Company Profile

PFN creates technologies that provide intelligence to things and networks, pioneering the development of IoT's next generation : the Smart Internet of Things

Preferred Networks, Inc. (PFN)

- Founded : March, 2014
- HQ : Hongo (Tokyo, Japan)
- Branch: San Mateo (CA, USA)
- Directors : Toru Nishikawa, Daisuke Okanohra, Junich Hasegawa
- Mission :

  PFN creates technologies that provide intelligence to things and networks, pioneering the development of IoT's next generation: the Smart Internet of Things.

  - **To accelerate evolving business in IoT/IoE**
    PFN was split from PFI (founded in March of 2006)

- http://www.preferred-networks.jp/

October 1, 2014

1. **Nippon Telegraph and Telephone Corporation**
   Preferred Networks, Inc.

   NTT and PFN sign a business capital tie-up contract with the aim of developing next-generation Big Data technologies for the age of IoT

2. **Joint R&D Contract with Toyota on Self-driving Cars**

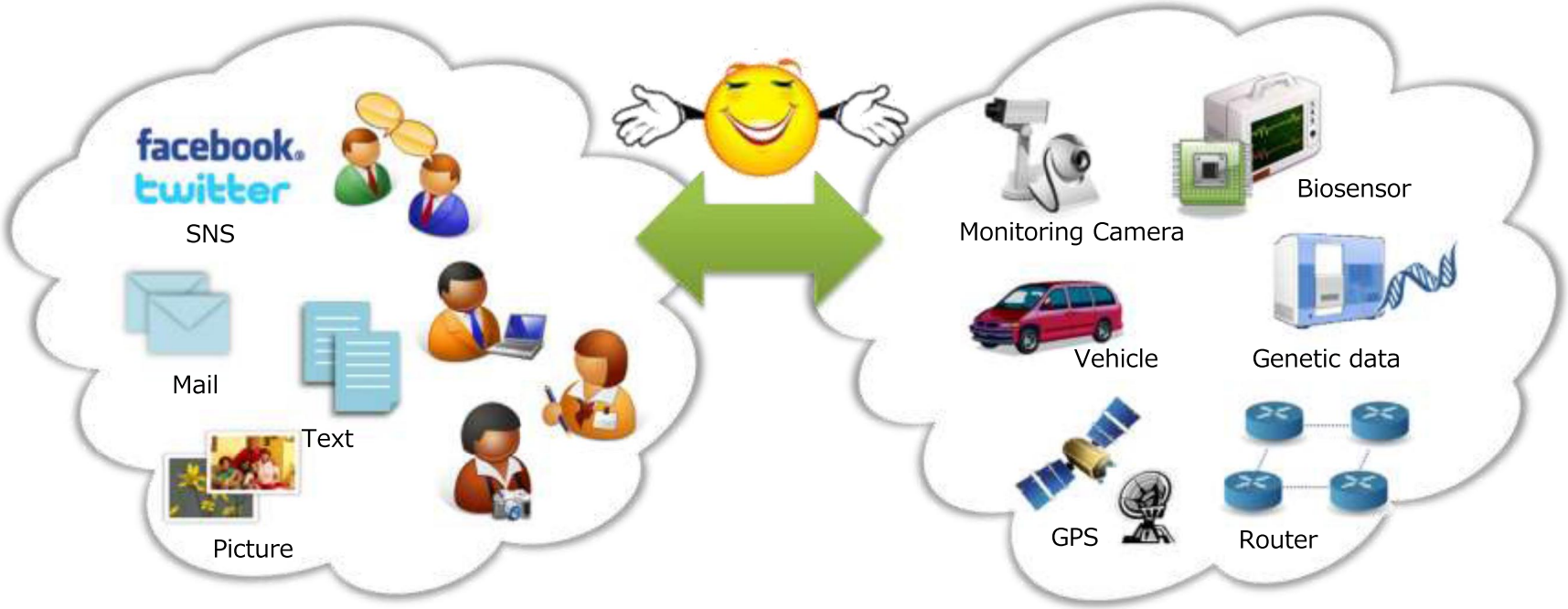
   Preferred Networks, Inc. (HQ: Tokyo, President & CEO: Toru Nishikawa) today announced that the company starts a joint research and development project with Toyota Motor Corporation (HQ: Aichi, CEO: Akio Toyoda) on self-driving cars to examine the feasibility of its machine learning and deep learning technologies.

http://blogs.wsj.com/japanrealtime/2014/10/01/ntt-toyota-seek-deep-learning-expertise/

Problems that PFN solves and How we do it

Problems that IoT/IoE applications face

- Massive amounts of data are generated at the edge of the network
  - e.g. surveillance cameras (100TB/year per one camera), Point Cloud, sensors

