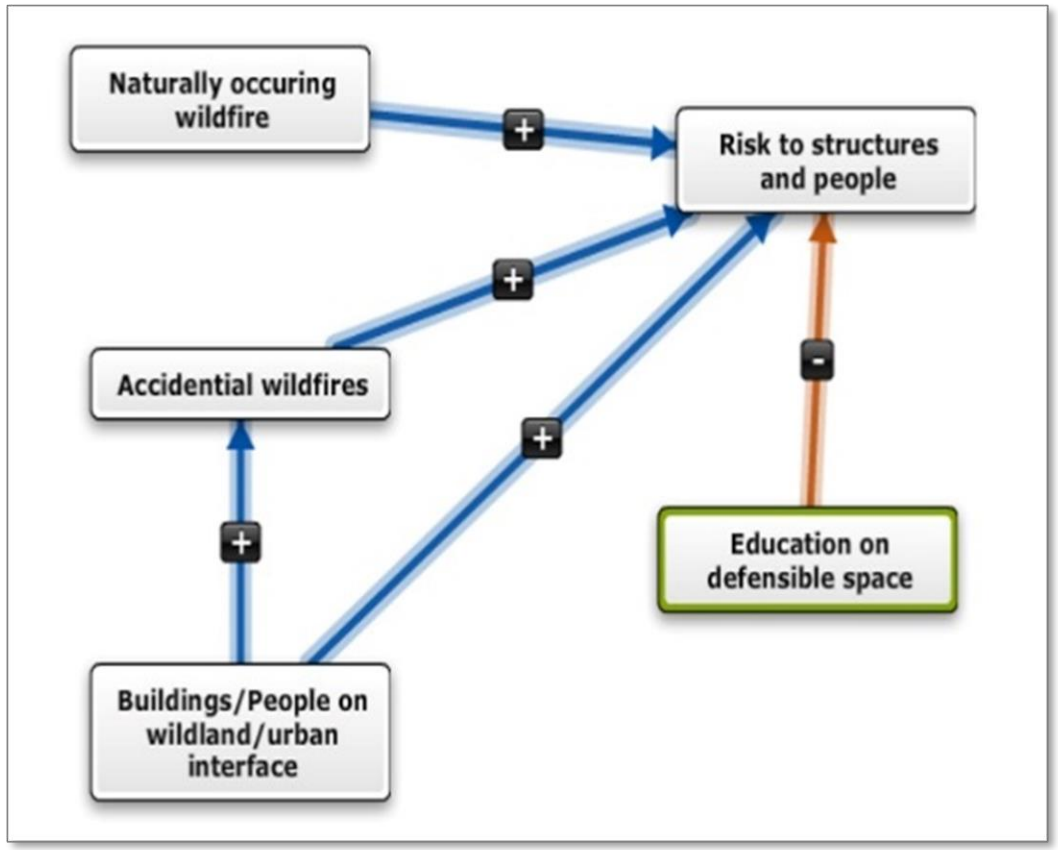
Participatory Modeling with Stakeholders, using FCM

Fuzzy Cognitive Maps (FCM)

- Fuzzy Cognitive Maps (FCMs) are used to analyze interrelations between phenomena that are graphically represented in **causal maps** (Jetter 2003)

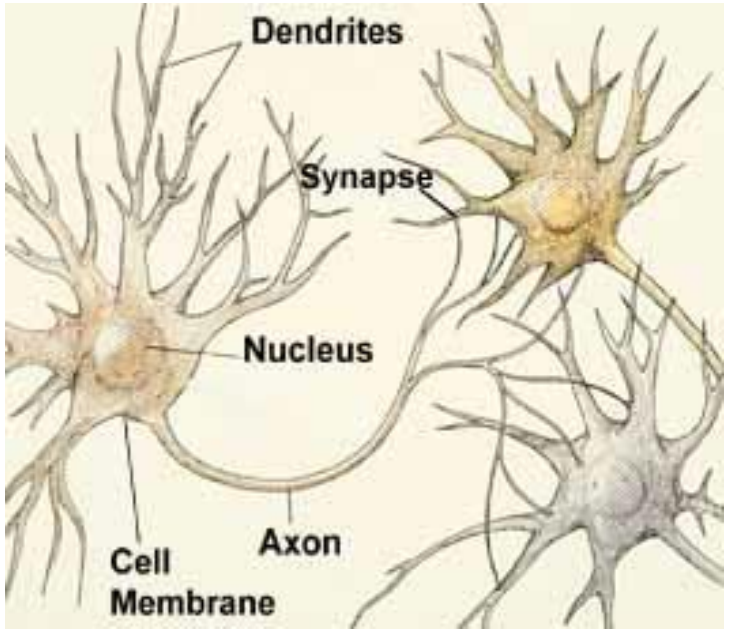
- Fuzzy cognitive map is a soft computing technique for **modeling systems**, which combines synergistically the theories of **neural networks** and **fuzzy logic**. (Papageorgiou, Stylios, Groumpos 2004)

