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GSDM Global Leader Program for Social Design and Management

IBM

Innovation in the Data-Rich World

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Outline

- **Innovation**
  - What is Innovation
  - Characteristics of Innovation
  - Holistic View
- **Data**
  - Smarter Planet
  - Case Studies
  - General Model & Vision
- **Obstacles & Path Forward**
- **Summary**

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What Is Innovation ?

Innovation has never been more important – it creates value and drives growth

Innovation is…

in•no•va•tion \ˌi-nə-ˈvā-shən\ *Noun*

Origin: *Latin,* 1548
Derives from the Latin word *innovatus*, past participle of *innovare,* "to make changes; do something in a new way," from *in-* + *novus*—"new"[1]

Innovation: Utilizing new Ideas that create value, which can become a major source of strategic advantage and economic benefit

- **Innovation** refers to the usage of a new idea or method
- **Invention** refers to the creation of the new idea or the method

- **Innovation** requires doing things in a different way
- **Improvement** is only about doing better

- **Innovation is NOT:**
  - "Incrementalism," or business-as-usual thinking
  - New ideas or R&D that do not create value
  - "Creativity" for the sake of creativity

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Is This Innovation ?

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Is This Innovation ?

Innovation Creates VALUE

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Timing is Everything!

"**It's always about timing**. If it's too soon, no one understands. If it's too late, everyone's forgotten."
– Anna Wintour, editor-in-chief, Vogue

2000, 2001

- **IBM LinuxWatch & WatchPad**
  - First Linux Watch, 2.2 & 2.4
  - 74 Mhz ARM CPU, 8 MB Ram, 16 MB ROM
  - Touchscreen, 320x240
  - Bluetooth

1994

- **IBM Simon: World's First Smartphone**
  - First cellphone + PDA
  - CPU 16MHz x86, 4.5-inch B&W 640×200 LCD display, stylus support for touch input, 1MB of RAM, 1 MB memory card support
  - Phone calls, add contacts, task lists, check "mail" and use third party apps (via PCMCIA Card Slot)

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Timing is Everything!

"It's always abou t's too soon, no one und t's too late, everyone's f
– Anna Win Vogue

xWatch &
d
Linux Watch, 2.2
2.4
74 Mhz ARM CPU, 8
MB Ram, 16 MB ROM
Touchscreen, 320x240
– Bluetooth

2000, 2001 **2015**

1994

2007

• IBM phone
W
support for
B memory
k lists,
y apps

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Key Characteristics

"**We used to write this down by saying, 'move fast and break things.' And the idea was, unless you are breaking some stuff you are not moving fast enough**"
– Mark Zuckerberg, founder and CEO, Facebook

"**We thought we needed the solitary genius.** But if Alexander Graham Bell had fallen into the Grand River and drowned that day back in Brantford, the world would still have had the telephone, the only difference being that the telephone company would have been nicknamed Ma Gray, not Ma Bell"
– Malcolm Gladwell, author and social scientist

- Speed
- Iteration
- Ecosystem
- Timing
- Multidisciplinary
- Collaborative
- Co-Created

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"**The Googly thing is to launch [products] early on Google Labs and then iterate**, learning what the market wants — and making it great.' The beauty of **experimenting** in this way is that you never get too far from what the market wants. The market pulls you back."
– Marissa Mayer, CEO Yahoo, former VP, Google

"**Innovation almost always is not successful the first time out**. You try something and it doesn't work and it takes confidence to say we haven't failed yet. … Ultimately you become commercially successful."
– Clayton Christensen, Harvard Business School professor

"We are all looking for the magic formula. Well, here you go: **Creativity + Iterative Development = Innovation.**"
– James Dyson, founder, Dyson

Holistic View of Innovation

PI

Product & Service Innovation

Create or improve products to differentiate in the marketplace

- Product concept
- Product design
- Product use

OI

Operations Innovation

Revolutionize business processes to create efficiencies

- Operational models
- Process design
- Production technology

BMI

Business Model Innovation

Fundamentally change how the organization creates value

- Industry model
- Enterprise model
- Revenue model

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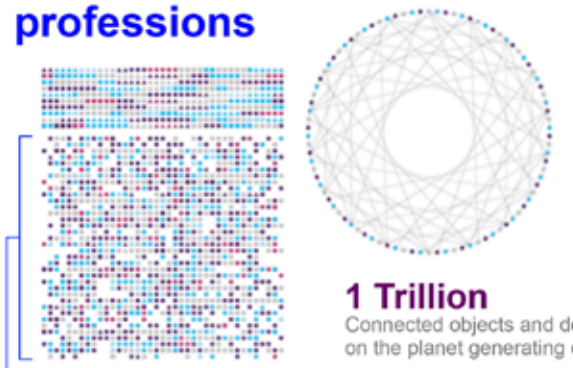
Data is the New Natural Resource, transforming industries and professions



- **Leaders Will:**
  - **Drive Business Outcomes** by applying more sophisticated analytics across more disparate data sources in more parts of their organizations
  - **Capture the time value of data** by developing "speed of insight" and "speed of action" as core differentiators
  - **Change the game in their industry or profession** with cognitive capability (Unstructured analysis)

1 Trillion
Connected objects and devices on the planet generating data

In 2014 alone, digitized data grew by 50% to 6 zetabytes
Growing to 40 Zettabytes by 2020 (IDC)

2.5 Trillion
Gigabytes (1 EB) of data generated every day (1 ZB/yr)

80%
Of the worlds data is unstructured. Audio. Video. Sensor data. Weather. Satellite. Mobile. Geo-Spatial. Social Media. All represent opportunities for analysis for value generation

"Data is the New Oil"
- Clive Humby - Association of National Advertiser Summit | Nov 3, 2006

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Trends: "Smarter Planet"

Interconnected Technologies Are Changing The Way The World Literally Works

An opportunity to think and act in new ways - economically, socially and technically.

