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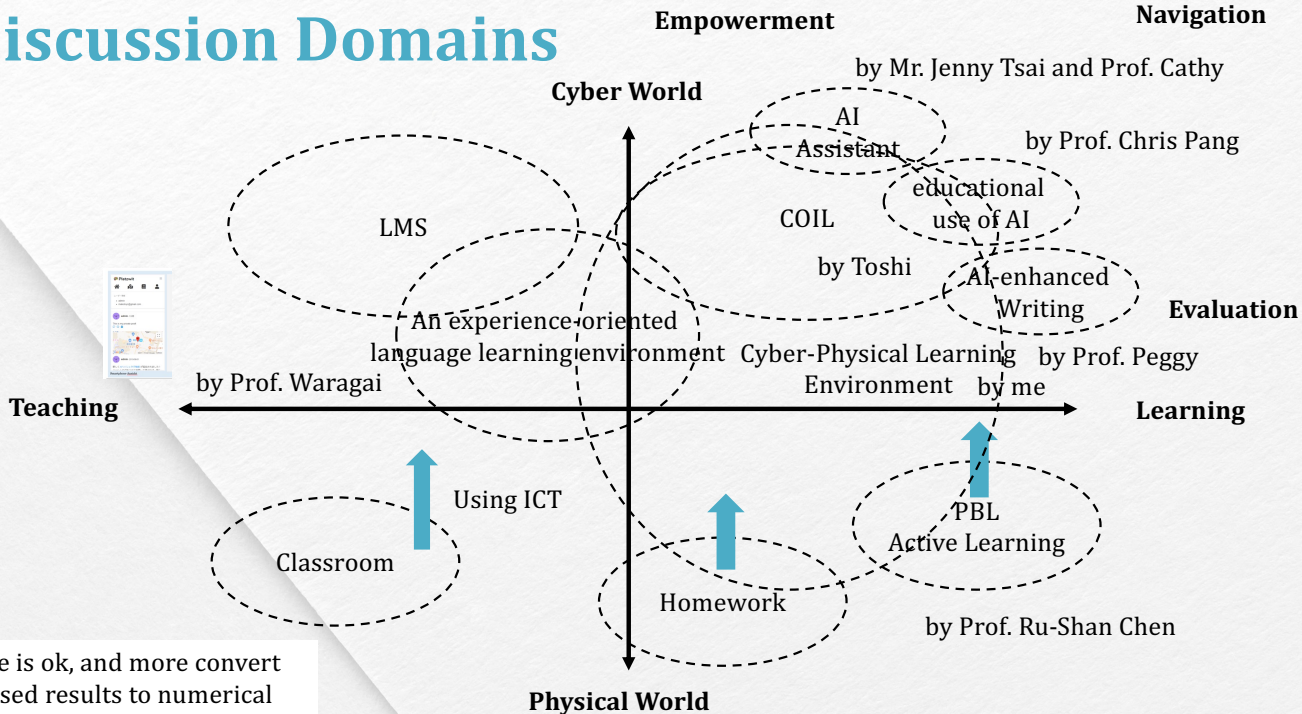
A Context-Based Learning Environment Using Cyber-Physical System For Contribution Degree Calculation

Yasuhiro Hayashi
yhayashi@musashino-u.ac.jp

Associate Professor, Department of Data Science, Musashino University, JAPAN
Researcher, Research Institute at SFC, Keio University, JAPAN

Discussion Domains



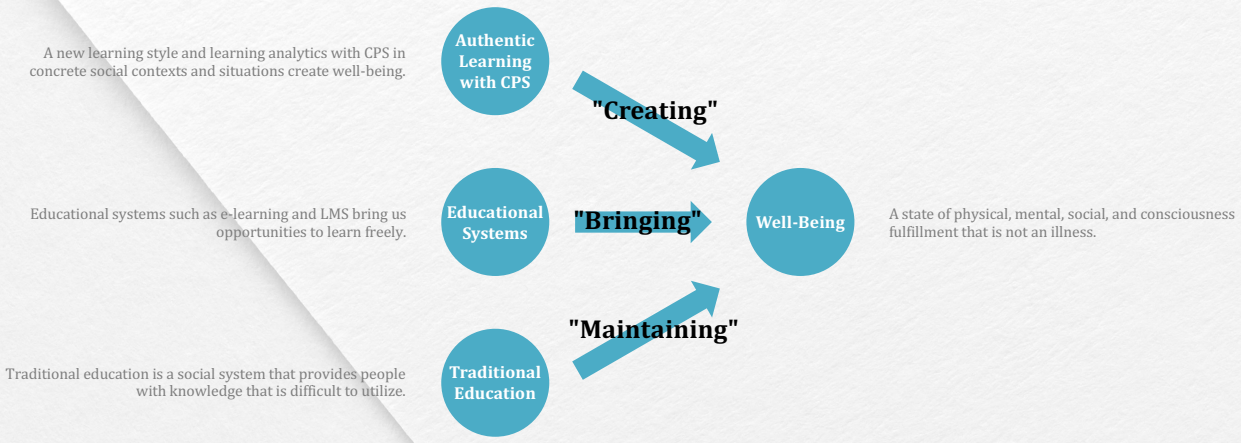
AI use is ok, and more convert assessed results to numerical data by a new contribution axis.