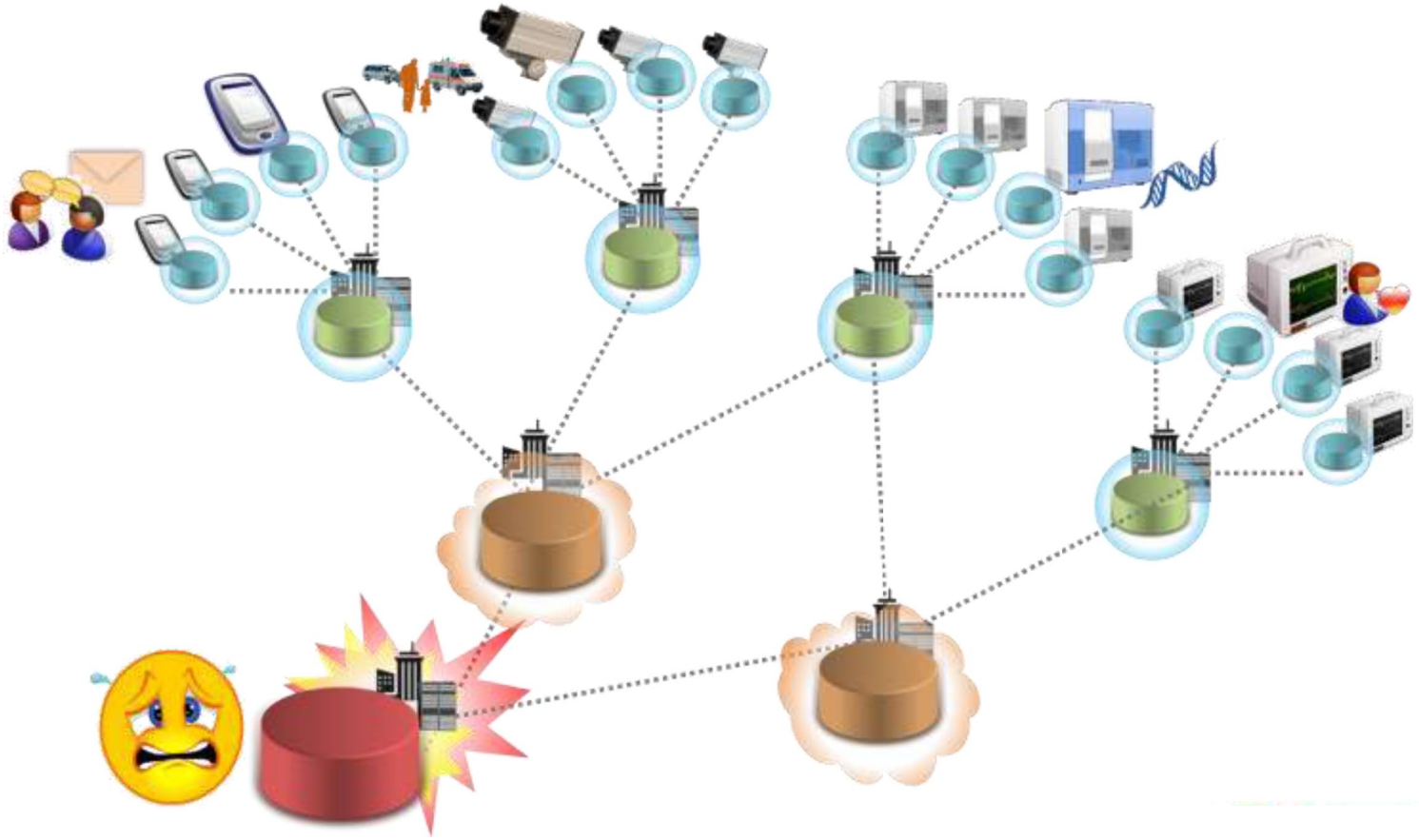


Human-generated data
- Not so big
- Less noise
- Limited data representations
  - Text, audio, video

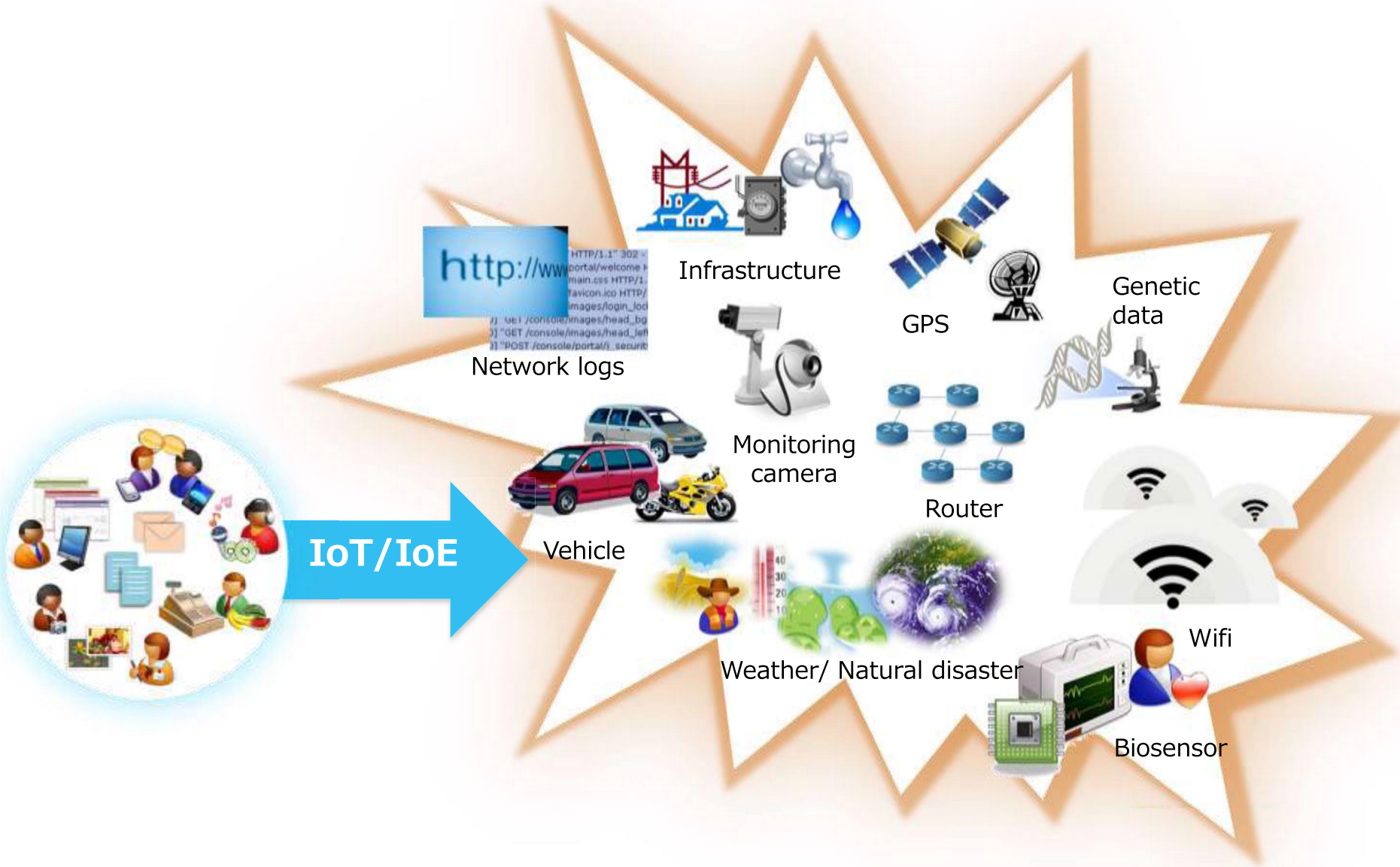
Machine-generated data
- Very large
- May be noisy
- Various data representations
  - Depends on devices