Illustrative Cognitive Map

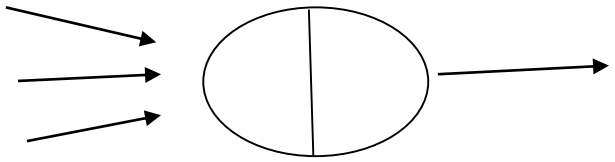


"People push into formerly uninhabited areas, and more structures and people are exposed to the risks of natural wildland fires. Also, incidents of accidental fire go up because power lines are strung through former wildlands and people operate machinery. Better education on defensible space helps to minimize the harm to property and people, but there will be more fires and our overall risk will increase."

What Is a Neural Network?



- neurons: primitive information processors that receive input signals from other neurons and transfer them into output signals
- FCMs: cognitive map is interpreted as neural network with feedback (activated concepts or neurons „fire“ and activate additional concepts)
- Concepts are non linear functions that transfer the weighted input values into output values in [0,1].

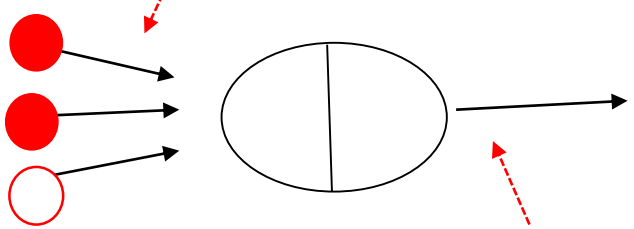


[Kosko 1986, 1988]

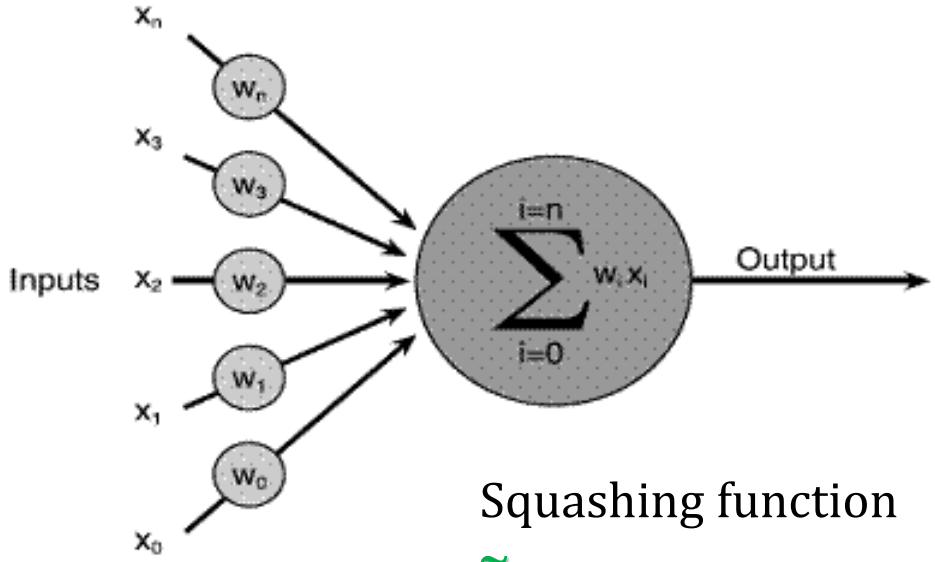
Artifical Neuron

Activation transmitted from other neurons

Strength of transmission?



What's the output?

