GreenTouch™

The Internet of Everything: Powering and Empowering - A vision for the Digital World in 2030

By

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About the Report

'The Digital World in 2030: What Place for Europe?' launched on 18th March in the European Parliament and is created by the European Internet Foundation (EIF) – an independent European Parliament network. While the responses reflect the report – they also reflect my personal views.

Oxford Uni (Big Data for Mobile) - Technical University of Madrid (Smart cities/City sciences) - World Economic Forum - future of the Internet UK based – Consulting – Operators, Governments EU, Startups - feynlabs

Recent and forthcoming talks include Mobile world congress (2007,2008,2009, 2011), CEBIT, Stanford University - MIT Sloan - Web 2.0 expo - Ajaxworld Supernova - CNN money - BBC - Oxford University European parliament
Smart cities: Advisory board – World Smart Capital (Amsterdam), Connected Liverpool

University of Oxford Continuing Education
Delivering learning online

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Global top 20 wireless blogger
According to fierce wireless
www.opengardensblog.futuretext.com
Phd research on resilience of sensor networks in
Advisory board World Smart Capital startup - @feynlabs
Research –Machine Learning and IOT

Is Europe behind in the world digital race?

We believe the picture is mixed.

European strengths – especially in the deep rooted European culture, ideas of humanism and expertise in design. European strengths include : *Design, engineering, scientific research, academic excellence, cultural legacy and creativity, urban planning, management and social integration (the "agora"), social services, global leadership in many highly sophisticated industrial and service sectors, established presence in many 3rd markets*

What are the main digital trends the report foresees for 2030?

The report has **five chapters**.

- Chapter 1: updates our findings from 2009.
- Chapter 2: relates to the technologies and tools driving the revolution.
- Chapter 3: observable economic trends.
- Chapter 4: political and social trends.
- Chapter 5: what will be Europe's place in the digital world of 2030, looking more specifically at those public policy areas which – for better or worse – will largely determine the answer.

The report also speaks about the '**knowing society**'. This relates to a world in which we have real-time, real-world ability to continuously track, measure, and interpret – i.e. to "know" – and react to the current state of virtually any external condition or phenomenon at any scale at any time through continuous targeted real-time data capture and analysis (today widely referred to as "Big Data") becomes the primary source of economic, social and political power at any scale.

Smart systems, smart – sustainable – growth In the digital economy of 2025, digital intelligence will be embedded across entire systems, and systems of systems, notably those constituting the core infrastructures: transport, energy and environmental management. This vision remains a central feature of a 2030 “Knowing Society”, but progress has been spotty in Europe and elsewhere. ***Today we can see – notably through the prism of “Smart Cities” policies and leading-edge experience that the essential factor for progress is political leadership. This trend takes on particular importance in view of the unrelenting urbanisation of humanity.***

Smart Cities – a European priority and opportunity For the first time in history, more than half of the world's population now live in towns and cities. By 2030 this number will swell to almost 5 billion, with urban growth concentrated in Africa and Asia with many mega-cities (10 million + inhabitants). By 2050, 70% of humanity will live in cities. That's a profound change and will demand a different development and management approach from what is possible today. Europe's urban, human-centric civilization has its roots in the ancient world and continues to stand out for spatial organization, aesthetic and cultural value, public services and spaces, and social integration. Europe's cities can be models for tomorrow's world. ***Europe's Innovation Partnership for Smart Cities and Communities needs to be seen in this context not only for our own urban development based on digital systems integration, but also as a virtually limitless opportunity for European innovators in this space to export their experience and know-how to the world***.

- Can we power the billions of devices in a sustainable and an energy efficient way?
- Can we use the opportunity of deploying new devices to gain a quantum leap in energy efficiency (1000 times more efficient)?
- How can Cloud technology be used to further the benefits of a Green / sustainable economy?
- How will the ‘knowing society’ act as a catalyst for reduction of energy consumption
- What new policies are needed and how will they impact the lives of citizens?