1. Massive increase in volume and velocity of data

- Data collected at the edge of the network has low value density
  - Collecting all data in the Cloud does not make sense

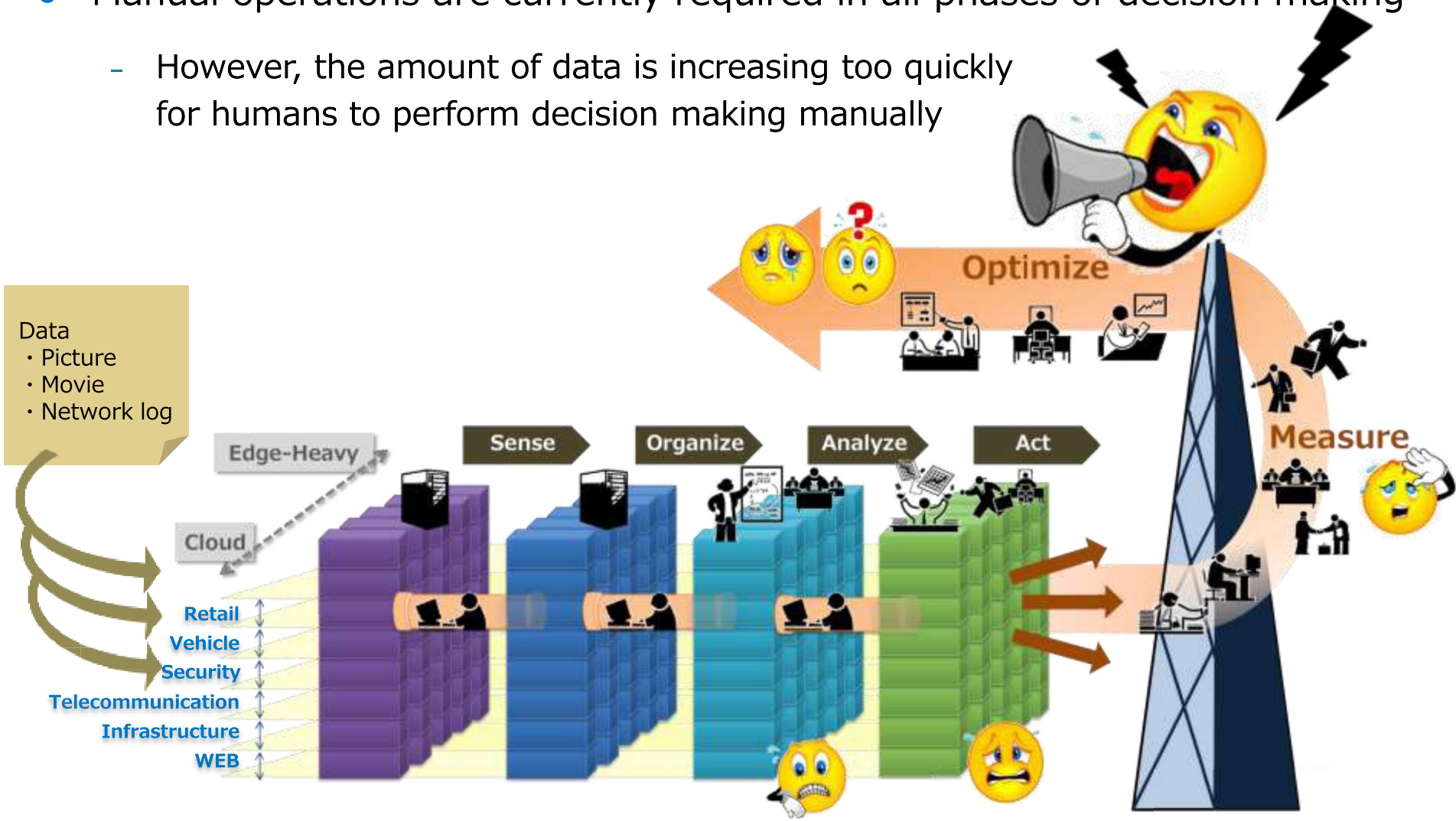


2. Massive increase in variety of data