Overview

- Explore global collaborative research and its directions
  1. What is Authentic Learning, and how to build a Cyber-Physical learning environment required for it?
  2. As context: Calculate the degree of contribution to ocean garbage reduction.

Vision: Learners' Well-Being by Data Mining of Knowledge Utilization, "Well-Mining"

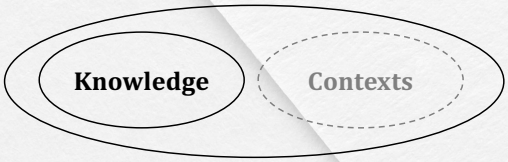
- **Knowledge** is utilized in a specific **context**.
- The context **a cyber-physical system** provides is a realistic and valuable experience for learners.



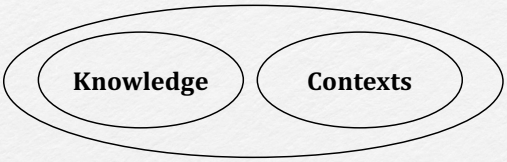
Knowledge and Contexts

- Simple Question: Why can't people change their behavior against many global issues?
  - We know what actions we should take to address global-scale issues.
  - People can only utilize knowledge with context/situation information on when and where to apply it.
  - In the current educational system, knowledge is often simplified into general propositions or facts and taught separately across different disciplines.
  - **Review the origin:** Rational education system by John Locke (1632-1704). Separation of the basic and the applied began in education.

Traditional



Future



Essential Issue: Transfer of learning

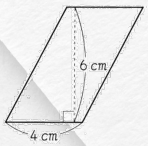
- **"Transfer of learning"** is a phenomenon in which past knowledge, acquired skills, and experiences influence subsequent new learning.

The Examination for Sixth-Grade Arithmetic in 2007 National Survey of Academic Performance and Learning, Japan

Question-A: (without context) Write the equation and answer to find the area of the following figure

次の図形の面積を求める式と答えを書きましょう。

(1) 平行四辺形 Parallelogram

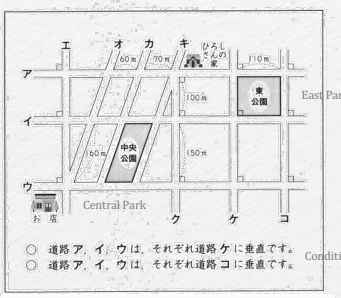


Percentages of correct answers
Question-A: 96%, Question-B: 16%

c.f. People can hardly utilize the knowledge they have learned daily.

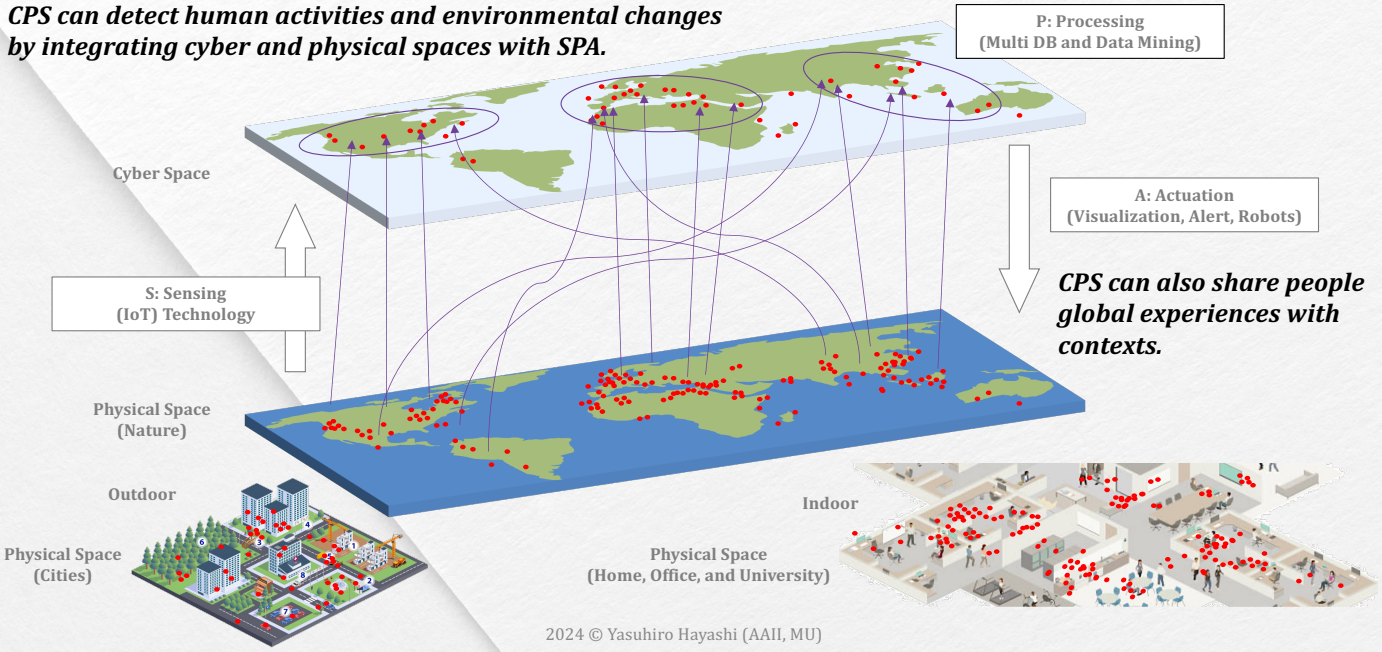
Question-B: (with context) There is an east park near Hiroshi's house.
Which is larger in area, East Park or Central Park?
Write the answer. Also, write why, using words, equations, etc.