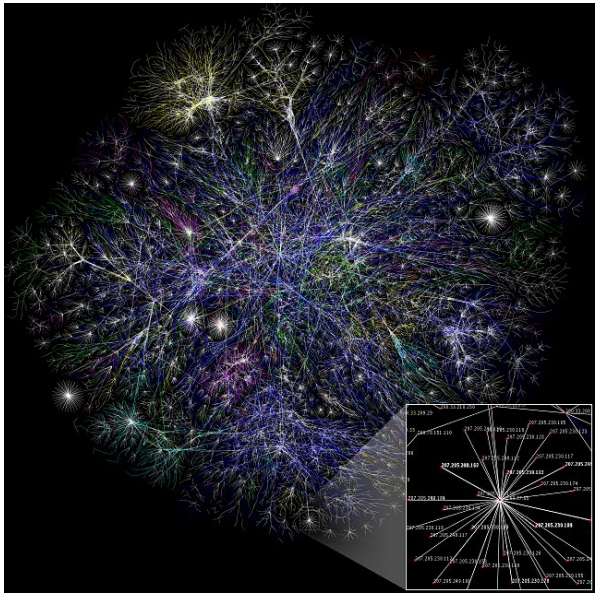
GreenTouch™

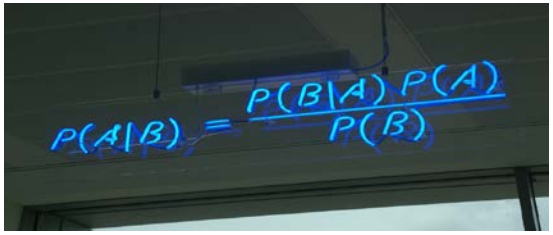
Why it matters?

Greentouch: To deliver the architecture, specifications and roadmap to increase network energy efficiency by a factor of 1000 compared to 2010 levels.

Proposition : *A smart city is a 'learning city' and hence network is at the center of the City. The 'learning' being defined as 'machine learning' i.e. a system that improves with experience ..*

