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Topic in Part III?
(Research data infrastructure of Japan)

Inductively Think about Impacts of Open Platforms on Research

オープンなプラットフォームが研究に与える影響を帰納的に考える

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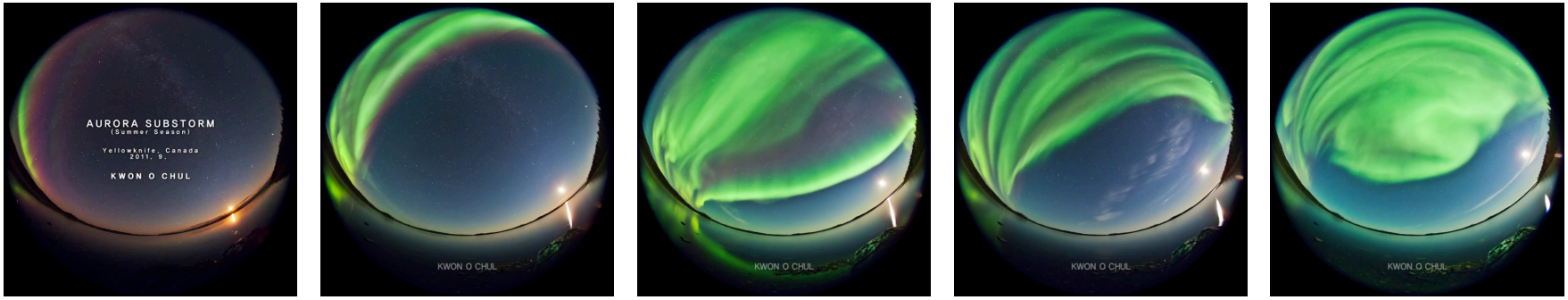
2015/10/21 SPARC Seminar@NII

My talk is about “What is e-Science?”

Tentative title of my talk in the proposal:

- “E-Science and research data 2
  - in case of the physics of the upper atmosphere –”
- I’m expected to talk about the following research:
  - “Forecasting Aurora Substorms from Observed Data with a Supervised Learning Algorithm”, Tanaka et al., 11th IEEE Intl. Conf. on eScience, Munich, Germany Aug 31- Sept 04, 2015



http://www.kwonochul.com/

Is this a Science?

Approach: Two Questions about e-Science

What is a difference between impacts of the 3rd and 4th pillars of Science?

Is it an e-Science if we use data ant analysis tools, such as machine learning?

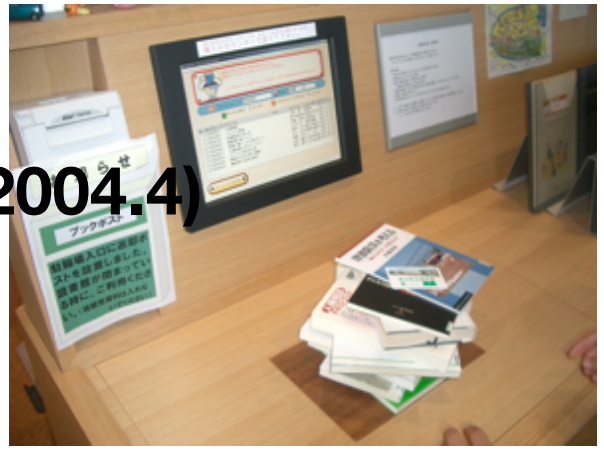
Educational Background

Bachelor: *Dept. of Physics*, Faculty of Sciences, Kyushu Univ.

Master: Dept. of Information System, Interdisciplinary Grad. School of Engineering Sciences, Kyushu Univ.

Doctor: Dept. of Informatics, Grad. School of Information Science and Electrical Engineering, Kyushu Univ.

Job & Research Career



Kyushu Univ. Computer Center (1997.4〜2004.4)

- HPC, Campus network and security
- Research: Web mining, text mining

Kyushu Univ. Library (2004.5〜2006.7)

- Infrastructure of scholarly communication, such as institutional repository, and Automatic identification (e.g., bar codes, RFID, IC cards)
- Research: Text mining (information extraction from the Web, spam detection)

Dept. of Informatics, Kyushu Univ. (2006.8〜)

- Research: Bioinformatics, e-Science, information retrieval, data infrastructures

Research Topics in My Lab

Data Analysis (Inductive approach):