(3) ひろしさんの家の近くに東公園があります。
東公園の面積と中央公園の面積では，どちらのほうが広いですか。
答えを書きましょう。また，そのわけを，言葉や式などを使って書きましょう。



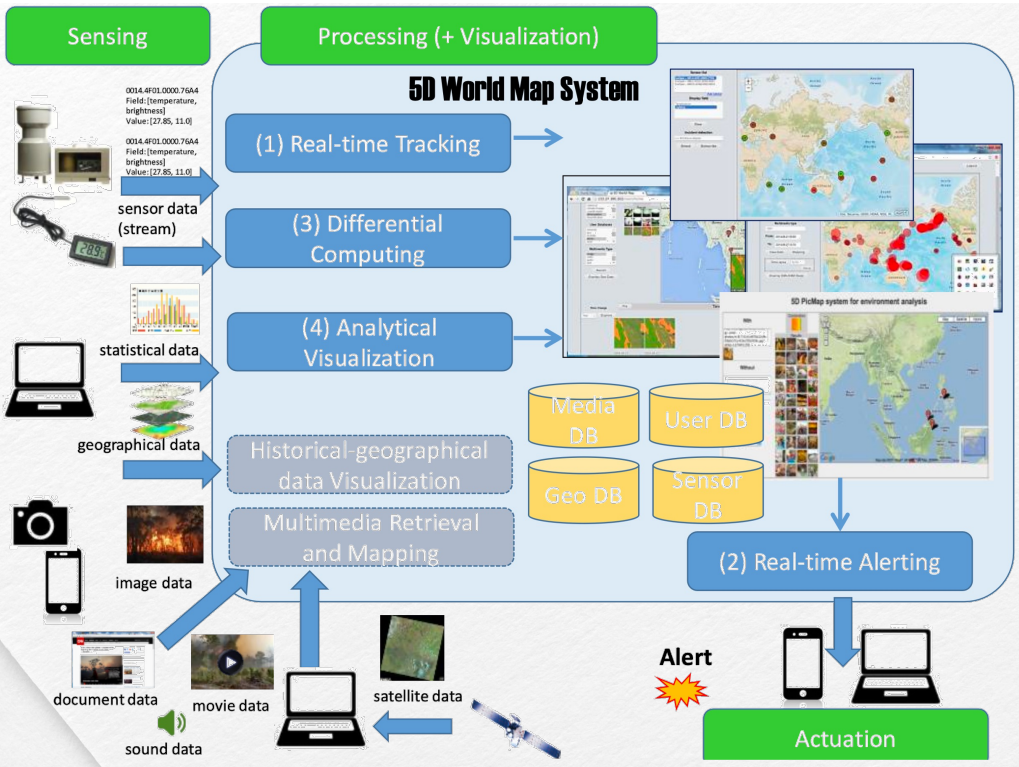
Cyber-Physical Space and SPA Technologies

CPS can detect human activities and environmental changes by integrating cyber and physical spaces with SPA.



5D World Map System

Global & Collaborative Knowledge Sharing & Visualization as Environmental Artificial Intelligence



Yasushi Kiyoki, Shiori Sasaki, Asako Uraki, Chalisa Veesommai Jinmika Wijitdechakul, Irene Rachmawan, Yasuhiro Hayashi: "5D-World Map System: Global & Collaborative Knowledge Sharing & Visualization as Environmental Artificial Intelligence Environmental Computing System with Big-Data Mining and '5-Dimensional World Map System'"

5D World Map System

- United Nations ESCAP (UN ESCAP) & KEIO SFC Joint Project "5D World Map as an Environmental Artificial

5D-WMS is currently used in United Nations: ESCAP: SDGs 9, 11 & 14 as
Global Knowledge Base System for Disasters and Ocean Environment