Our world is becoming
INSTRUMENTED

Our world is becoming
INTERCONNECTED

Virtually all things, processes and ways of working are becoming
INTELLIGENT

1

Societal Need: Water Conservation

1) Case Study: California, USA

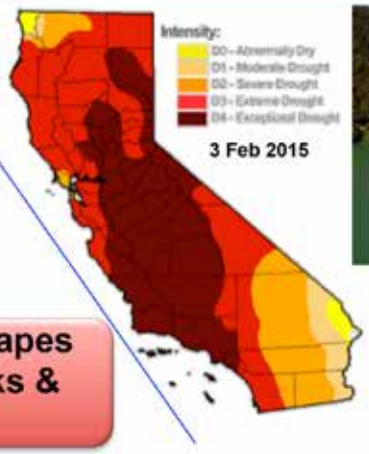
12% of Worlds Fresh Water in Brazil

41% of Water Used for Agriculture

4th Year of Historic Drought

2) São Paulo, Brazil

36% of treated water escapes system through leaks & illegal siphoning



http://upriser.com/posts/alarm-bells-toll-for-human-civilization-as-world-s-12th-largest-mega-city-is-running-out-of-water
http://www.bloomberg.com/news/articles/2015-03-03/sao-paulo-water-everywhere-not-enough-to-drink-corporate-brazil
http://mobile.nytimes.com/2015/02/17/world/americas/drought-pushes-sao-paulo-brazil-toward-water-crisis.html?referrer&_r=1
http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?CA
http://www.waterboards.ca.gov/waterrights/water_issues/programs/hearings/cachuma/exhibits_2012fws/cachuma_fwir_mu289.pdf
http://www.theatlantic.com/photo/2014/09/dramatic-photos-of-californias-historic-drought/100804/

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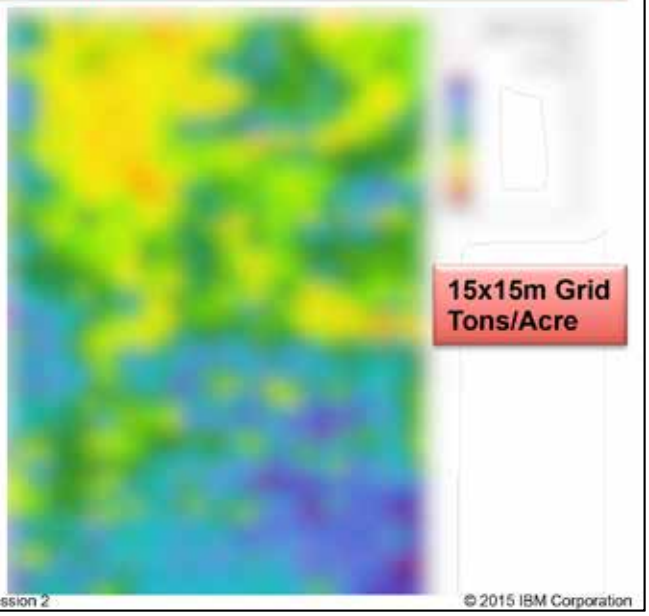
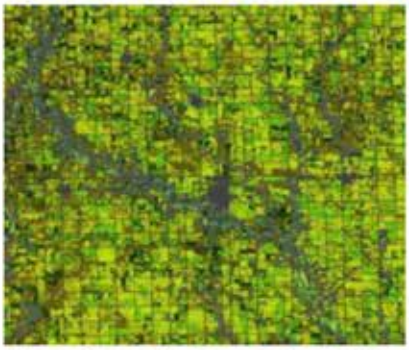
Data Sources in a Vineyard: After Harvesting

- Geospatial Yield Data



Real-Time or Near Real Time Data Sources in the Vineyard

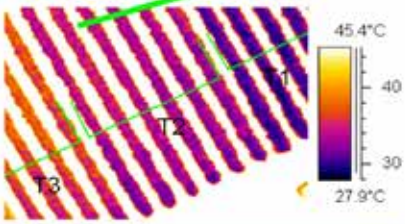


BigData:
LandSat
Images

Less moisture

Semi-spherical mirror

IR camera



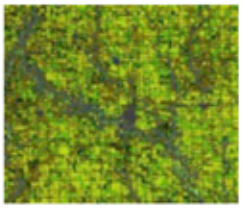
Large Area Infra-Red Imaging

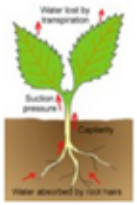
Sensors

Mote Technology

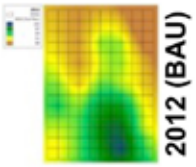
Results

Improving crop yields while reducing water consumption through physical analytics (PA)