- Mining from search histories and access logs
- Graph mining
- Finding a pure pattern in genomic sequences
- Mining from geotagged text (Tweets)
- Forecasting latent popular hashtags
- Authorship estimation from a Japanese historical texts
- Simulation for Emerging New Words (deductive)

Data Infrastructure:

- Context-aware information retrieval
  - create context vector from corpus
- Institutional Repository
- Infrastructure for Data Repository
- Database for Science

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Four Pillars for Science

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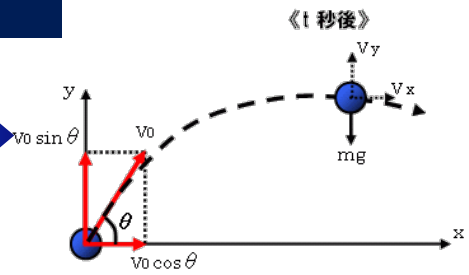
Traditional Pillars of Science

1. Theory

$$M\frac{d^2x}{dt^2} = F$$



速度
x方向：$V_x = V_0 \cos\theta$
y方向：$V_y = V_0 \sin\theta - gt$

距離
x方向：$V_x = t \cdot V_0 \cos\theta$
y方向：$V_y = t \cdot V_0 \sin\theta - \frac{1}{2}gt^2$

Deductive

General models
→ Individual phenomena

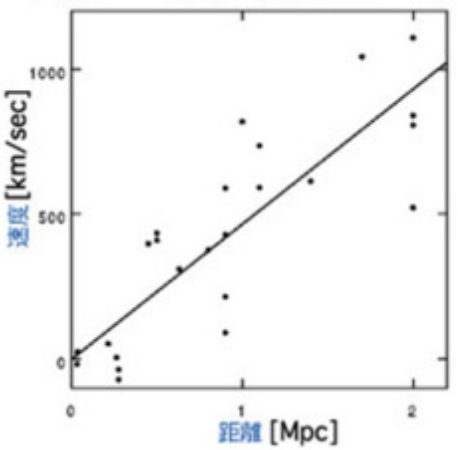
Inductive

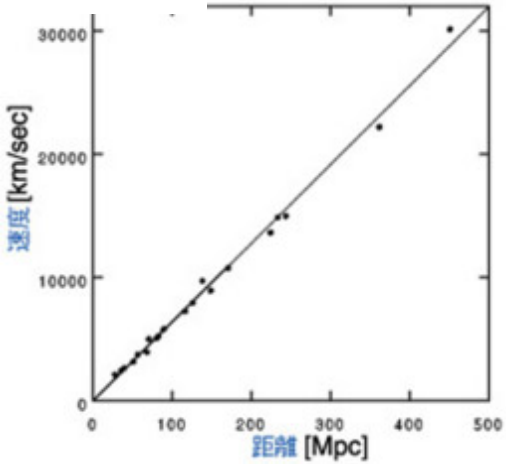
Individual instances
→ General models

2. Experimentation

a falling body and its mass

distance to astral bodies vs.
their recessional velocities





New Pillars of Science

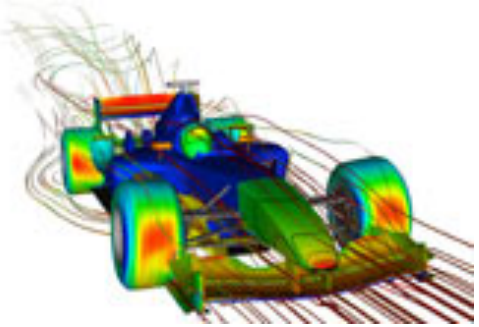
Deductive

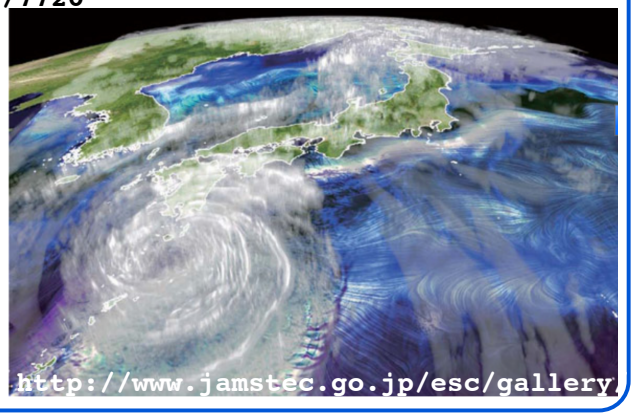
1. Theory

$$M\frac{d^2x}{dt^2} = F$$

3. Simulation

http://www.f1technical.net/news/7720





2. Experimentation

4. Data Science

High-speed network
sensing technologies
data analysis tools

Inductive

Examples in 3rd and 4th Pillars

3rd Pillar (simulation):