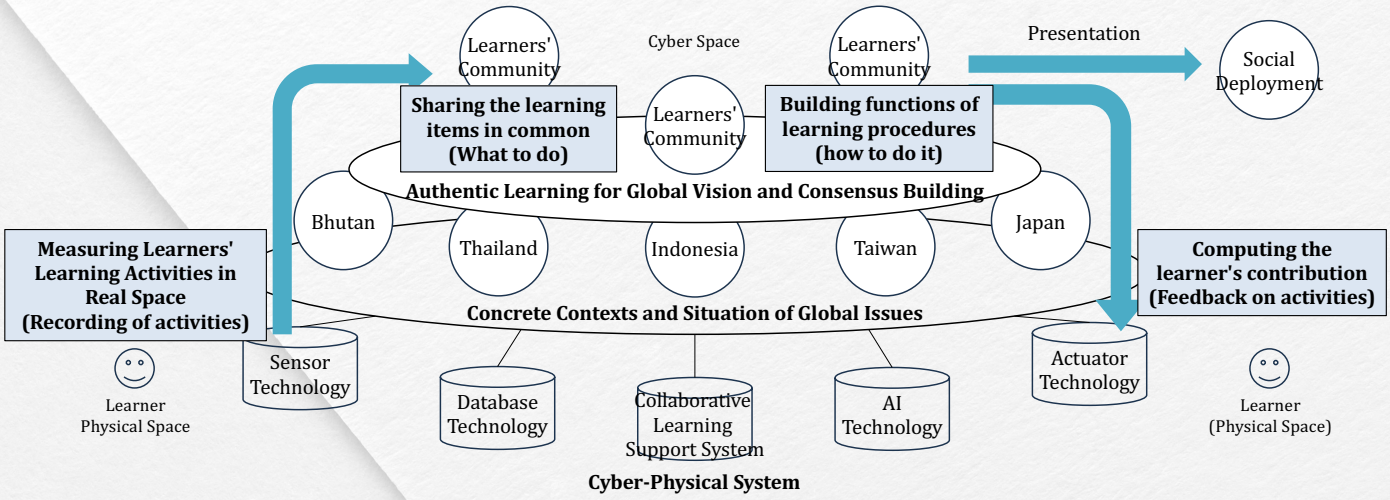
5D WORLD MAP SYSTEM
KEIO UNIVERSITY

5D World Map System - Keio University

5DWMS provides a multi-dimensional global knowledge platform to collect and analyze 'real time' data on SDGs-related phenomena. The system integrates the analytical visualization of sensing data into a knowledge sharing with multimedia (images, videos, etc.), which helps community-based data sharing, awareness building and evidence-based decision making.

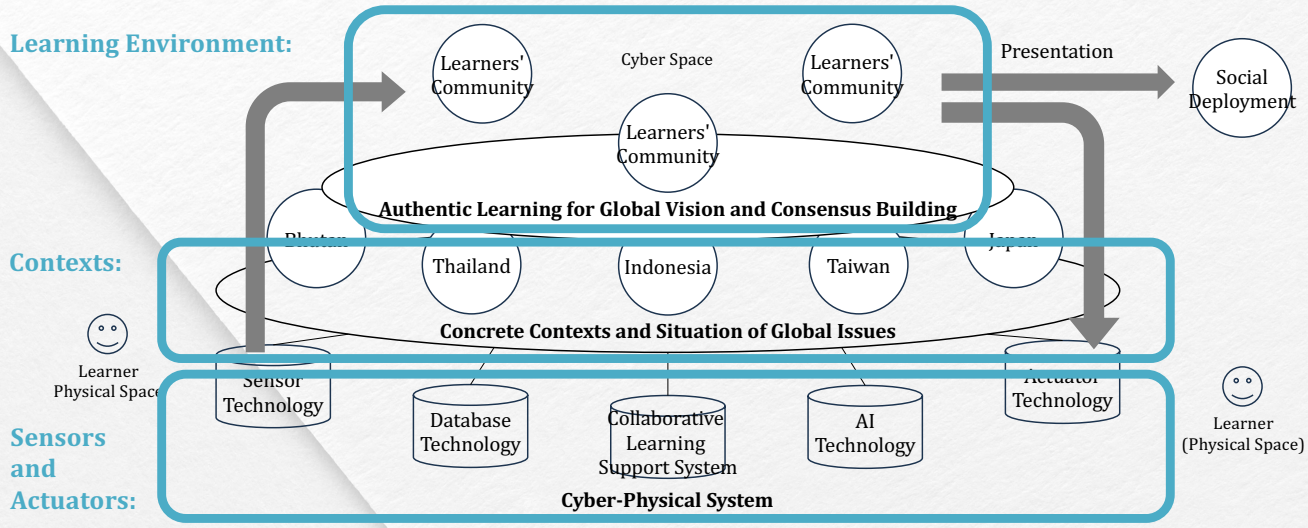
Yasushi Kiyoki, Shiori Sasaki, Asako Uraki, Chalisa Veesommai Jinmika Wijitdechakul, Irene Rachmawan, Yasuhiro Hayashi: "5D-World Map System: Global & Collaborative Knowledge Sharing & Visualization as Environmental Artificial Intelligence Environmental Computing System with Big-Data Mining and '5-Dimensional World Map System'"

A Context-based Learning Environment with CPS for Authentic Learning



Features: Providing a contextual experience of real-world issues for good consciousness/motivation.
Recording all learning activities as a trajectory for good behaviors/careers.