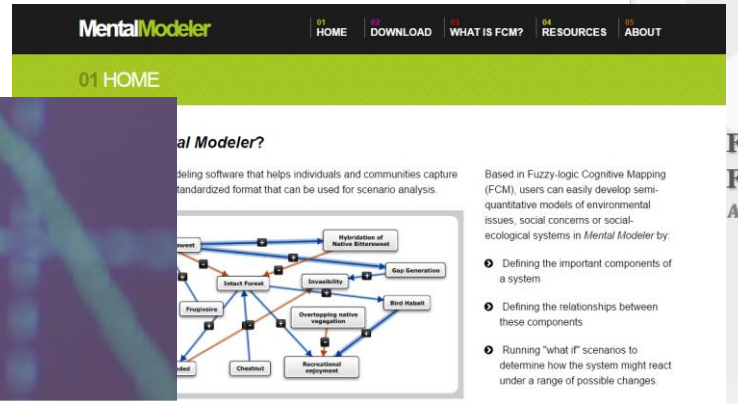


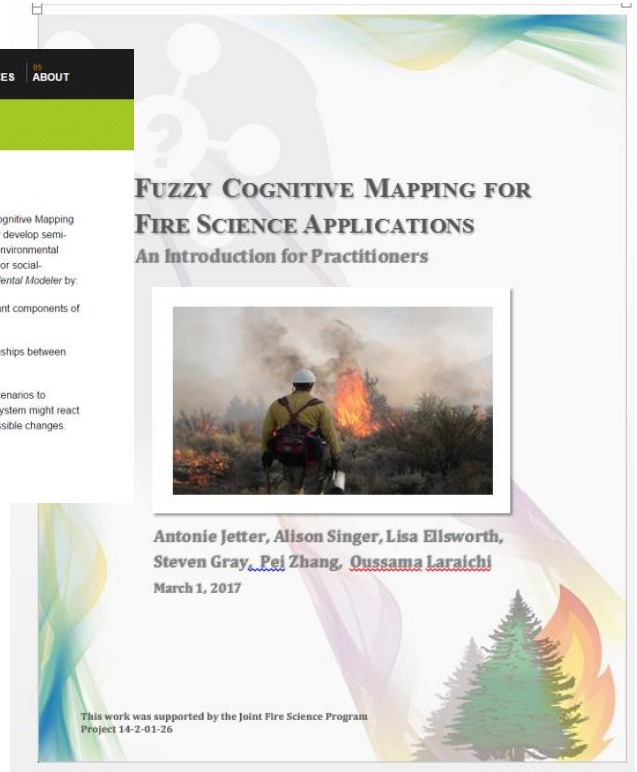
Squashing function

≈

(Activation function + Transfer function)