- Computer Simulation of Typhoons
- Computer Simulation of Atomic Bombs
- Computer Simulation of Forest Fires
- Computer Simulation of Stock Markets

→ Same Research Style (closed-style) with HPC

4th Pillar (data science):

- Computer Shougi (Japanese chess) Programs
  - Machine learning with records of professional games
- Automatic Driving
  - pattern recognition, such as image recognition
- Forecasting Influenza Epidemics with Search Records

→ High accurate recognition and prediction, but without (scientific) mechanism

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Impact of Open Platforms to Research

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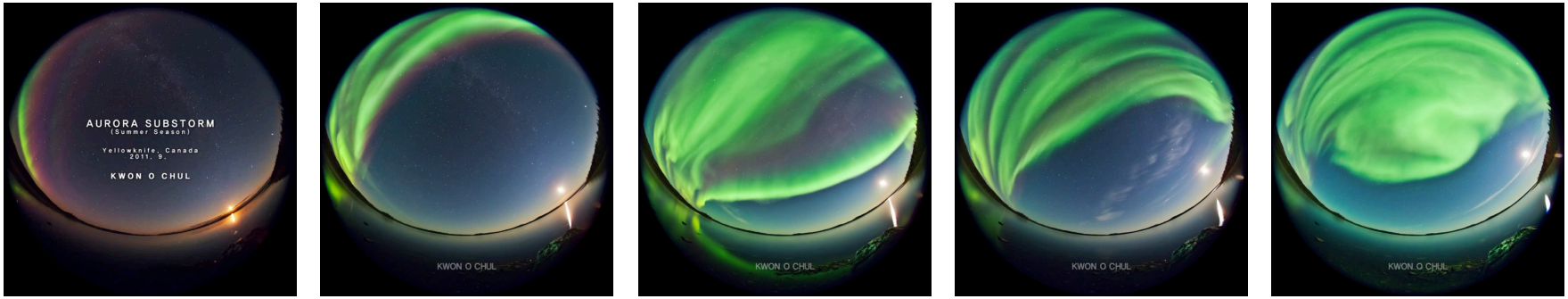
Example of e-Science: Auroral Substorms

Auroral Substorm:

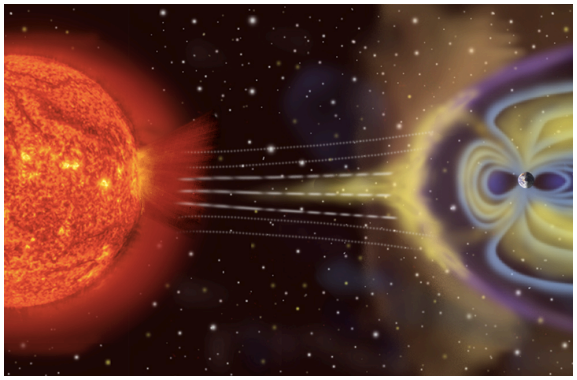
- sudden brightening and increased movement of auroral arcs
- detailed physical models still remains a subject of dispute.



http://www.kwonochul.com/

(Supervised) Machine learning from solar wind and geomagnetic field data

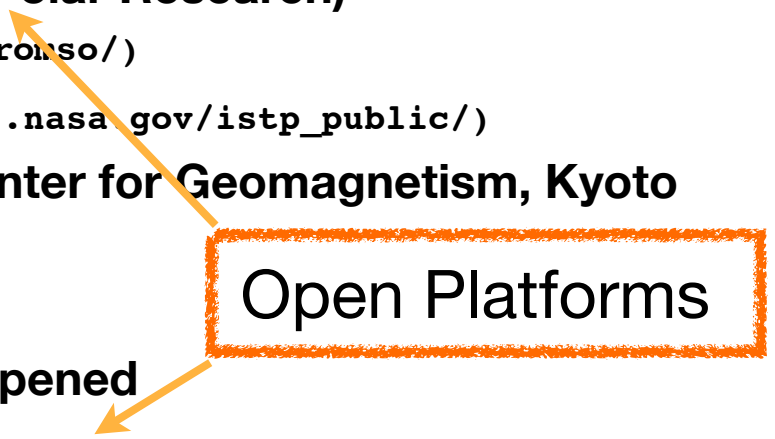
- training data: data with labels, that is, data collected when the phenomena happen or not.
- parameter tuning
- algorithm creates a *model* to classify unlabeled data.