Normalized Difference Vegetation Index



LandSat Image Processing → Plant transpiration model → Feedback to automated dripline irrigation → More uniform and higher vegetation index (Quality Metric)

- **Higher uniformity in growth in 2013 (physical analytics) compared to 2012 (BAU)**
- **Significant improvements in:**
  - **Yield**
  - Product **quality**
  - Reduced **variability**

VINTAGE REPORT 2014 INNOVATION AWARD

20 Jan. 2015

This year's winner was a collaborative experiment by **E. & J. Gallo and IBM**, whose approach used a variable-rate irrigation system across separate quadrants of a 31-acre Cabernet Sauvignon vineyard. The result decreased vineyard spatial variability and increased water-use efficiency without compromising quality during a period of historic drought.

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Results

Improving crop yields while reducing water consumption through physical analytics (PA)

Normalized Difference Vegetation Index

20% **Reduction in Irrigation Water Consumption, while improving yield and quality Through Utilizing Data and Physics**

- Higher uniformity in growth in 2013 (physical analytics) compared to 2012 (BAU)
- Significant improvements in:
  - Yield
  - Product quality
  - Reduced variability

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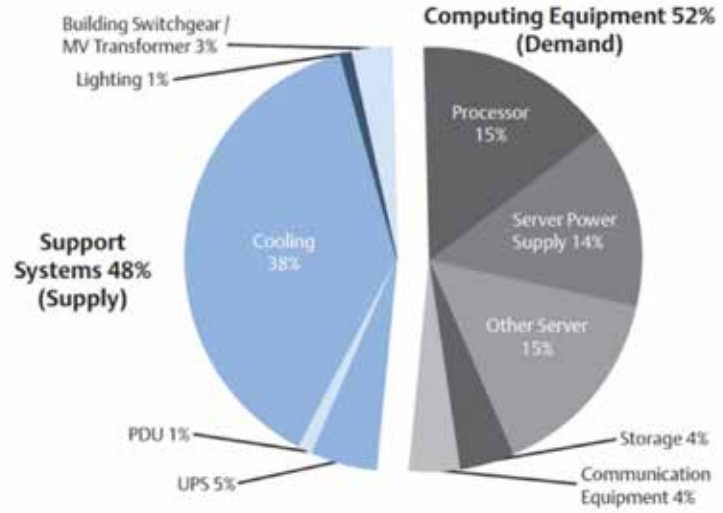
Societal Need: Energy Conservation in Data Centers



3% Electricity Consumed in Data Centers

10% Annual Increase Through 2020

20kW Power to One Dense Compute Rack

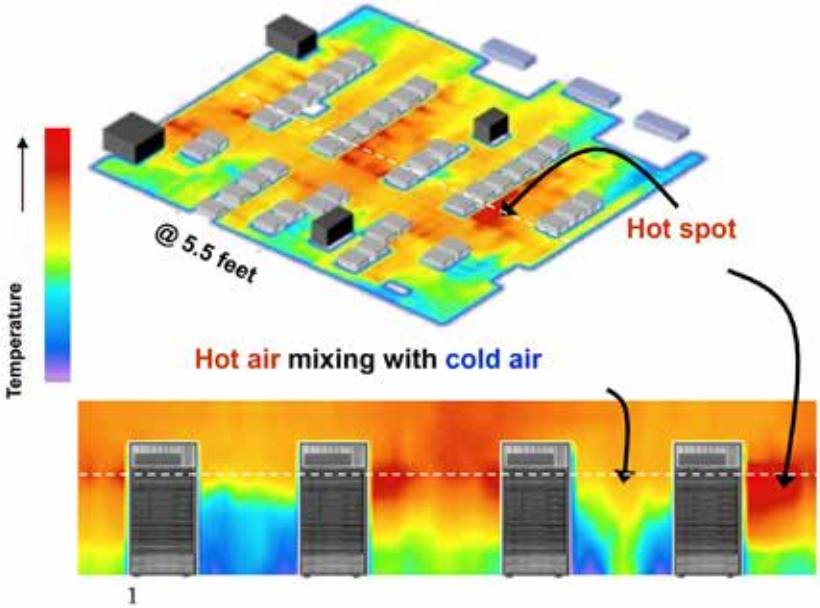
½ Data Center Electricity For Support Systems

- Every company utilizes data centers

http://www.energystar.gov/ia/products/power_mgt/ES_Data_Center_Utility_Guide.pdf
http://www.emersonnetworkpow[1].com/documentation/en-us/latest-thinking/edc/documents/white%20paper/energylogicreducingdatacenterenergyconsumption.pdf