3. Limit of manual operations

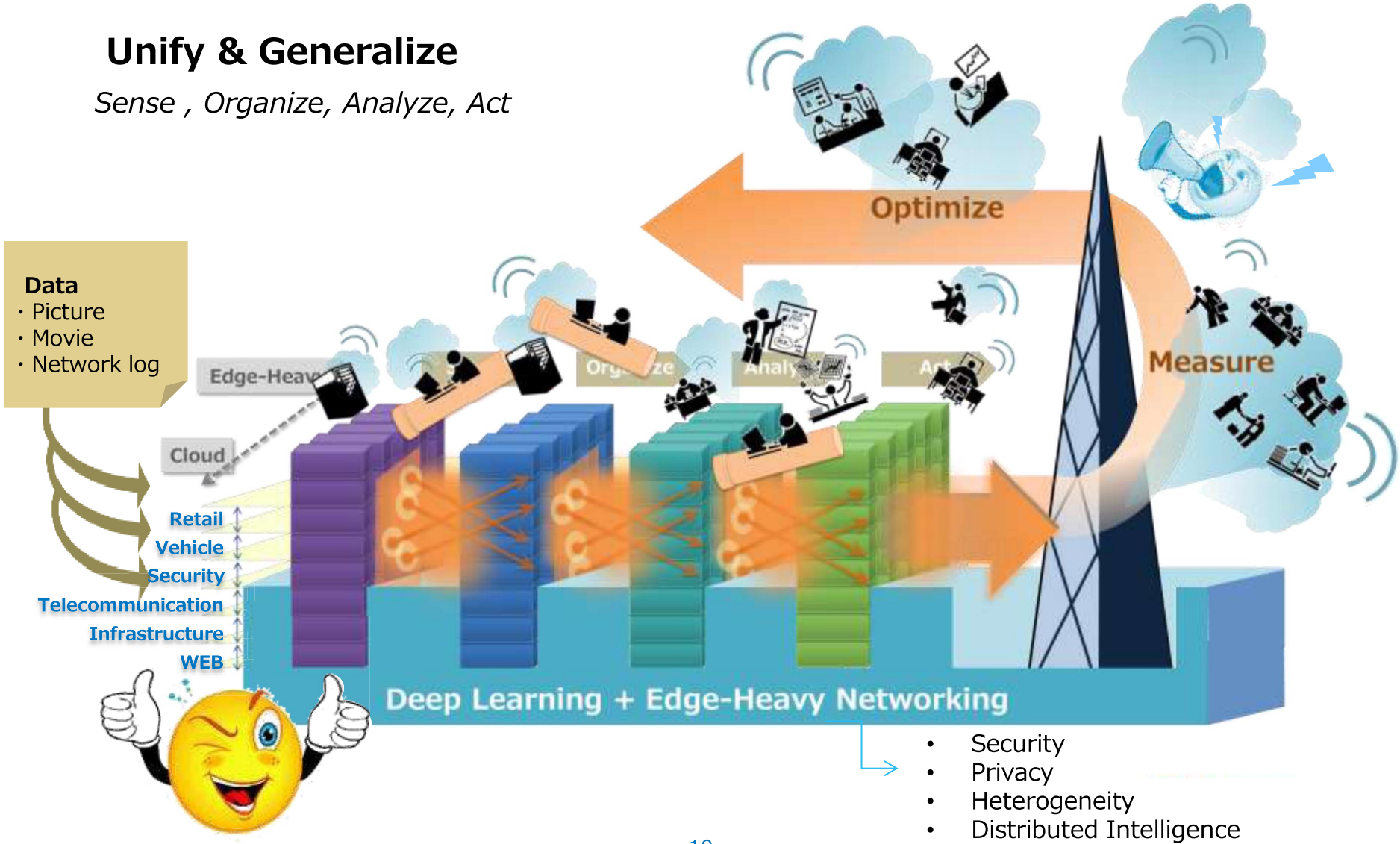
- Manual operations are currently required in all phases of decision making
  - However, the amount of data is increasing too quickly for humans to perform decision making manually