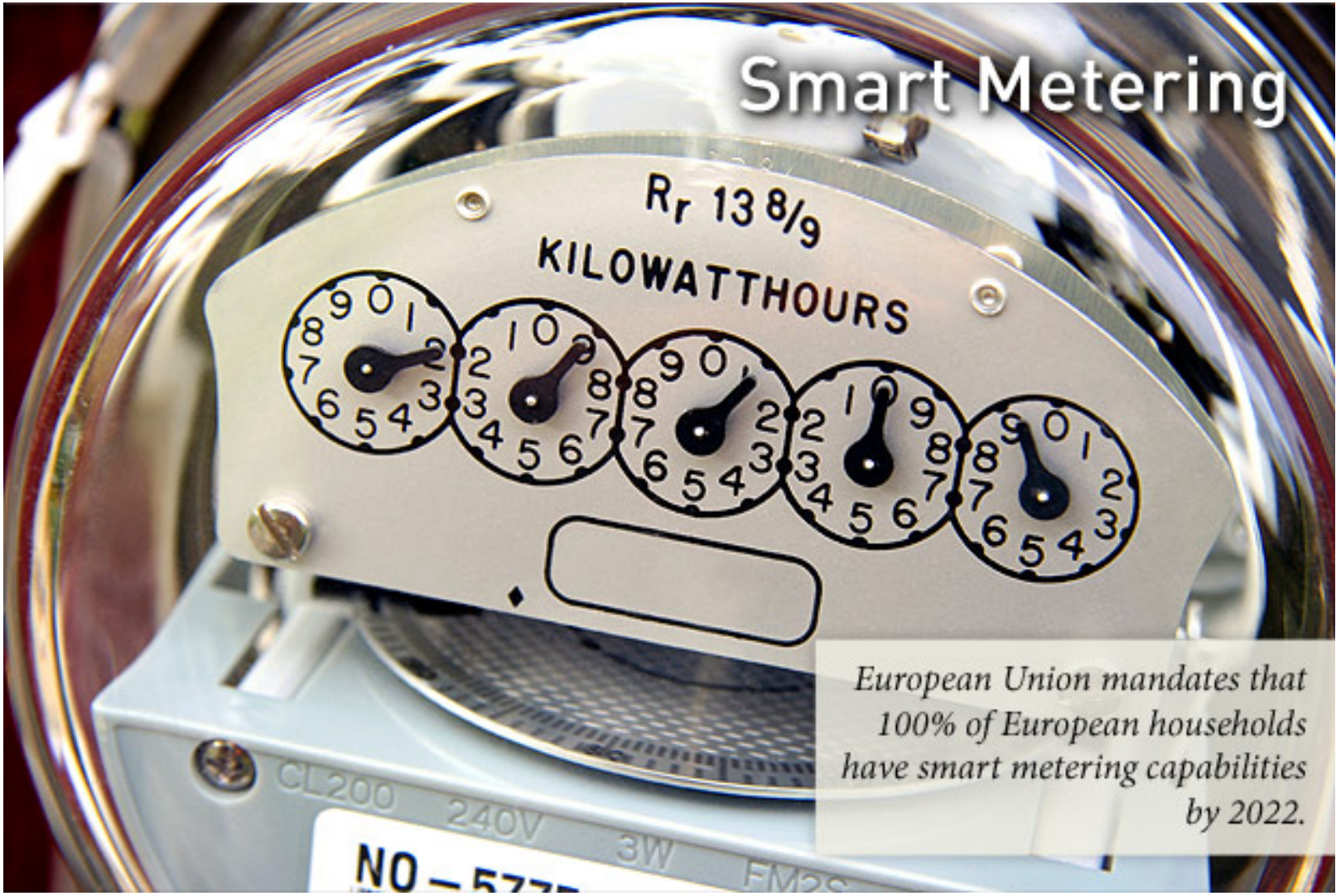
Image Source: Libellium.





Network energy efficiency by a factor of 1000 – will drive an intelligent/learning city

- Model a city mathematically
- Overlay sensor information
- Add predictive/machine learning algorithms to the data generated