A Context-based Learning Environment with CPS for Authentic Learning



Features: Providing a contextual experience of real-world issues for good consciousness/motivation.
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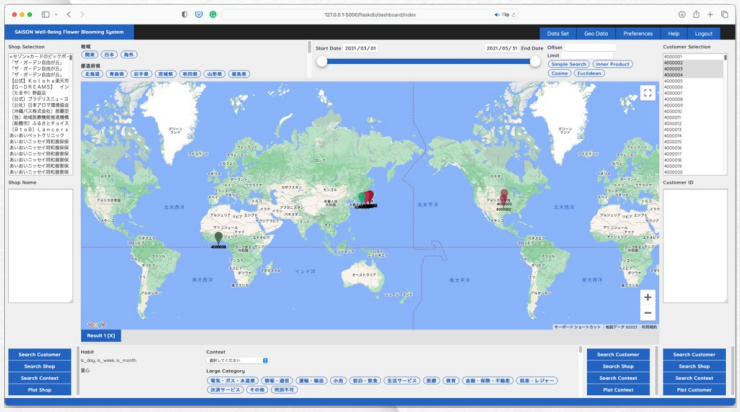
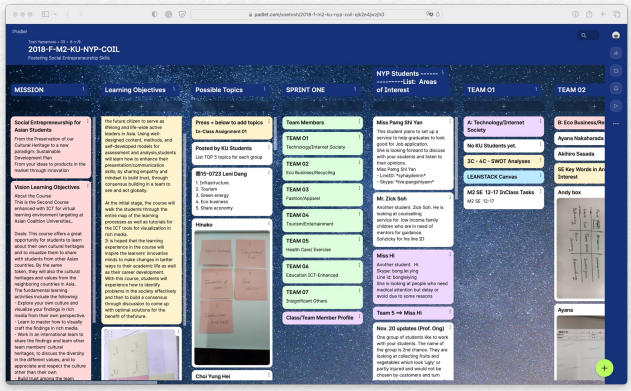
Spatio-Temporal & Contextual Visualization and Discussion Board

Two prototype systems are under development, and they will be integrated.
All human activities are mapped onto a semantic space to calculate correlation and extract association rules.



Yasuhiro HAYASHI, Yasushi KIYOKI, Yoshinori HARADA, Kazuko MAKINO and Seigo KANEOYA: "A Spatio-Temporal and Categorical Correlation Computing Method for Inductive and Deductive Data Analysis," Information Modelling and Knowledge Bases XXXIIV, Frontiers in Artificial Intelligence, IOS Press, 2024.



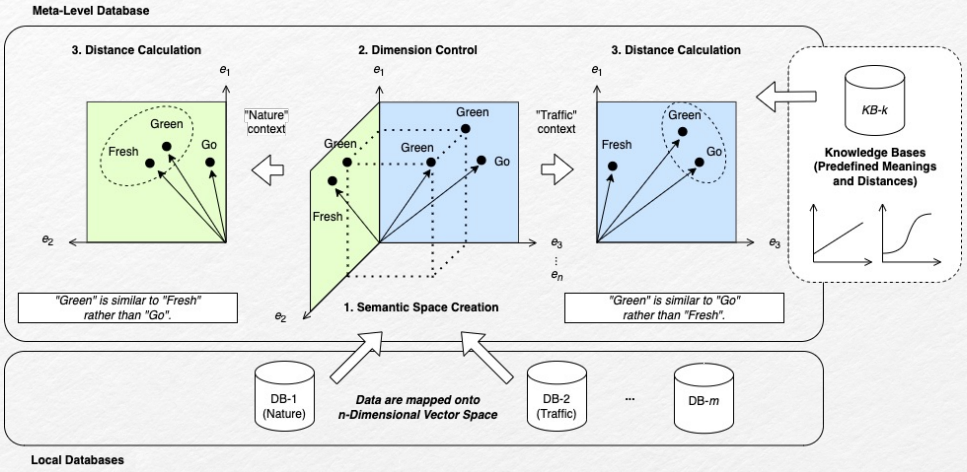
Discussion Results on collaborative online international learning (COIL Project)
https://padlet.com/soetosh/2018-f-m2-ku-nyp-coil-ojk2e4jwzjh0

Inspiration: Semantic Computing

A method to calculate semantic association, consists of **MMM & Meta-Level System**, based on contexts that is occurred various events.

The Mathematical Model of Meaning [1,2]:
To compute semantic associations between data that change dynamically according to context or situation.

Meta-Level System [2,3] :
To perform integration and linkage of heterogeneous local database systems by setting up a meta-database system in the upper layer.