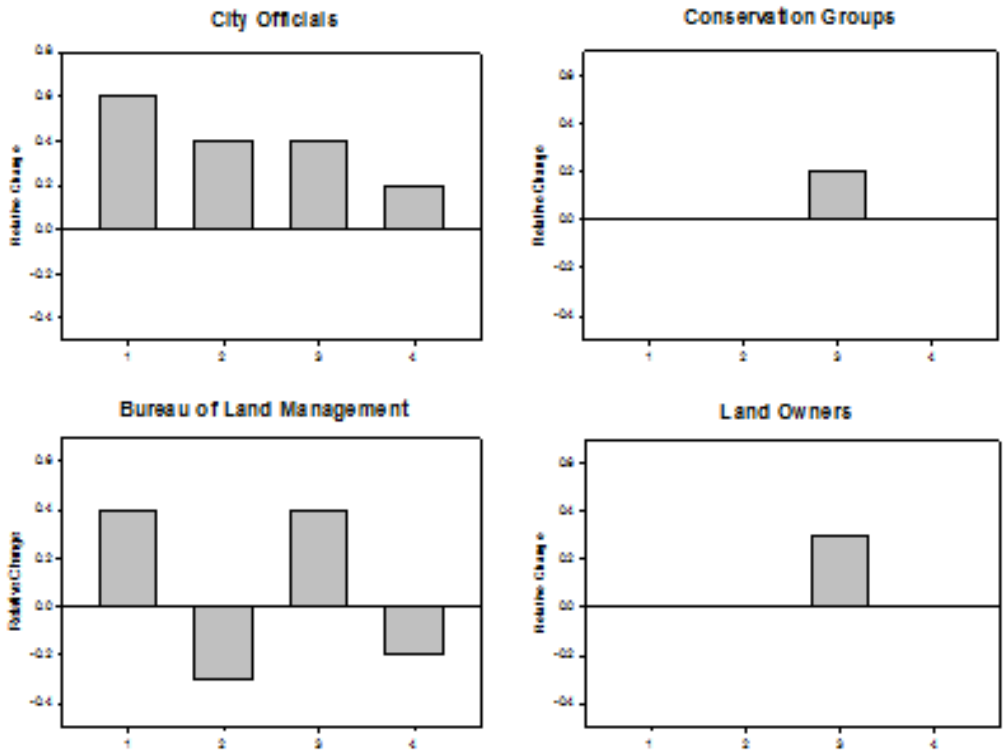
Modeling with Fuzzy Cognitive Maps

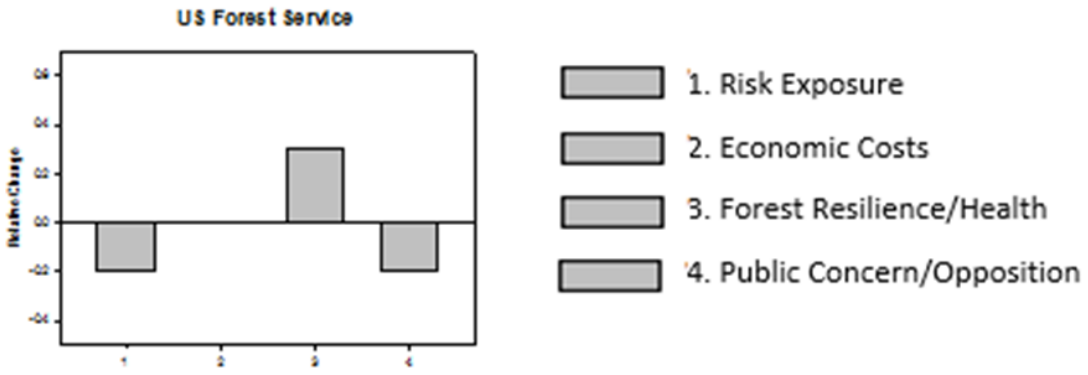




https://sites.google.com/pdx.edu/fcm-tutorial-umkc/home?authuser=1&read_current=1

Understanding Policy Preferences





Expert

FCM as “expert” system

- Capture deep knowledge correctly (could be lay people with specific knowledge)
- Creates an asset (“the model”)
- Allows others to take action, similar to what an expert would do
- 1:1 interview more common than group sessions

Participant with deep expertise

- Scarce
- Multiple interactions possible
- Challenge: intuitive decision making

System is well-bounded with relatively few concepts

Philosophy: “the truth”

Stakeholder / “the public”

FCM as boundary object

- Pool dissipated knowledge
- Creates social capital, buy-in, capacity…
- Involves participants in action taking
- Typically done in a group setting

Participant with partial knowledge of system

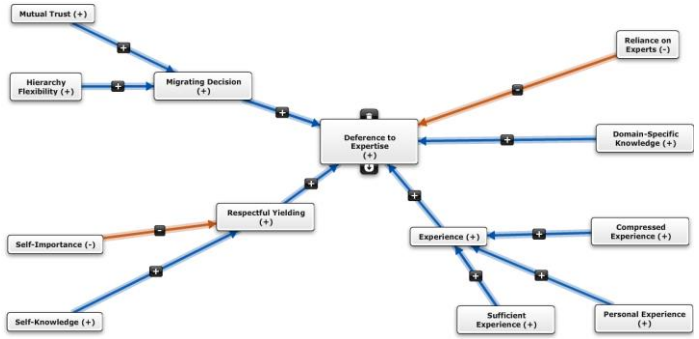
- Many
- Often “one shot” only
- Challenge: hidden profile effect

System has blurry boundaries with many concepts

Philosophy: constructivism

Mixed approaches: Literature, Experts, Stakeholders

Extract model about the subject matter from the literature, using thematic analysis