PFN's solution

Unify & Generalize

Sense , Organize, Analyze, Act

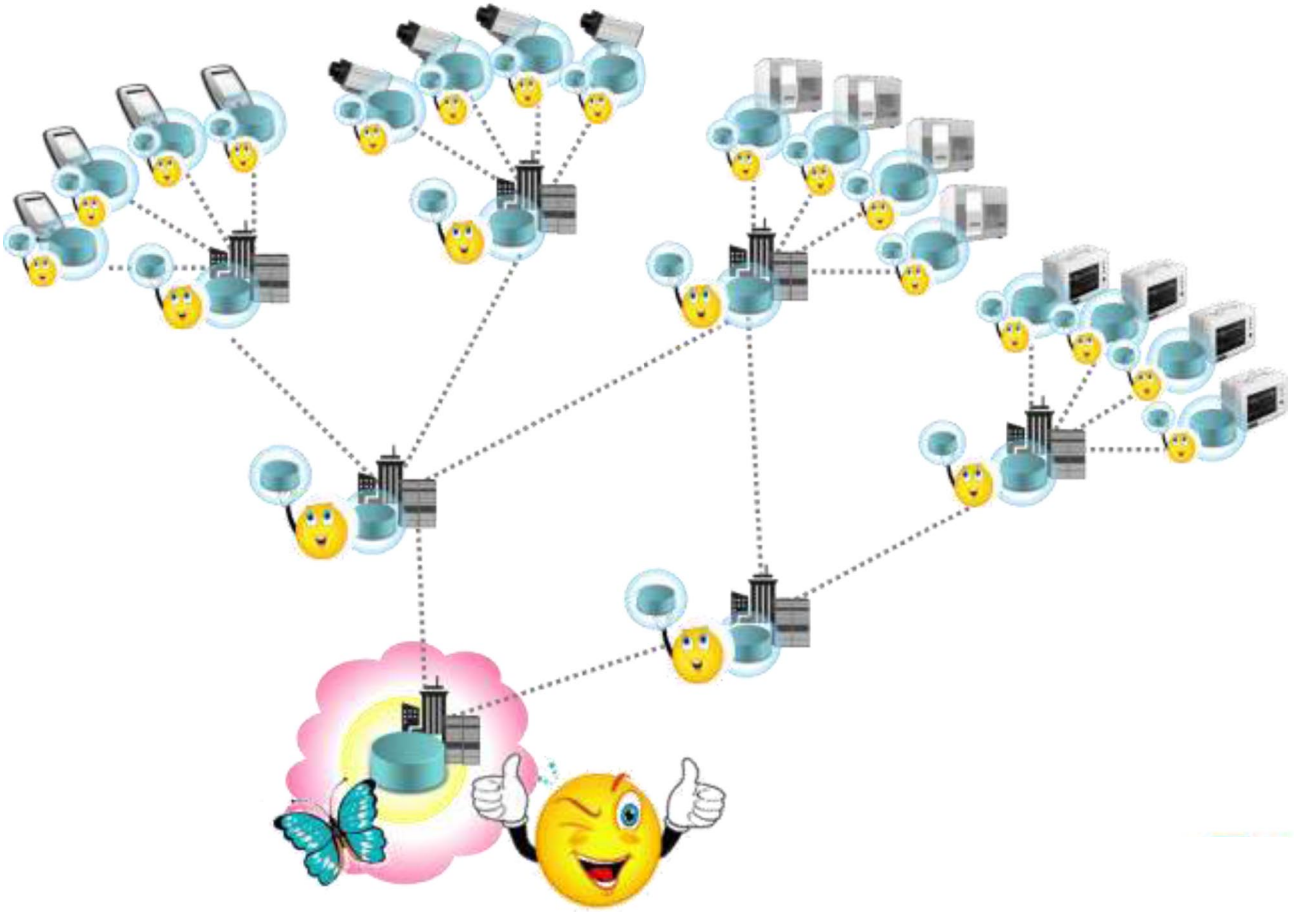


- Security
- Privacy
- Heterogeneity
- Distributed Intelligence

Core Technologies of PFN

1. Edge-Heavy Computing

- Some tasks can only be performed at the edge of the network
- In addition to Cloud-based global analytics, local analytics done by devices running at the edge will be important



2. Distributed Intelligence

Automatic & Real-Time

Learn / Optimize

Measure

Data
- Picture
- Movie
- Network log

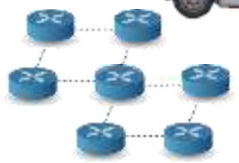
Edge-Heavy

Cloud

Sense | Organize | Analyze | Act

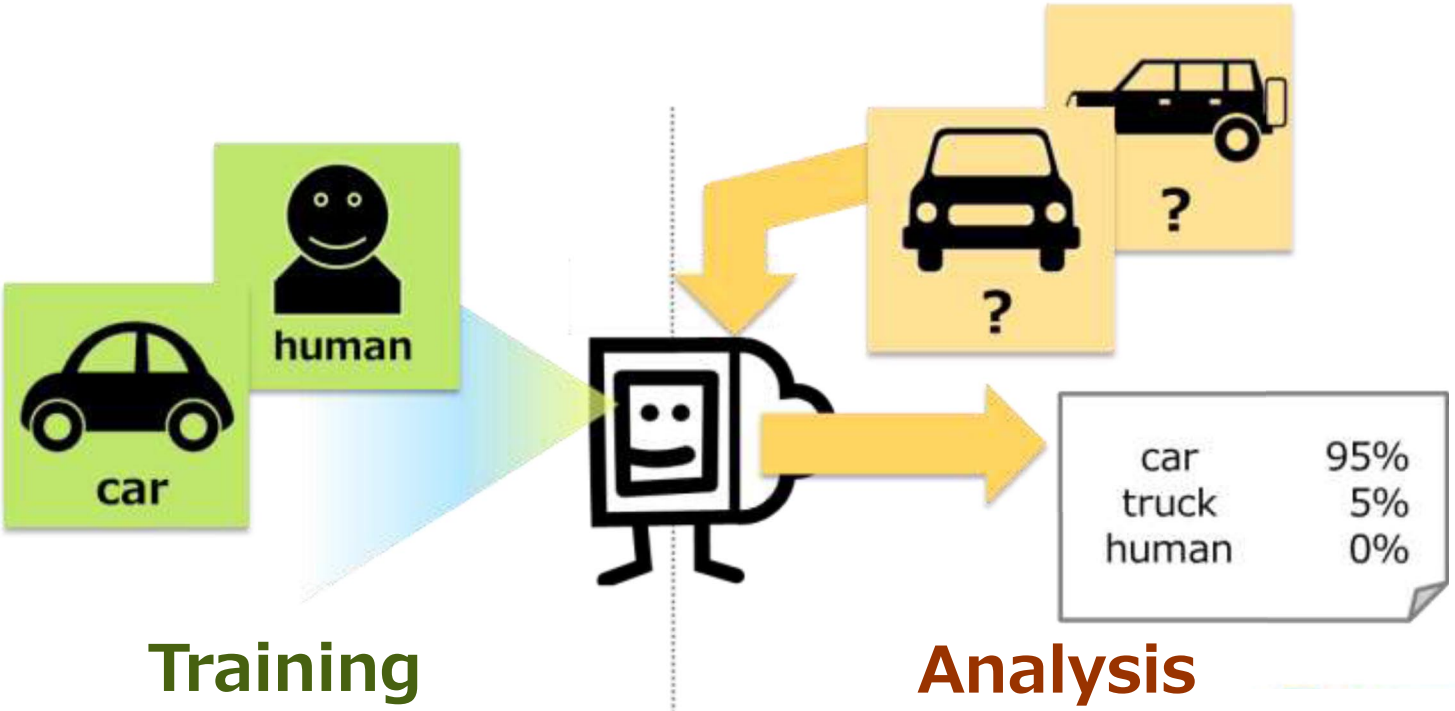
Retails
Vehicle
Security
Telecommunication
Infrastructure
WEB