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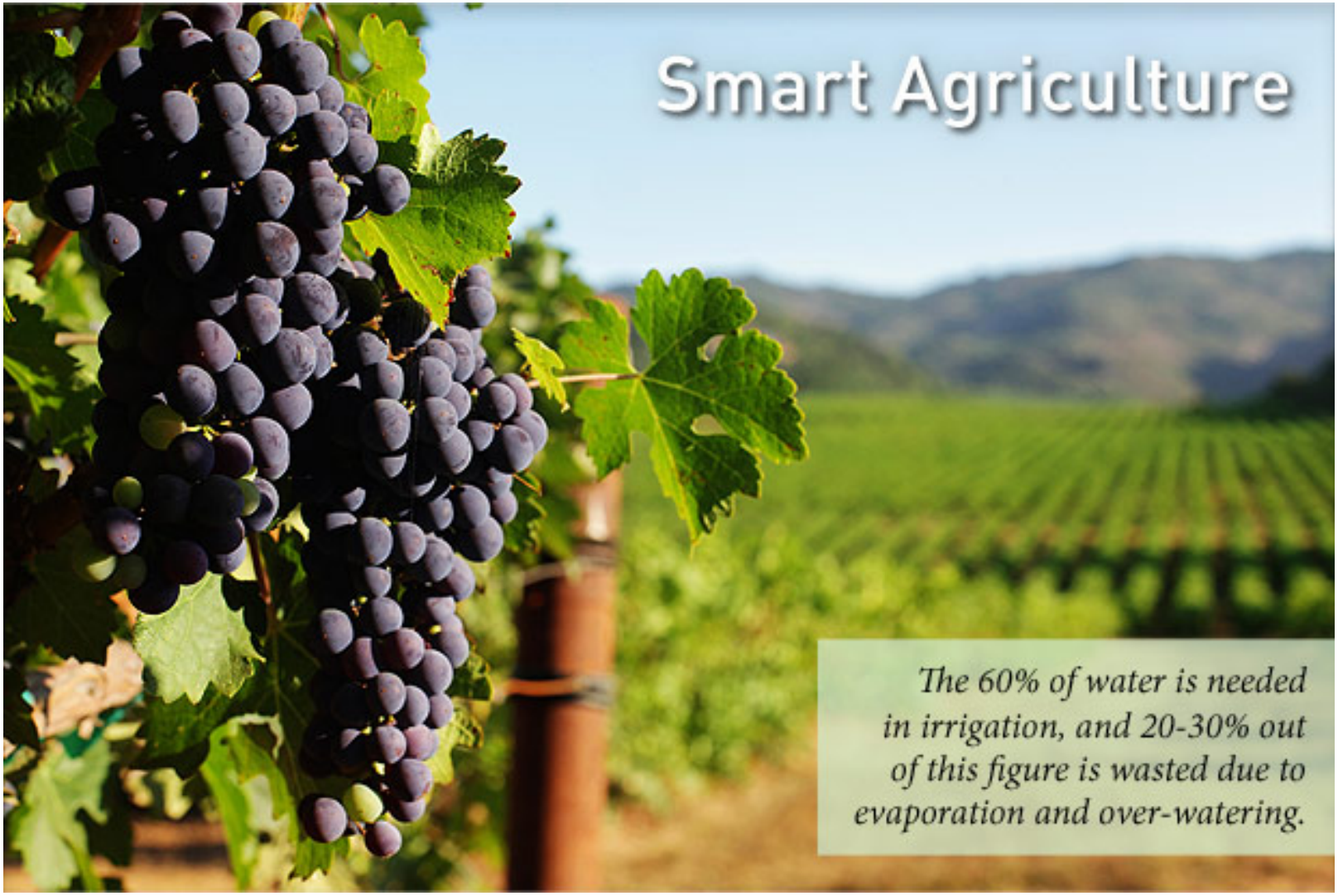

Source: Libellium.

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The story is not about incremental evolution of today's technologies. **It's about "5G"**, the next revolution in network technology. **5G network technologies will make the network like the air we breathe…**

5G will be a key focus for competitiveness for nations (European and Global) in the near future and impact the world of 50 billion devices

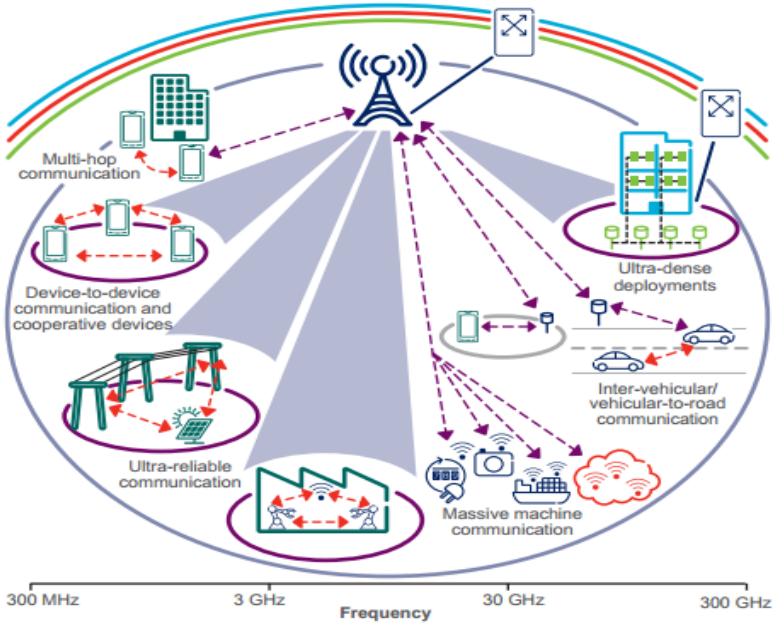


Figure 3: 5G radio access is an integrated set of technologies addressing a wide variety of use cases and requirements.