Create FCM model, based on thematic analysis and expert surveys

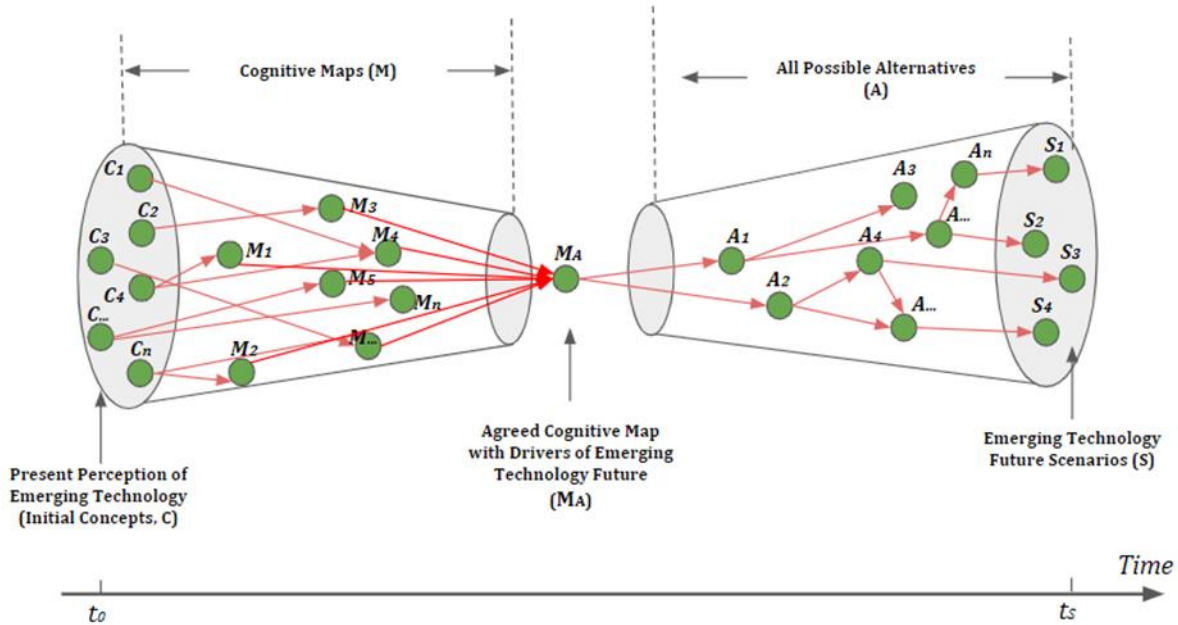
Localize/Contextualize model together with safety decision-makers in oil and gas industry

Participatory FCM Modeling of Smart Cities Technologies

- What features does a smart parkingmeter need to have?
- What drives the decision to implement smart water meters?
- Will trip generation increase, decrease, or stay the same when autonomous vehicles are adopted?
- How will low-income families be affected by smart city automation?
- What are alternative future scenarios for Austin in 2100?
- …

Smart Cities Technologies for Participatory Modeling

- Open Data
- Sensor networks and Opportunistic Data Collection with Smart Phones
- Intercept studies (Street Furniture, Push Messaging)
- Co-creation of system models through technology
- Natural Language Processing to make sense of public comments
- ….

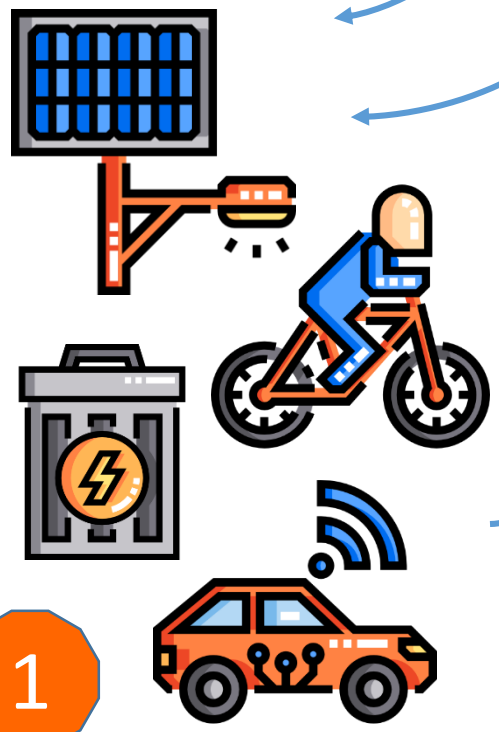

Cognitive Maps (M)
All Possible Alternatives (A)
C1
C2
C3
C4
C...
Cn
M1
M2
M3
M4
M5
Mn
M...
MA
A1
A2
A3
An
A...
A4
A...
S1
S2
S3
S4
Present Perception of Emerging Technology (Initial Concepts, C)
Agreed Cognitive Map with Drivers of Emerging Technology Future (MA)
Emerging Technology Future Scenarios (S)
Time
t0
ts


A tale of smart cities - the best and worst of times?