- network optimization
- robot
- digital signage
- automatic driving



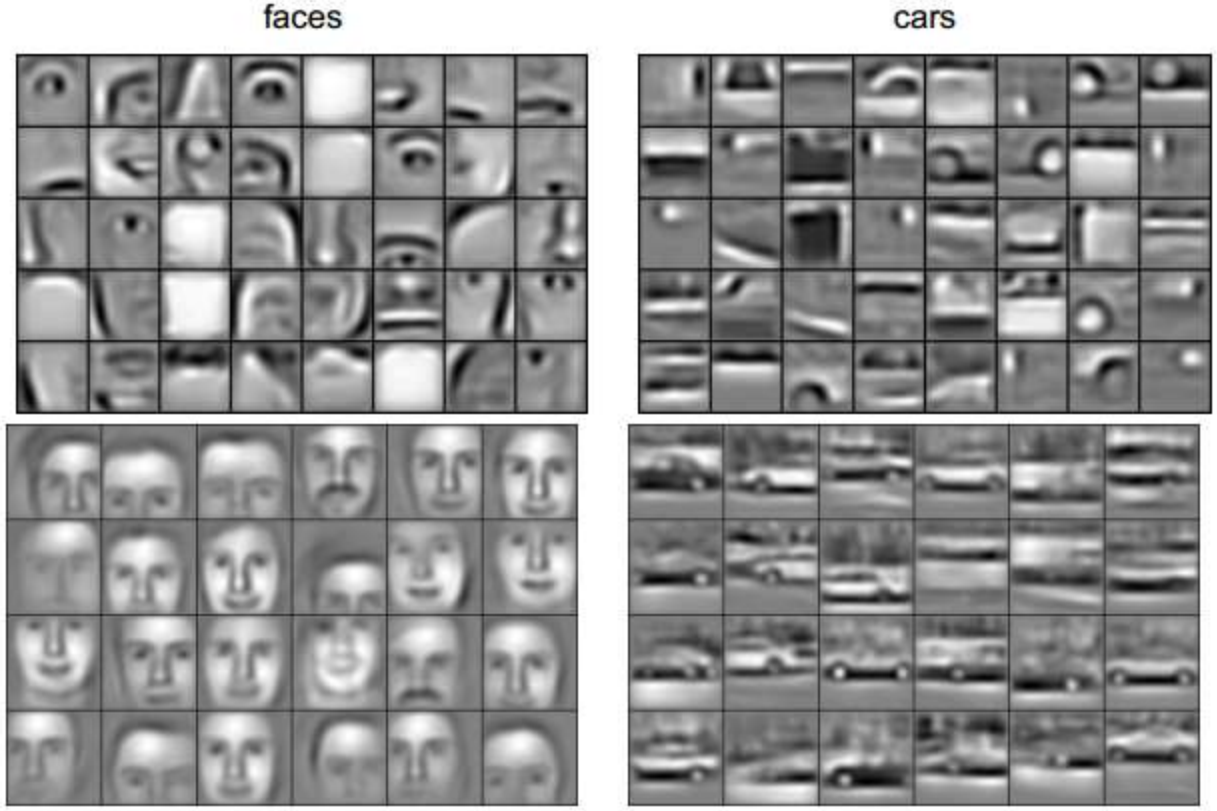
3. Machine Learning

- Machines learn how to recognize, classify, or predict something through learning from a large amount of data
- Compared to classic rule-based approach, Machine Learning can tolerate unknown conditions or problems without requiring human involvement
  - This leads to automatic decision making



4. Deep Learning

- Effective feature extraction has been a task solved only by an expert of both machine learning and a specific problem domain
- Deep Learning performs feature extraction by itself, in addition to traditional machine learning tasks. Its accuracy can be above human-level.



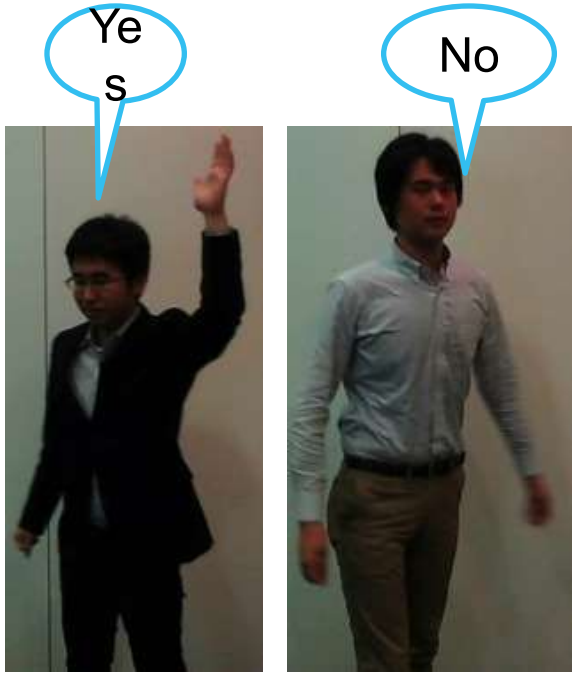
http://ai.stanford.edu/~ang/papers/icml09-ConvolutionalDeepBeliefNetworks.pdf

5. Visual Recognition

- Video data will be a universal sensor since it contains rich information
  - Humans gain about 80% of information through eyesight
- Performing time-series analysis on video data reveals valuable insights
  - Demo: https://www.youtube.com/watch?v=blMaZPEA5rA