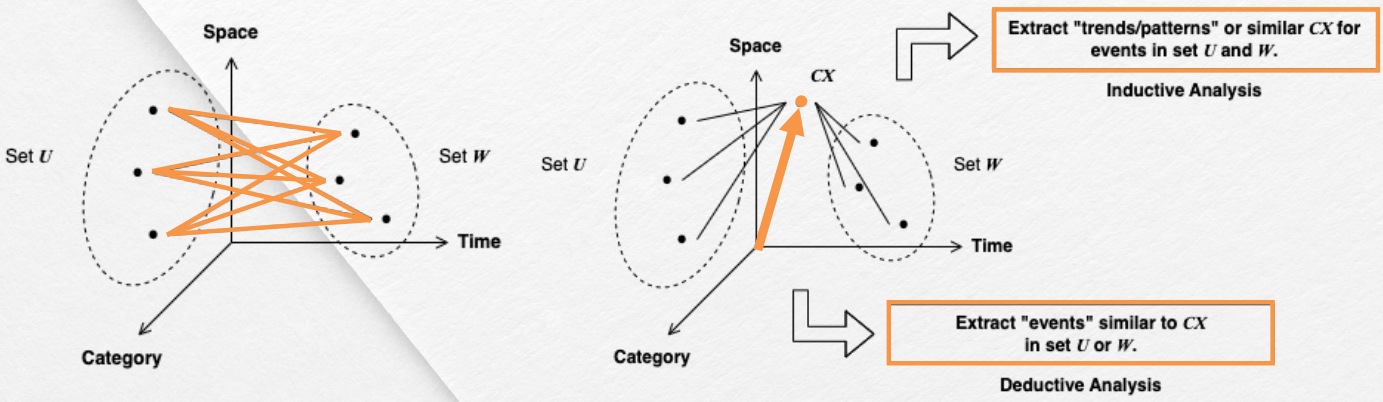
[1] Kitagawa, T. and Kiyoki, Y.: "The mathematical model of meaning and its application to multidatabase systems", Proceedings of 3rd IEEE International Workshop on Research Issues on Data Engineering: Interoperability in Multidatabase Systems, pp.130-135(1993).

[2] Kiyoki, Y., Kitagawa, T. and Hayama, T.: "A Metadatabase System for Semantic Image Search by a Mathematical Model of Meaning", Multimedia Data Management-- using metadata to integrate and apply digital media --, McGrawHill, A. Sheth and W. Klas(editors), Chapter 7 (1998).

[3] Kiyoki, Y., Chen, X., Veesommai, C., Wijitdechakul, J., Sasaki, S., Koopipat, C., & Chawakitchareon, P.: "A semantic-associative computing system with multi-dimensional world map for ocean-environment analysis", Information Modelling and Knowledge Bases XXX, pp. 147-168.

A Spatio-Temporal and Categorical Correlation Computing Method for Induction and Deduction Analysis to Interpret Human Activities

- To compute relationships between two heterogeneous sets U and W in the same vector space by common features (space, time, category).
- To provide inductive and deductive data analysis by applying a context vector as a hypothesis onto the vector space.



Brief Summary of Topic 1

- **Authentic:** real, genuine, honest-to-goodness
- **Authentic Learning:** A method to make knowledge function authentically in the actual world while experiencing social and practical issues.
- **Cyber-Physical System as Authentic Learning Environment:**
  - detects actual human activities and global environmental changes and clarifies the process and essence.
  - connects learners to places where real environmental change is occurring.
  - gives learners real-world experience in knowledge utilization.

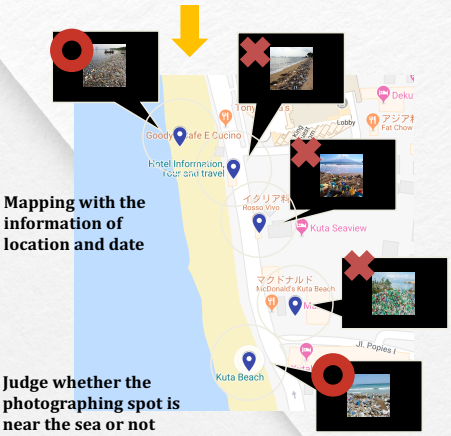
Natural Environment Changes

https://infonet.vietnamnet.vn/the-gioi/dat-nuoc-van-dao-doi-mat-voi-tham-hoa-rac-thai-khung-khiep-nhat-lich-su-254177.html

https://www.poandpo.com/news/indonesia-to-reduce-marine-plastic-waste-70-13122019479

Environment-Visualization with Images and Spatio-Temporal Information

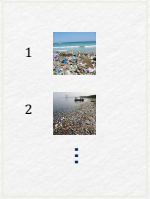
There are many images with plastic garbage



Main Point:

- Make a new direction to solve the plastic issues (marine garbage and microplastics) with image retrieval method
- Not only an image retrieval but also mapping and selecting images based on the distance with image processing will increase the precision to find the source of plastic garbage