Machine Learning

What is Machine Learning?

Mitchell's Machine Learning

Tom Mitchell in his book Machine Learning

"The field of machine learning is concerned with the question of how to construct computer programs that automatically improve with experience."

More formally:

"A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E."

Think of it as a design tool where we need to understand: What data to collect for the experience (E)
What decisions the software needs to make (T) and
How we will evaluate its results (P).

What Problems Can Machine Learning Address? (source Jason Brownlee)

- **Spam Detection:** Given email in an inbox, identify those email messages that are spam and those that are not. (classification)

- **Credit Card Fraud Detection:** Given credit card transactions for a customer in a month, identify those transactions that were made by the customer and those that were not.

Digit Recognition: Given zip codes hand written on envelops, identify the digit for each handwritten character. A model of this problem would allow a computer program to read and understand handwritten zip codes and sort envelops by geographic region.

- **Speech Understanding:** Given an utterance from a user, identify the specific request made by the user. A model of this problem would allow a program to understand and make an attempt to fulfil that request. The iPhone with Siri has this capability.

- **Face Detection:** Given a digital photo album of many hundreds of digital photographs, identify those photos that include a given person.

●**Product Recommendation:** Given the purchase history for a customer and a large inventory of products, identify those products in which that customer will be interested and likely to purchase. A model of this decision process would allow a program to make recommendations to a customer and motivate product purchases.

Amazon has this capability. Also think of Facebook, Google+ and Facebook that recommend users for you to connect with.

●**Medical Diagnosis:** Given the symptoms exhibited in a patient and a database of anonymized patient records, predict whether the patient is likely to have an illness. A model of this decision problem could be used by a program to provide decision support to medical professionals.

●**Stock Trading:** Given the current and past price movements for a stock, determine whether the stock should be bought, held or sold. A model of this decision problem could provide decision support to financial analysts.

● **Customer Segmentation:** Given the pattern of behaviour by a user
during a trial period and the past behaviours of all users, identify those usersthat will convert to the paid version of the product and those that will not.
A model of this decision problem would allow a program to trigger customer interventions to pe rsuade the customer to covert early or better engage in a limited trial.

●**Shape Detection:** Given a user hand drawing a shape on a touch screen
and a database of known shapes, determine which shape the user was tryingto draw. A model o f this decision would allow a program to show the platonicversion of that shape the user drew t o make crisp diagrams. The Instaviz iPhone app does this.

So, why not a whole (learning) city instrumented by sensors and powered by optimized networks and algorithms ...

Types of Problems

•**Classification:** Data is labelled meaning it is assigned a class, for example spam/non-spam or fraud/non-fraud. The decision being modelled is to assign labels to new unlabelled pieces of data. This can be thought of as a discrimination problem, modelling the differences or similarities between groups.

•**Regression:** Data is labelled with a real value rather than a label. Examples that are easy to understand are time series data like the price of a stock over time. The decision being modelled is the relationships between inputs and outputs.

Clustering: Data is not labelled, but can be divided into groups based on similarity and other measures of natural structure in the data. An example from the above list would be organising pictures by faces without names, where the human user has to assign names to groups, like iPhoto on the Mac.