Data and Approach

Mobile Data Acquisition Cart



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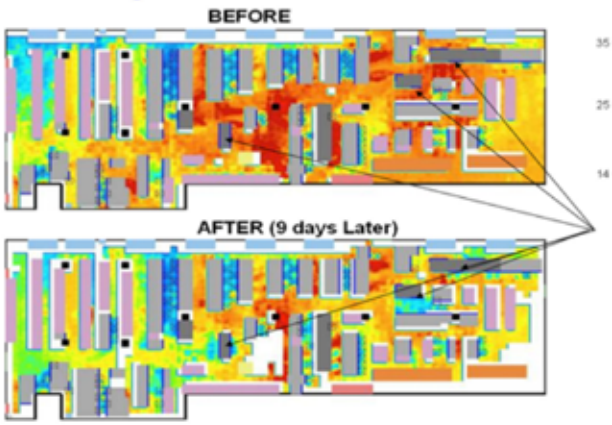
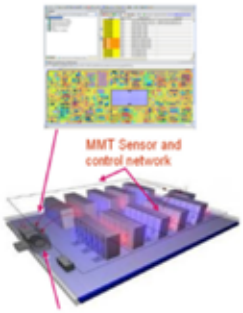
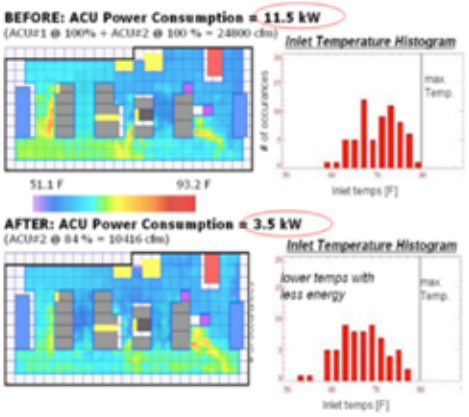
Example Results



- **Reduced air conditioning energy consumption without generating hotspots**
  - >2.5 x reduction in cooling power
  - Improved inlet temperatures

- **Improved thermal management**
  - Enabled accurate air flow provisioning to reduce hotspots by more than 8°F (4.4°C)
  - Improves chiller efficiency (>10 %)





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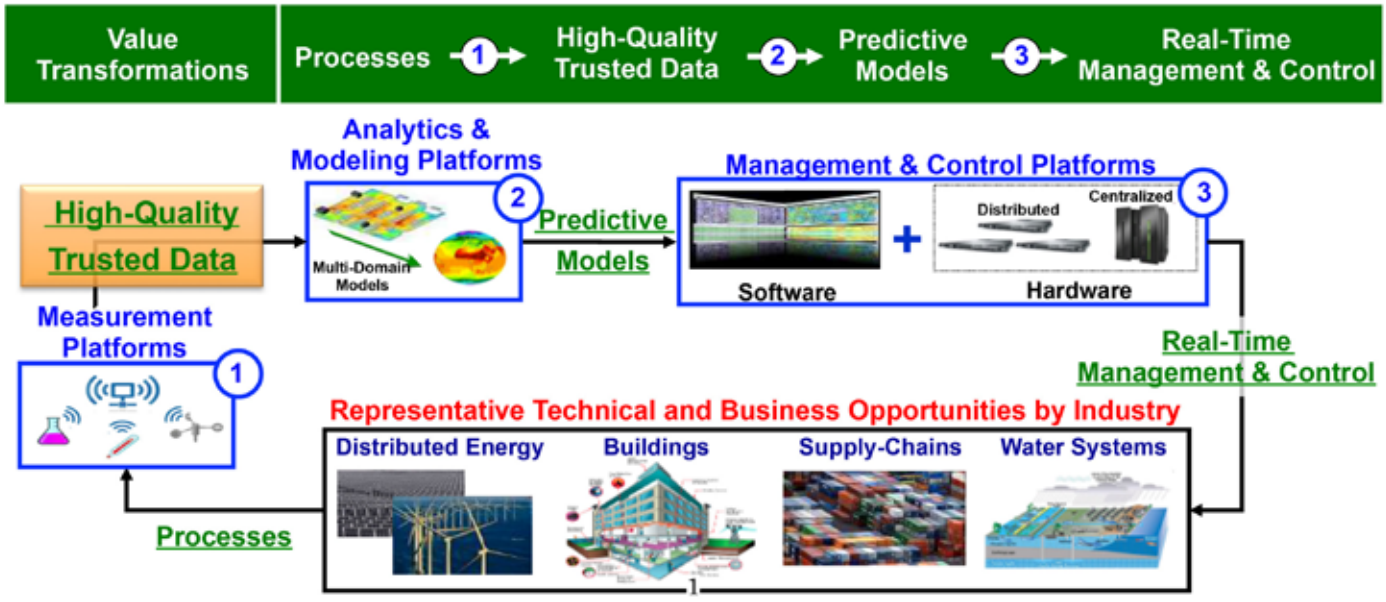
Example Results

10-15% **Energy Reduction on Average**

>500M kW-Hr **WW Energy Saving to Date in over 300 Data Centers**

- Improved thermal management
  - Enabled accurate air flow provisioning to reduce hotspots by more than 8 F
  - Improves chiller efficiency (>10 %)

Real-Time Measurement, Modeling & Control Platforms will Drive a Smarter Planet Through the Broad Implementation of Feedback Control



Real-Time Measurement, Modeling & Control Platforms will Drive a Smarter Planet Through the Broad Implementation of Feedback Control

- **Case Studies have shown that there is VALUE in using data to solve problems**
- **Leaders will implement these types of solutions on their own**
  - Cost Savings
  - Product Quality Improvement
  - Green Image

There are many different visions of a "smart city", built upon data

A "mission control" for infrastructure

A showcase for urban planning concepts

A totally "wired" city

A self-sufficient, sustainable eco-city

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Sources: NASA, Songdo IBD., Smartcitiescouncil.org.