Query-Image

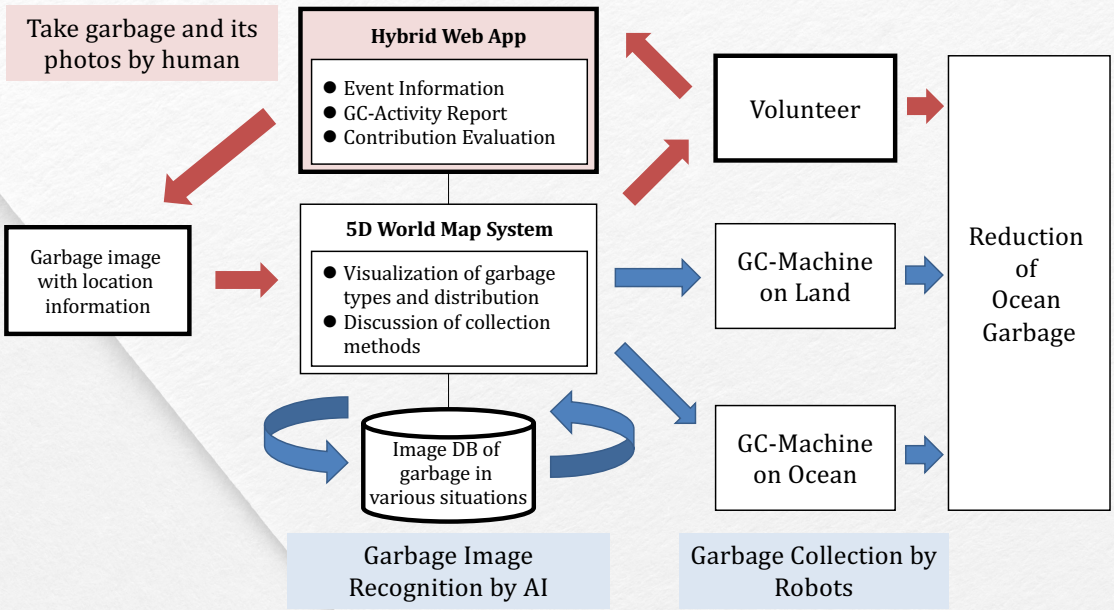


Making a Data Set for Supervised Learning by Composition-based Image Retrieval and Spatio-Temporal Information

Just select the images which is near the ocean and reflect in the result of a composition-based image retrieval

Yuka Toyoshima, Yasuhiro Hayashi, Yasushi Kiyoki: "A Composition-Based Image Retrieval Method for Environment-Visualization with Images and Spatio-Temporal Information", KCIC2019

Two Cycles for Garbage Reduction



Sensors and Actuators for Garbage Collection

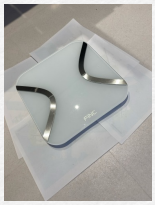
Several prototype applications and devices are under development, and they will be connected.

(1) Hybrid Web App
with ID, Event Management, Grouping, GPS, Photo Uploader, and Garbage Recognition Functions

(2) Tongs with GoPro

(3) Kick Scooter with GoPro

(4) Bath Scale



(5) 5D World Map System

The results of A GC-Event around MU

There were cigarette butt ends around the university.

Team 2 walked on red route to take pictures and picked up garbage on yellow area

Weight of Collected garbage

Team 1:
58.2 - 57.45 = 0.75 kg

Team 2:
58.65 - 57.45 = 1.20 kg

Team 3:
58.4 - 57.45 = 0.95 kg

Global Garbage Collection Activity Competition (GGCAC) Join Procedure

Step 1: Access to the portal site for GGCAC

↓

Step 2: Create your account for GGCAC

↓

Step 3: Check missions and where you should go for GCA

↓

Step 4: Select an appropriate way to collect garbage (walk, kickskater, sup, etc.)

↓

Step 5: Join missions and pickup garbage

↓

Step 6: Bring garbage to GC center

↓

Step 7: Check evaluation and score on the portal site

↓

Step 8: Report activity on the portal site

https://ggcac.5dwm.mydns.jp/

Contribution Degree Calculation

Static Contribution Degree × Dynamic Contribution Degree

	Volunteer Works Determined by the portal	Garbage Situation Determined by Uploaded Photos and Videos
Static Contribution Degree	● How many people attended the event? ● How often did people hold the event? ● How many people taken pictures of garbage with geo code? ● How much trash could people collect?	● How accurately did people sort trash? ● How much trash could people collect from the hardest places?