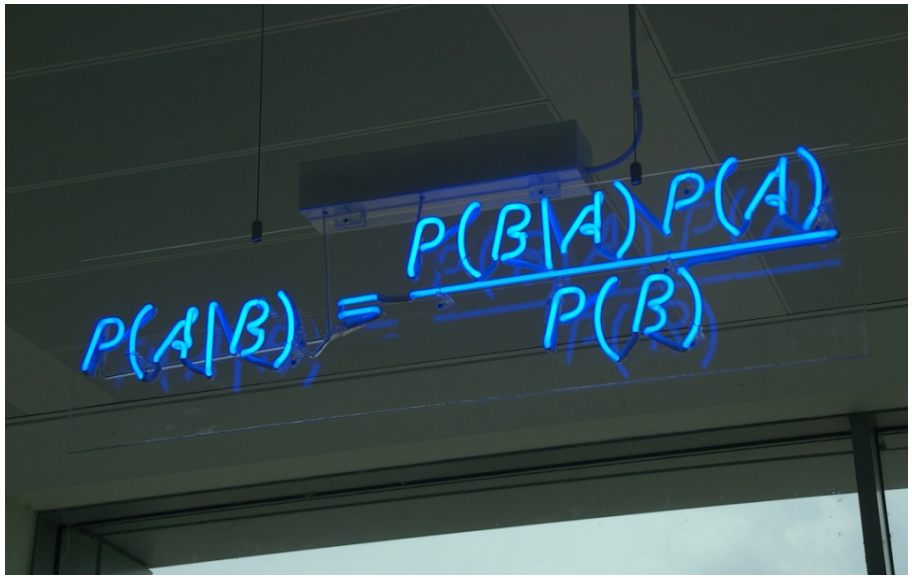
●**Rule Extraction:** Data is used as the basis for the extraction of propositional rules (antecedent/consequent or if-then).
Often necessary to work backwards from a Problem to the algorithm and then work with Data.
Hence, you need a depth of domain experience and also algorithm experience

Bayesian

Bayesian methods are those that are explicitly apply Bayes' Theorem for problems such as c lassification and regression.

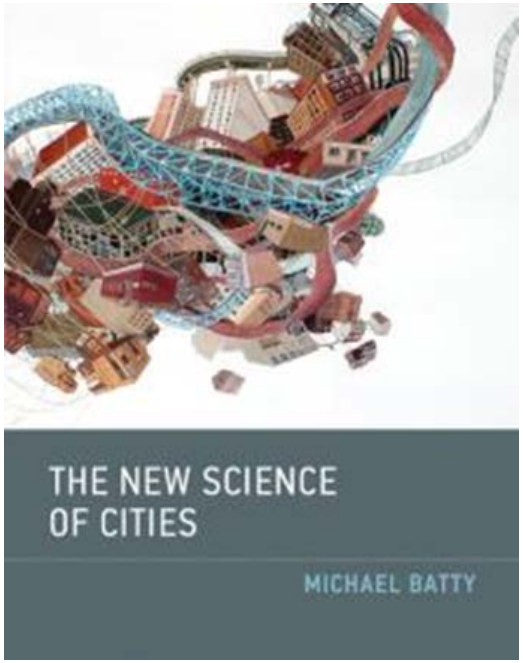
Naive Bayes, Averaged One-Dependence Estimators (AODE) ,

Bayesian Belief Network (BBN)



A Smart City and Machine Learning: A city that learns ..

- How can mathematical models help us understand contemporary cities?
- Michael Batty – Complexity theory (New Science of cities)

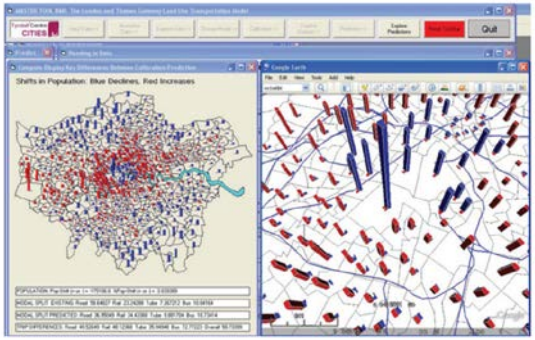


- Interpret cities as ‘sets of actions, interactions, and transactions’
- Design and decision-making processes can be supplemented and enhanced by mathematical modelling and simulation tools.
- Building blocks of complexity and network theory – flows, relations, connectivity, networks, hierarchies, spatial syntax, distance, fractals etc.
- Bottom up modelling (Organism) - organically structured activities that shape and influence urban systems.
- Complexity theory also rejects steady state assumptions about cities reflecting more closely disruptive events, social and political change and Climate change
- Small changes rather than comprehensive masterplans are more effective in steering urban development processes towards more desirable futures conditions (whether they are labelled as liveable, sustainable, or resilient).