Obstacles: Technological (T), Economical (E), Social (S)

- Privacy (T,S)
- Security (T)
- Inadequate Funding (E)
- Risk Avoidance (S)
- Siloing (T,S)
- Time Commitments (E)
- Incorrect Metrics / Measurements (E,S)
- Infrastructure Limitations (T,E)
- Ecosystem / Market / Client / Timing (T, E, S)

Potential Solutions Require **Security Solutions**, **Privacy Guarantees**, **Commitments** (Funding, Policy), and **Ecosystem** to Realize the Value Hidden in Data!

Soritatsu Kabe (そり立つ壁)

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The Path Forward:Building an Innovation Ecosystem and Economy

- **Solutions to the obstacles: Technical, Economic, Social**
- **Innovate across all sectors of the economy, not just in the high tech sector so that the productivity gains of innovation are widespread**
  - Maintain and enhance ***established industries***
  - Nurture and grow ***new industries***
- **Focus on partnerships between Academia / Government / Innovation Institutions / and Small & Mid-Size Companies, including Start Ups**
  - Large corporations may grow organically through Research innovations or inorganically through acquisitions
  - Small and Mid-Size companies are more agile and eager to grow, and willing to take risks to *move innovative, radical technologies from the lab to the market*
  - **Establish University-led Innovation Institutions** in partnership with the government as a focal point for industrial engagement
    - Fraunhofer (Germany), ITRI (Taiwan), INRIA (France), AMRC (UK), IRAP (Canada)
    - Technology, IP & People!
- **Human Capital Development: Continuing education and training of the experienced, skilled workforce to maintain and improve skills and learn how to adopt new technologies to improve products and processes**

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Summary: Innovation in the Data-Rich World

- **Innovation: refers to the usage of a new idea or method, requires doing things in a different way, creates value**
  - Multidisciplinary, Collaborative, Co-Created, Speed, Iteration, Ecosystem, Timing
  - Holistic View: **Product & Services, Operations, Business Model**
- **Data is the New Natural Resource, transforming industries and professions**
  - Technology Case Studies: Agriculture, Data Centers
  - Endless Opportunities to Innovate Using Data to Foster Progress & Growth
- **Osbtacles**
  - Security, Privacy Guarantees, Commitments, and Ecosystem **can be overcome**
- **The Path Forward**
  - Innovate across **all sectors of the economy**
  - Focus on **partnerships** between Academia / Government / Innovation Institutions / and Small & Mid-Size Companies, including Start Ups
  - **Human Capital Development: Continuing education** and training of the experienced, skilled workforce

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どうもありがとうございます

Thank You!

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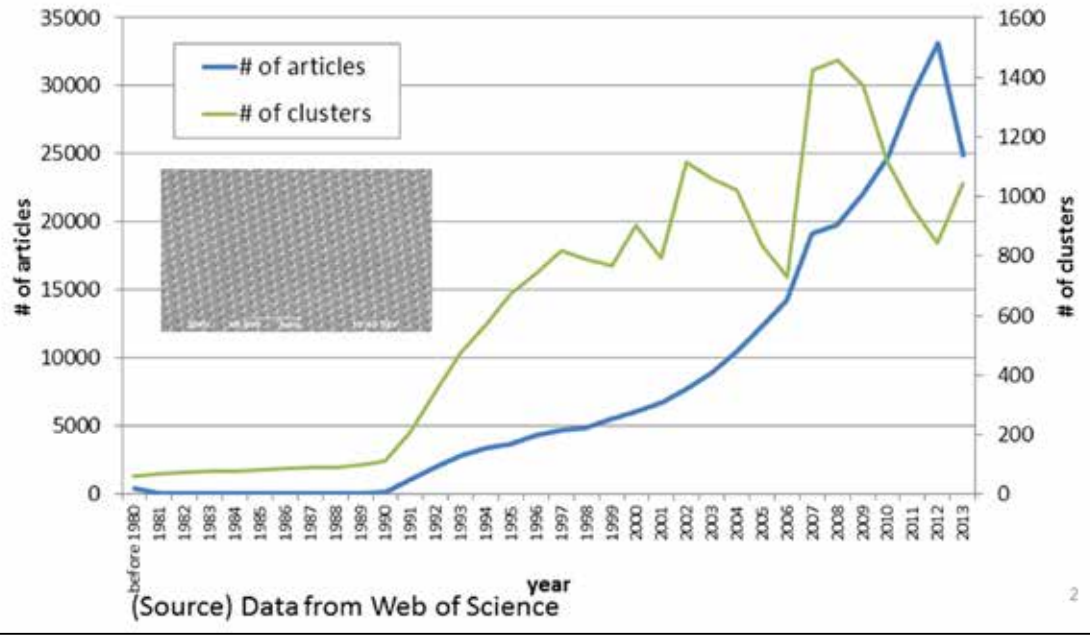
Computational Intelligence for Innovation management