http://sdo.gsfc.nasa.gov/mission/spaceweather.php

Process of "Auroral Substorms"

0. Hearing from domain experts
   - available data and its basic characteristics
1. Find data related to auroral activities
   - all-sky images from NIPR (National Inst. of Polar Research) (http://polaris.nipr.ac.jp/~acaurora/aurora/Tromso/)
   - solar wind from CDAWeb (http://cdaweb.gsfc.nasa.gov/istp_public/)
   - geomagnetic field data from World Data Center for Geomagnetism, Kyoto (http://wdc.kugi.kyoto-u.ac.jp/)
2. Create Training Data
   - manually identify when the phenomena happened
3. Apply some machine learning algorithms
   - LibSVM (http://www.csie.ntu.edu.tw/~cjlin/libsvm/)
4. Evaluate the results with domain experts



Collaboration with unknown people

Open Software for Science

Impact for business: LAMP

- Linux (OS), Apache (Web server), MySQL (DB), PHP/Perl/Python (Programming language)
- Programming skills are necessary to use LAMP.

Impact for Science

- Programming Language (including R)
- Scientific Libraries
  - Linear Algebra
  - Fourier Transform
  - Plotter (Graphics)
  - Machine Learning
  - Data Mining
  - Statistics
  - Natural Language Processing

Easy to use state-of-the-art data analysis tool

Fine-grained Unit of Scholarly Communication

Data Journals

Ecological Researchは日本生態学会が刊行する英文誌で、水域・陸域を問わず、あらゆる生態学の領域において、生態学についての理解を本質的に発展・変化させる論文を掲載します。単純な記載論文や、既存の研究論文の単純な繰り返しや改変は査読対象となりません。出版される論文のタイプは、Original articles, Current topics in ecology (総説), Special features, Technical reports, Notes and comments, Data papers, Forumです。また、「Biodiversity in Asia—アジアにおける生物多様性」についての論文を掲載したいと計画しています。

Ecological Research
(Ecological Soc. of Japan)

Database/Software Papers

3. 論文の種類 ： 本論文誌は次の３種類の論文を受け付けます。なお、いずれの論文に対しても査読が行われます。

【オリジナル論文(original paper)】
バイオ情報学に関するオリジナルな研究成果について述べた論文
【サーベイ論文（survey paper）】
バイオ情報学に関する既存研究のサーベイを行った論文。ただし、読者にとって有用性のあるサーベイである必要があります。
【データベース・ソフトウェア論文(database/software paper)】
開発し、かつ、公開したデータベースもしくはソフトウェア（Webサーバーを含む）を紹介する論文です。方式自体は既存のものを用いて いても構いませんが、他のデータベースやソフトウェアと比較して有用性があることが必要です。最終フォーマットに換算して3ページ以上の長さで

Inter- & Trans-disciplinary Researches

If So Trans. on Bioinformatics

The 4th Pillar for Complex Phenomena

Complex phenomena are left to be solved, such as environmental issues and geoscience.

In such a field, the approach of the 4th pillar would be useful.

- **even though it does not directly yield a mechanism of phenomena.**

Habu, Yoshiharu (top professional of Shougi):

from now, human beings are tested if we can understand a move derived by a computer algorithm and we can derive the same move.

- **He said after a retired top professional took a beating in a match with a computer algorithm.**

Conclusion

e-Science is important for understanding complex phenomena.

To do that, the followings are important:

- **collaboration with domain experts**
  - **find data, creating labels, and evaluating results**
- **collaboration with data scientists**
- **open data and open software**

One more thing ...

Creating a common mental model of “Data” is important.

- mental model of “Paper” seems to be clear.

For that, keep in mind there exists two types of approach

1. DB like approach:

- This approach requires that DB is abstracted by metadata.
  - But, “Data” is difficult to be abstracted in general.

2. IR (Information Retrieval) like approach:

- This approach requires text index.
- PR: KAKENHI (Grants-in-Aid for Scientific Research) project
  Project Number: 15H02787
  Basic idea: data = list of words
  data1 = [“aurora”, “substorm”, “geomagnetic”, ...]