Visually-Driven Urban Simulation: exploring fast and slow change in residential location

Michael Batty - Centre for Advanced Spatial Analysis (CASA), University College London,

- The model is structured to distribute trips across competing modes of transport from employment to population locations.
- It is cast in an entropy-maximising framework which has been extended to measure actual components of energy—travel costs, free energy, and unusable energy (entropy itself i.e. measure of disorder)—and these provide indicators for examining future scenarios based on changing the costs of travel in the metro region.
- Flows defined as Tijk are movements from origin zones i I ,1,2, , f to destination zones j J ,1,2, , f with respect to the mode of travel k K ,1,2,f .



$$\sum_i \sum_j T_{ij}^k c_{ij}^k = C_t,$$

http://www.libelium.com/top_50_iot_sensor_applications_ranking/

Smart Cities

What can be measured and predicted?

- **Smart Parking**: Monitoring of parking spaces availability in the city.
- **Structural health**: Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.
- **Noise Urban Maps**: Sound monitoring in bar areas and centric zones in real time.
- **Smartphone Detection**: Detect iPhone and Android devices and in general any device which works with WiFi or Bluetooth interfaces.
- **Eletromagnetic Field Levels**: Measurement of the energy radiated by cell stations and WiFi routers.
- **Traffic Congestion**: Monitoring of vehicles and pedestrian levels to optimize driving and walking routes.
- **Smart Lighting**: Intelligent and weather adaptive lighting in street lights.
- **Waste Management**: Detection of rubbish levels in containers to optimize the trash collection routes.
- **Smart Roads**: Intelligent Highways with warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

- **Forest Fire Detection**: Monitoring of combustion gases and preemptive fire conditions to define alert zones.
- **Air Pollution**: Control of CO2 emissions of factories, pollution emitted by cars and toxic gases generated in farms.
- **Snow Level Monitoring**: Snow level measurement to know in real time the quality of ski tracks and allow security corps avalanche prevention.
- **Landslide and Avalanche Prevention**: Monitoring of soil moisture, vibrations and earth density to detect dangerous patterns in land conditions.
- **Earthquake Early Detection**: Distributed control in specific places of tremors.
- **Smart Water**: Potable water monitoring Monitor the quality of tap water in cities.
- **Chemical leakage detection in rivers**: Detect leakages and wastes of factories in rivers.
- **Swimming pool remote measurement**: Control remotely the swimming pool conditions.
- **Pollution levels in the sea**: Control realtime leakages and wastes in the sea.
- **Water Leakages**: Detection of liquid presence outside tanks and pressure variations along pipes.
- **River Floods**: Monitoring of water level variations in rivers, dams and reservoirs.
- **Smart Metering**: Smart Grid Energy consumption monitoring and management.

- **Tank level**: Monitoring of water, oil and gas levels in storage tanks and cisterns.
- **Photovoltaic Installations**: Monitoring and optimization of performance in solar energy plants.
- **Water Flow**: Measurement of water pressure in water transportation systems.
- **Silos Stock Calculation**: Measurement of emptiness level and weight of the goods.
- **Perimeter Access Control**: Access control to restricted areas and detection of people in non-authorized areas.
- **Liquid Presence**: Liquid detection in data centers, warehouses and sensitive building grounds to prevent break downs and corrosion.
- **Radiation Levels**: Distributed measurement of radiation levels in nuclear power stations surroundings to generate leakage alerts.
- **Explosive and Hazardous Gases**: Detection of gas levels and leakages in industrial environments, surroundings of chemical factories and inside mines.
- **Supply Chain Control**: Monitoring of storage conditions along the supply chain and product tracking for traceability purposes.
- **NFC Payment**: Payment processing based in location or activity duration for public transport, gyms, theme parks, etc.
- **Intelligent Shopping Applications**: Getting advices in the point of sale according to customer habits, preferences, presence of allergic components for them or expiring dates.