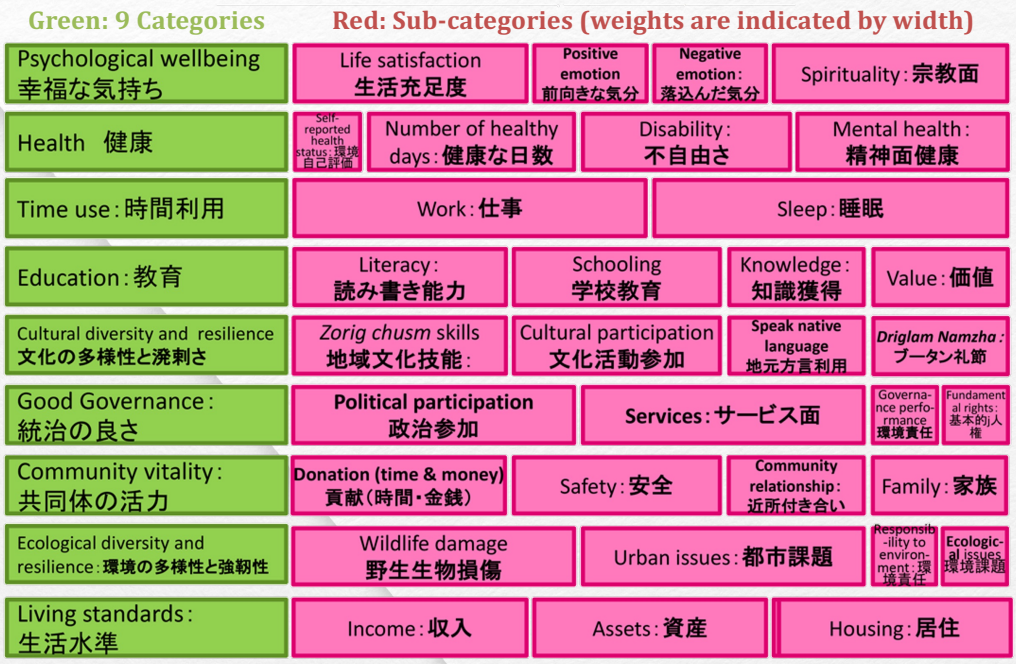
Dynamic Contribution Degree

Dynamic Contribution Degree = Difficulty / Location
Difficulty: Cost for GC (Amount, Weight, Access)
Location: Number of locations of GC

Contribution: High
(Nobody picked up garbage)

Contribution: Low
(Many people picked up garbage)

Bhutan Gross National Happiness (GNH) Indicator System



炭素中立世界を先駆けるブータン 2018年5月号 [Vol.29 No.2] 通巻第329号 201805_329001 (公財) 地球環境戦略研究機関 参与 西岡秀三
https://www.cger.nies.go.jp/cgernews/201805/329001.html

Incentive for Good Human Activities

- Knowledge and its utilization in concrete contexts and situations
- Providing a contextual experience of real-world and global issues
  - Survey and Think (Input)
  - Discussion or Negotiation (Processing)
  - Presentation and Creation (Output)
- Recording all activities as a trajectory for global issues
  - Good behavior is a sign of learning motivation.
  - Good contributions can be a career for the learner.

The Fourth Pillar "Contribution" for Well-Being

- Well-being: A state of physical, mental, social, and **"contribution"** fulfillment that is not an illness.

Maslow, Abraham H: "A Theory of Human Motivation"
https://www.simplypsychology.org/maslow.html

Daniel Kahneman: "Thinking, Fast and Slow"
https://uxdesign.cc/better-decisions-72e955c70a5c?gi=68e17dc52b89

The Model of Motivation and Contribution

Applying a model of motivation to detect motivation from sensing data and trajectory data in learning activities.

Attention	Relevance	Confidence	Satisfaction
Inquiry	Immediate Applicability	Learning Requirements	Scheduling
Humor	Future Usefulness	Self-Confidence	Positive Outcomes
Variability	Need Matching	Expectations	Unexpected Rewards
Participation	Experience	Attributions	Natural Consequences
Concreteness	Modeling	Difficulty	Avoid Negative Influences
Incongruity & Conflict	Choice		

Contribution Degree

John Keller: "ARCS Model of Motivation"

Authentic Assessment on Learning

A matrix is a knowledge base to evaluate each learner's behaviors against the obtained knowledge in the learning contexts and its trajectory.

Contribution Degree

The Knowledge Dimension given Knowledge or Information	The Cognitive Process Dimension: Learner's Activities and Reactions					
	Passive Learning		Active Learning			
	Remember	Understand	Apply	Analyze	Evaluate	Create
	Knowledge	Comprehension	Application	Analysis	Evaluation	Synthesis
Factual						
Conceptual						
Procedural						
Meta-Cognitive						

Made by Prof. Toshiyuki Yamamoto

Conclusion

Knowledge < Behavior < Contribution < Imagination

- **Topic 1:** The cyber-physical learning environment for authentic learning we have developed can provide learners with real experiences as a learning context for utilizing knowledge.
- **Topic 2:** We also showed the ocean garbage reduction activity as a learning context and the calculation method for calculating the degree of contribution to it.
- **Collaborative Points:** Make an original contribution degree function to evaluate human activities by numerical data and share it on the cyber-physical learning environment!