Thank you!

How ?

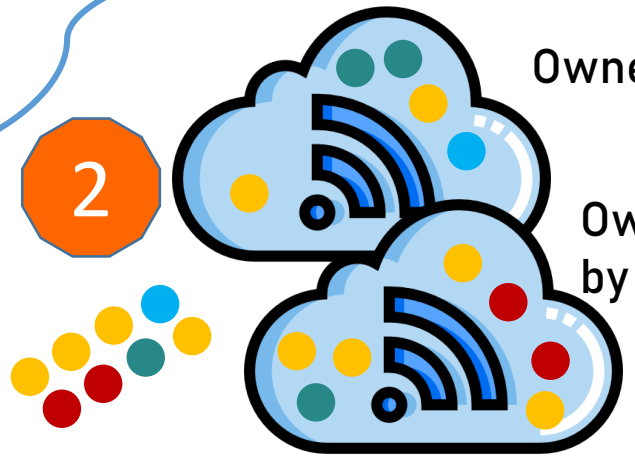
Changes to the City



1

Things (cell phones, cars, thermostats, garbage cans, lamp posts, etc.) collect data

2



Owned by city

Owned by company A

The raw data is stored in a network of computers (the cloud)

3

Data is selected and organized

4

What is happening? **Descriptive**

Why is this happening? **Diagnostic**

What will happen? **Predictive**

What do I need to do? **Prescriptive**

Data is processed to answer questions

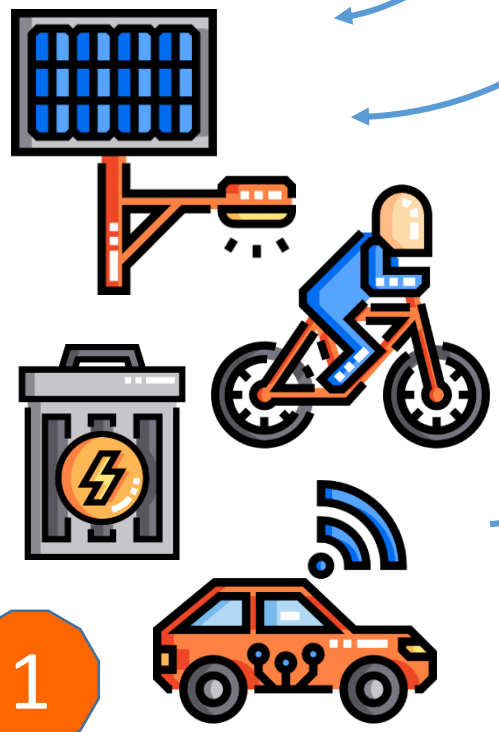
5

Decisionmakers (e.g. city managers, product users) decide and take action

Software decides and takes action

How ?

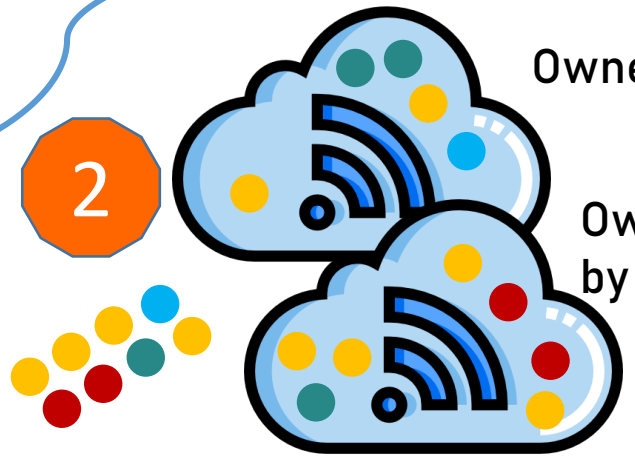
Changes to the City



1

Things (cell phones, cars, thermostats, garbage cans, lamp posts, etc.) collect data

2



Owned by city

Owned by company A

The raw data is stored in a network of computers (the cloud)

3

Data is selected and organized

4

What is happening? **Descriptive**

Why is this happening? **Diagnostic**

What will happen? **Predictive**

What do I need to do? **Prescriptive**

Data is processed to answer questions

5

Decisionmakers (e.g. city managers, product users) decide and take action

Software decides and takes action