- **Smart Product Management**: Control of rotation of products in shelves and warehouses to automate restocking processes.
- **Quality of Shipment Conditions**: Monitoring of vibrations, strokes, container openings or cold chain maintenance for insurance purposes.
- **Item Location**: Search of individual items in big surfaces like warehouses or harbours.
- **Storage Incompatibility Detection**: Warning emission on containers storing inflammable goods closed to others containing explosive material.
- **Fleet Tracking**: Control of routes followed for delicate goods like medical drugs, jewels or dangerous merchandises.
- **M2M Applications**: Machine auto-diagnosis and assets control.
- **Indoor Air Quality**: Monitoring of toxic gas and oxygen levels inside chemical plants to ensure workers and goods safety.
- **Temperature Monitoring**: Control of temperature inside industrial and medical fridges with sensitive merchandise.
- **Ozone Presence**: Monitoring of ozone levels during the drying meat process in food factories.
- **Indoor Location**: Asset indoor location by using active (ZigBee) and passive tags (RFID/NFC).
- **Vehicle Auto-diagnosis**: Information collection from CanBus to send real time alarms to emergencies or provide advice to drivers.

- **Wine Quality Enhancing**: Monitoring soil moisture and trunk diameter in vineyards to control the amount of sugar in grapes and grapevine health.
- **Green Houses**: Control micro-climate conditions to maximize the production of fruits and vegetables and its quality.
- **Golf Courses**: Selective irrigation in dry zones to reduce the water resources required in the green.
- **Meteorological Station Network**: Study of weather conditions in fields to forecast ice formation, rain, drought, snow or wind changes.
- **Compost**: Control of humidity and temperature levels in alfalfa, hay, straw, etc. to prevent fungus and other microbial contaminants.
- **Hydroponics**: Control the exact conditions of plants grown in water to get the highest efficiency crops.
- **Offspring Care**: Control of growing conditions of the offspring in animal farms to ensure its survival and health.
- **Animal Tracking**: Location and identification of animals grazing in open pastures or location in big stables.
- **Toxic Gas Levels**: Study of ventilation and air quality in farms and detection of harmful gases from excrements.

- **Energy and Water Use**: Energy and water supply consumption monitoring to obtain advice on how to save cost and resources.
- **Remote Control Appliances**: Switching on and off remotely appliances to avoid accidents and save energy.
- **Intrusion Detection Systems**: Detection of windows and doors openings and violations to prevent intruders.
- **Art and Goods Preservation**: Monitoring of conditions inside museums and art warehouses.
- **Fall Detection**: Assistance for elderly or disabled people living independent.
- **Medical Fridges**: Control of conditions inside freezers storing vaccines, medicines and organic elements.
- **Vital signs** : monitoring in high performance centers and fields.
- **Patients Surveillance**: Monitoring of conditions of patients inside hospitals and in old people's home.
- **Ultraviolet Radiation**: Measurement of UV sun rays to warn people not to be exposed in certain hours.

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Personal research – Machine learning and IoT

Machine learning techniques

- Supervised and unsupervised learning
- Neural Networks
- Machine Learning System Design
- Clustering
- Anomaly Detection
- Recommender Systems
- Large-Scale Machine learning systems
- Programming paradigms and Languages for machine learning
- Computation at the edge or Computation at the core

Problem domains include:

- Prediction Examples based on datasets (energy, pollution)
- Optimization based (traffic routing, commute optimization)
- Pattern identifying (predict hotspots based on health care data)
- New business processes based on machine learning for objects that have to navigate an unpredictable domain (driverless cars, drones)

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