Prof. Ichiro Sakata
Faculty of Engineering and PARI
The University of Tokyo

Rapid growth of knowledge

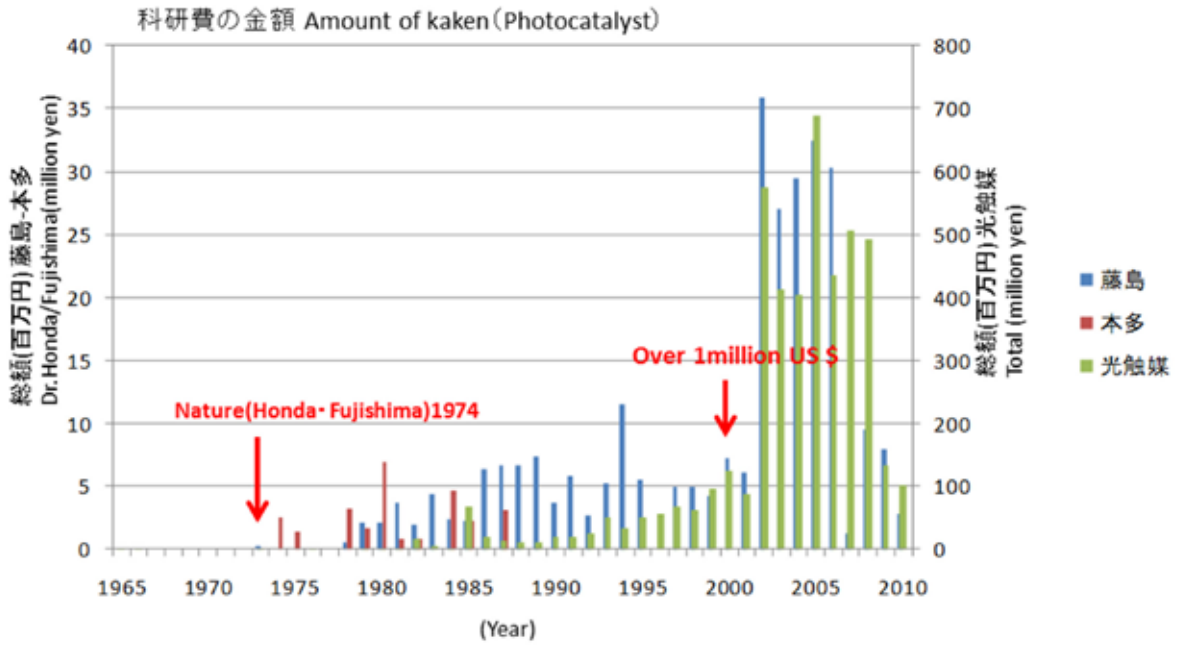
Example: Nano-Carbon field



(Source) Data from Web of Science

2

Difficulty of detection emerging domains



（Source) Sakata Lab and kajikawa Lab using Kaken DB

3

Limitation of expert-based approach

- Historically, such tasks have been handled by experts, such as by the so-called Delphi method initiated by the Rand Corporation of the US in the 1950s. These are known as the **social or expert based approach**.

- However, it becomes more **difficult** to create technological overview using an **expert-based approach** because:
  1) the amount of academic knowledge is increasing so fast that no expert can capture the entire knowledge structure of a specific knowledge domain;
  2) the expert-based approach is expensive and time consuming;
  3) the generally accepted definition of a targeted research field is sometimes lacking.

- Therefore, we have developed a **computer-based approach,** which analyzes explicit knowledge such as journal papers and letters.

4

Computational Intelligence for R&D management

Non-structured Information

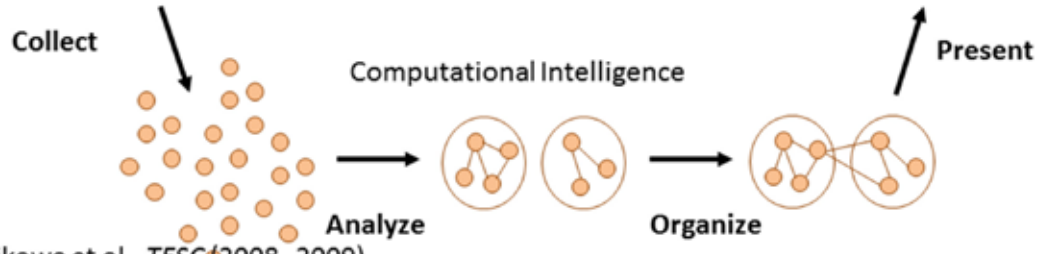
Vast amount of
- **Paper**
- **Patent**
- **Researcher**
- **Organization**

etc.

Structured Information

Observation of …
- **Trend of Science and Technology**
- **Emerging Research Field**
- **Complex Industrial Structure**
- **Collaboration Network**

etc.



Kajikawa et al., *TFSC* (2008, 2009)
Shibata et al., *Technovation* (2008)
Sakata et al., *TFSC* (2012)

5

Academic/ Industrial Technology Meta Analysis

①Knowledge structuring,②automatically detect emerging fields
③detect emerging research groups, ④indentify the potential of academic-Industry collaboration

(Source) Katsuhide Fujita, Yuya Kajikawa, Junichiro Mori, and Ichiro Sakata, Detecting Research Fronts Using Different Types of Weighted Citation Networks, Journal of Engineering and Technology Management 32 (2014) pp.129-146,
(Note) R&D supported by NEDO

Barriers for Computational Intelligence

1) Lack of reliable data of innovative activities
-Journal papers and patents are not enough.