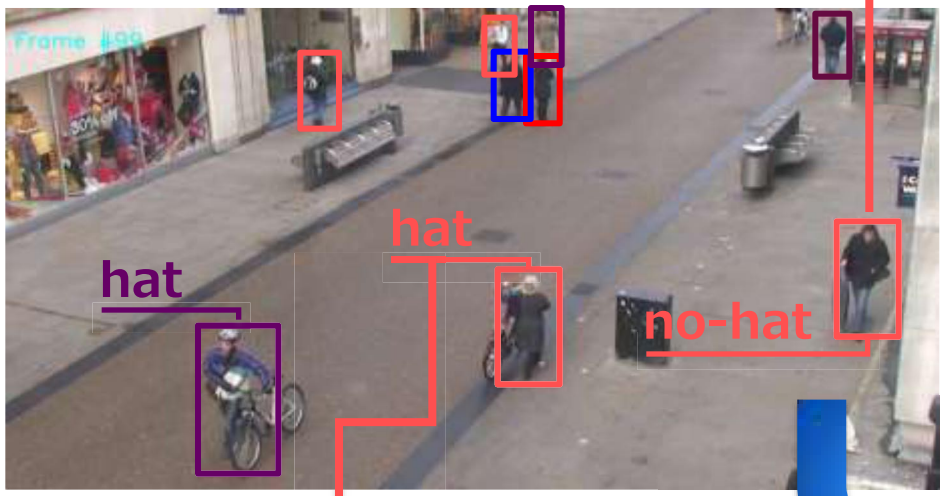
5. Visual Recognition
Status: Recognition of Hand Raising Action

Method	Error rate (less is better)
Conventional: AROW classifier (using only the dataset made in the office)	19%
Deep learning (using only the dataset made in the office)	8%
Deep learning w/ pre-training (using additional ImageNet dataset)	**2%**



- Achieved much smaller error rate by using deep learning
- Pre-training on a large amount of out-of-domain data greatly reduces the error rate (by extracting more robust features)

5. Visual Recognition / Functions and Improvements of Visual Recognition



1. Attribute Classification

Date	Error of Each Tag		
	Raising Hands	*Gender*	*Hat*
Feb. 2014	19%	-	-
May. 2014	2%	New! 10%	New! 3%

- Improvement given by Deep Learning
- Will improve further with more learning data

2. Person Detection

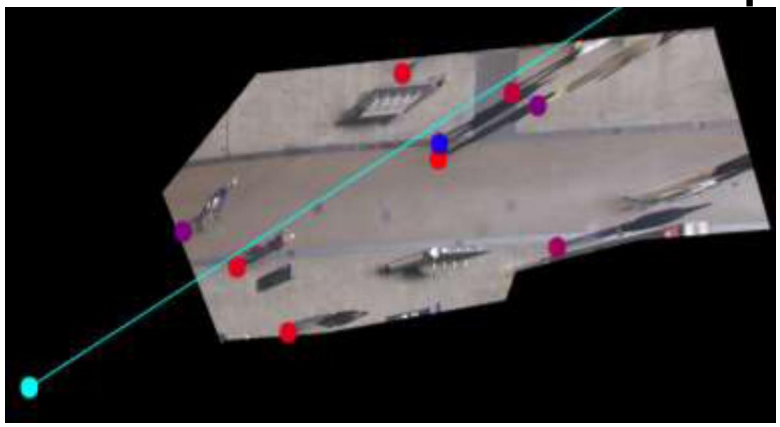
Date	Error @ 0.1 fppi*
Feb. 2014	40%
May. 2014	19%

*fppi means false positives per image.

- Will improve further with more learning data

New!

3. Position Estimation on the Map



- Higher accuracy compared to other position estimation methods based on e.g. Wi-Fi strength, geomagnetism
- Can be improved by using multiple cameras (to be added)

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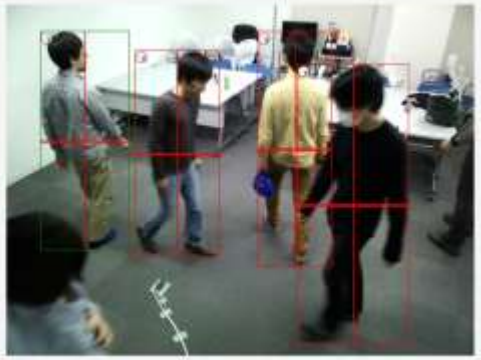
5. Visual Recognition / Tools to Improve Visual Recognition and Deep Learning

Hawk

Platform to manage learning process of large scale video data with efficient annotation

- Recognition is improved by quality and quantity of annotated video data
- Hawk is a platform for management of videos, annotations and learning results
- Hawk has UI for efficient annotation (right)
- Hawk will provide
  - Automated annotation via crowdsourcing
  - Management of learning process and resulting recognizers



Recognizer Inspection Tool

Understanding mechanisms of recognizer obtained through Deep Learning

- Visualizer shows what features are (not) recognized well
- Visualization makes it easy to find the tuning point of the complex recognizer
- Enables users w/o expertise in Deep Learning to improve the recognizer

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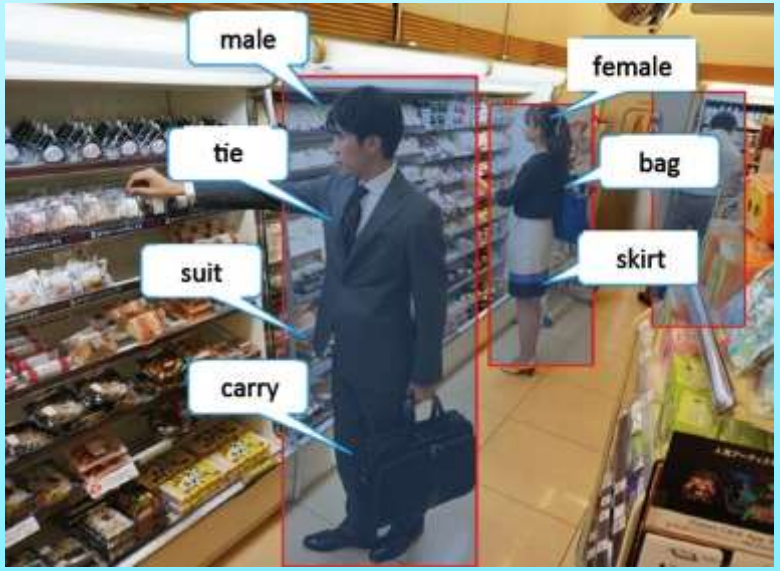
5. Visual Recognition Use-cases

(1) Surveillance

- Purpose
  - Annotate people's appearance and behaviors
  - Detect anomalies and make search index
- Application
  - Alarm for crimes and suspicious behaviors
  - Help investigating criminals on the run
  - Search and locate suspects by characteristics
- Advantage
  - No need to monitoring by human eye
  - Instant search by characteristics tags
  - No need to check all videos for massive hours

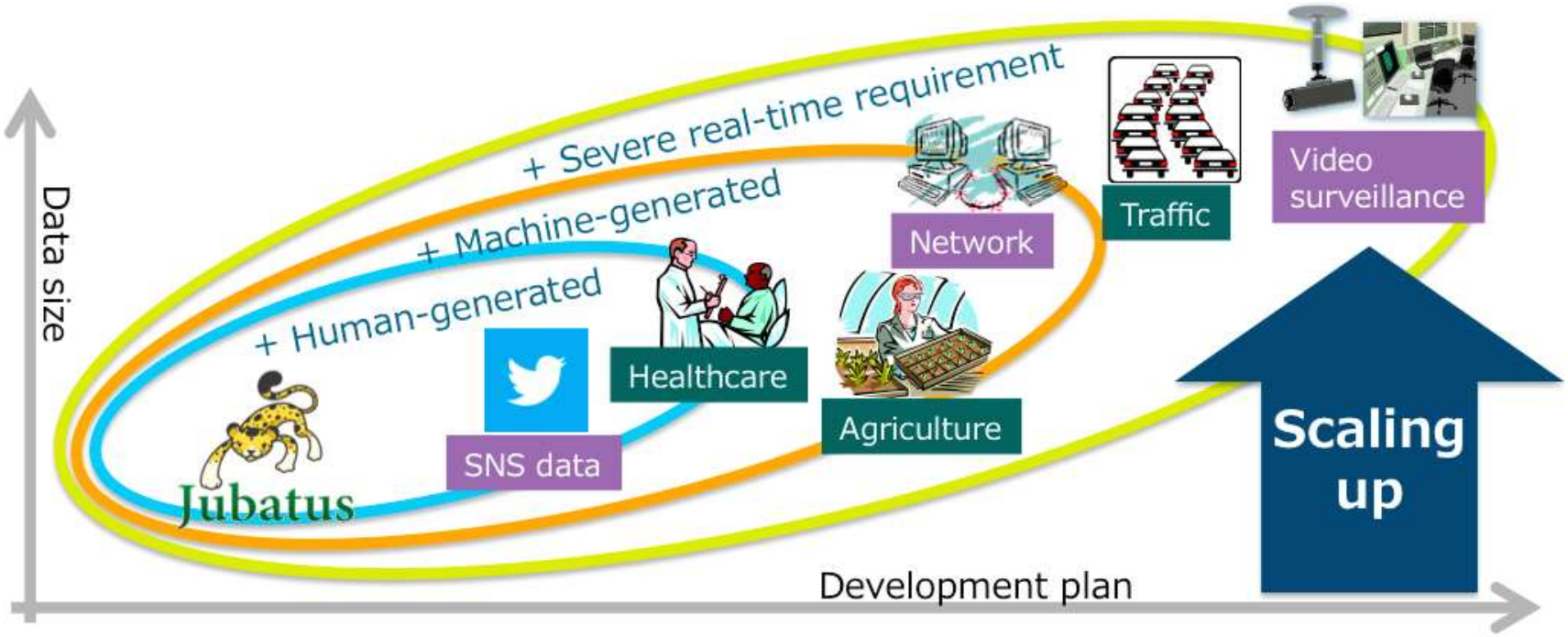
(2) In-store behavior analysis

- Purpose
  - Annotate customers' appearance and behaviors
  - Estimate their profile and intention in detail
- Application
  - Detect unseen demands to serve
  - Analyze POS data with detailed categorization
  - Optimize items, layout and shopping process
- Advantage
  - More precise and dynamic than analyzing only POS and membership information



6. Jubatus

- Open source, distributed online machine learning framework
  - Developed in 2011, many use cases in Japan and other countries
  - Loose model sharing enables effective distributed machine learning
- The result of joint development between NTT and PFN



Roadmap of Market Penetration

- R&D with various industrial leaders for exploring market opportunities
  - Joint projects with leading companies in each market

	FY2014		FY2020
Target Market: Starting full-fledged business	**・Retail (Advertiser)**	**・Vehicle ・Public Safety ・Security ・Manufacturing ・Public Transportation**	**・Transportation ・Healthcare**
Vertical industry focused Product	**Edge-heavy Intelligent Platform for Digital Marketing** ***1. Virtual Loyalty Program*** ***2. In-Store Ad Targeting***	**Automatic Cooperative Monitoring & Prediction for Risks**	**Understanding Relationships between Individuals and Environments**
Major Problems solved by ML ML = Machine Learning	Lacking information of non-loyalty program offline customers	Limited capacity and accuracy of human monitoring of complex situations	Complexity of problems and phenomena that humans cannot solve
Technical Issues	・Privacy protection ・Network & Computation Latency ・Band width	・Accuracy	・Adaptation to various environments

Preferred Networks