2) Lack of public platform for handling innovation related big data

3) Lack organizational culture to actively take advantage of data science

Big Data Analysis from Social Media

Yutaka Matsuo
University of Tokyo

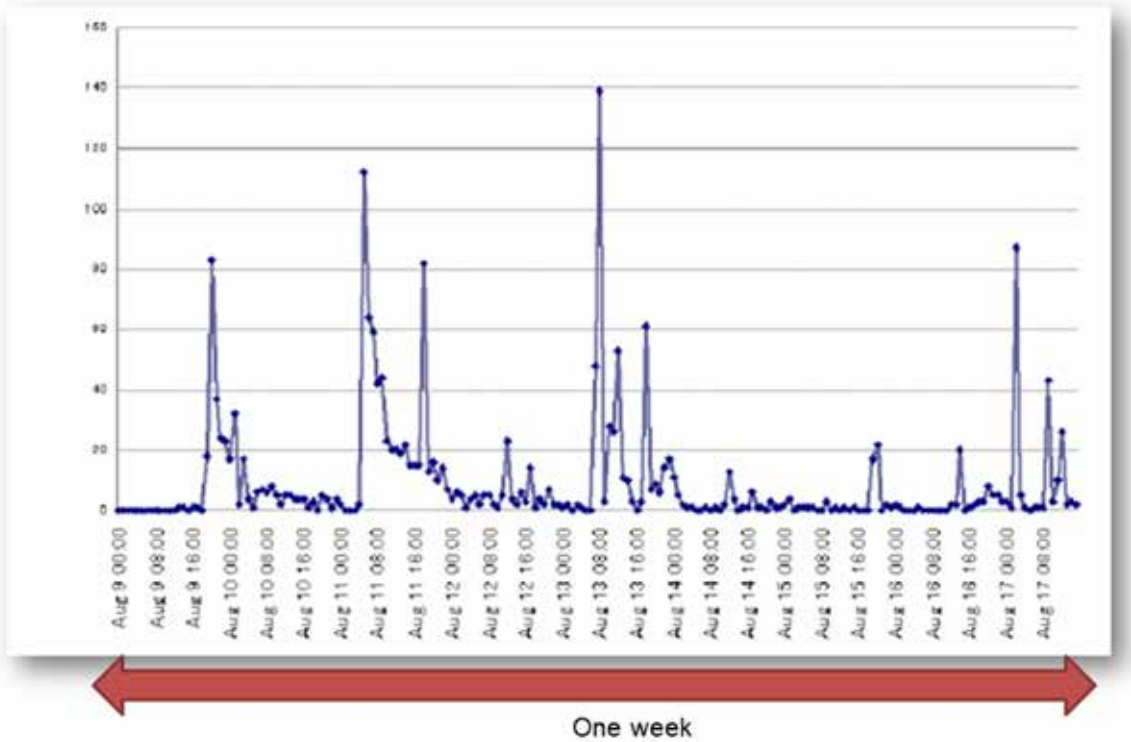
Yutaka Matsuo

Yutaka Matsuo is an associate professor at Department of Technology Management for Innovation (TMI), the University of Tokyo. He received his BS, MS, and Ph.D degrees from the University of Tokyo in 1997, 1999, and 2002 (supervised by Prof. Ishizuka). His major is web mining (especially on social network mining), text processing, and semantic web in the context of artificial intelligence research.

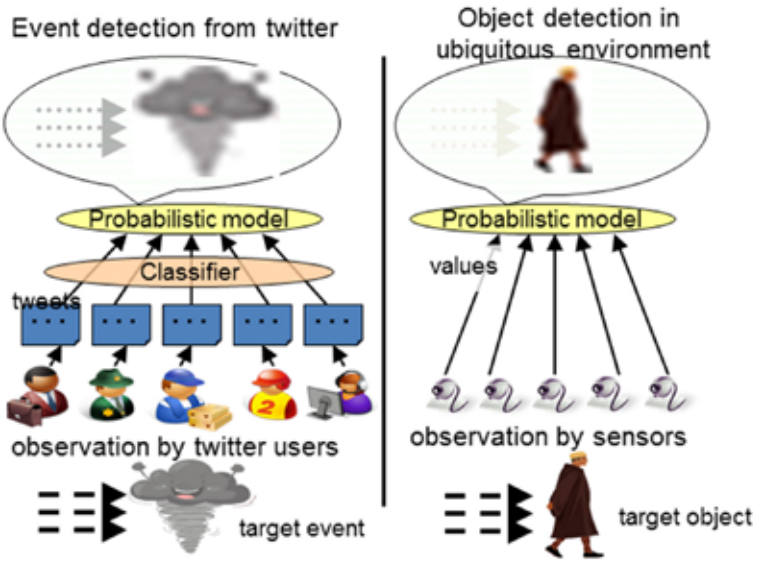
He is one of the prominent researchers in the information technology field in Japan. He wrote more than 50+ journal papers (including Japanese journals) for the past seven years besides 100+ international conference papers. He received the Japanese Society for Artificial Intelligence (JSAI) Best Paper Award in 2002, JSAI Anniversary Project Award in 2006, and Information Processing Society of Japan (IPSJ) Nagao Special Researcher Award in 2008. He joined the editorial committee of JSAI since 2004, and currently serves as editor-in-chief. He got Japan Society for the Promotion of Science (JSPS) Postdoctoral Fellowships for Research Abroad in 2005 and stayed for two years at Center for the Study of Language and Information (CSLI), Stanford University. After coming back to Japan, he joined the faculty of the University of Tokyo in 2007.

2

The Number of Japanese Tweets
Talking about Earthquakes



Social Sensors: Tweet as a Sensory Value



Predicting Society from Web Information: Earthquakes, traffic jam, flu, …

- Earthquake detection from Twitter: 2009-. WWW paper is cited 1000+ times.
  Traffic jam detection with Toyota

Earthquake

ワールドビジネスサテライト(2012/1/15)、
日経新聞1面(2012/3/25)、朝日新聞3面(2012/12/22)等

Traffic jam

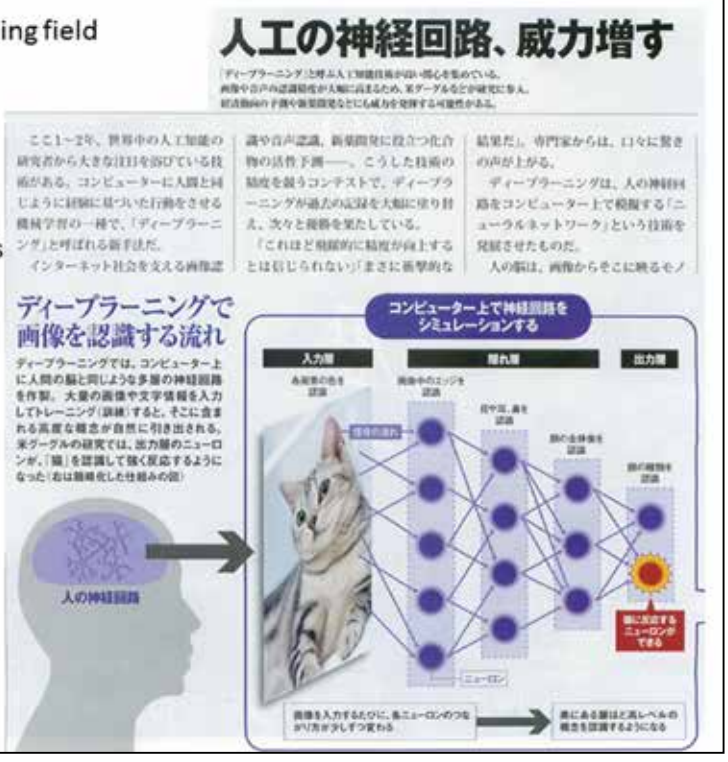
Flu

Deep Learning Community in Japan

- Breakthrough in machine learning field
- Multi-layer neural networks
- Learning "Representations"

- Organizing workshops
- Organizing articles and lectures

Jun 2014, Workshop on
"Whole-brain architecture"



人工の神経回路、威力増す

ディープラーニングで画像を認識する流れ

コンピューター上で神経回路をシミュレーションする

入力層 隠れ層 出力層

人の神経回路

日経ビジネス2013年4月15日号

Asia Trend Map: Forecasting "Cool Japan" Content Popularity on Web Data

- Anime, Manga and Game has become popular around the world.
- Japanese content industries are willing to promote their products overseas under the brand of "Cool Japan".
- However, localization processes (translation, promoting etc.) take costs a lot of money and time.

→ **Sellers need to grab the products' popularity in the market.**

Japan in London: Sushi, Manga, Cosplay and Camden - visitlondon.com
http://blog.visitlondon.com/2010/09/japan-in-london-sushi-manga-cosplay-and-camden/

2015/5/15

Project with METI (Ministry of Economy, Trade and Industry)

- Which manga/anime is popular in which country in Asia
- It can be considered as pre-marketing research.
- It can be expanded into automobiles, electrical appliances, fashion items, and so on.

Trend prediction model based on web information

http://asiatrendmap.jp

Chair of "Global Consumer Intelligence"

- Established April 2014 for 3 yrs in University of Tokyo
- Global consumer intelligence is the ability to understand global consumers from multiple angles and obtain integrated views of clusters of consumers from their lifestyles and values.
- It is more and more necessary because the companies has to understand consumers' potential needs and manage marketing based on them. On the other hand, the rapid progress of big data analysis enables this possible through latest technology of AI and web research.

Sponsorship

In corporation

Output of GCI chair: Education

- The objective of GCI chair is to educate students so that they can be a CMO (chief marketing officer) in large companies with skill of data analysis and the knowledge of marketing. It is a mixture among computer science, business management, economics, sociology under the recent progress of big data.

Conclusion

- We can observe society and real world through social media.
- It can be used to prediction and marketing.
- Research and education on global consumer intelligence (GCI) is important.
- A new machine learning technique, e.g., Deep learning (or representation learning), with social media may open a new frontier for prediction, analysis, and marketing.