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**PANEL**  
**ADAPTIVE/COGNITIVE**

**Challenges in Managing Fleets of  
Drones and Driverless Cars**

**MODERATOR:**  
Petre Dini, IARIA

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# Facts I

- <http://money.cnn.com/2016/02/29/autos/google-self-driving-car-accident/>
- **“... on February 14, a Lexus 450 hybrid SUV with Google's self-driving technology had a scrape with a city bus in Mountain View, California, the company's hometown. It said no one was injured in the accident. ”**

**“Google said the car was in the right lane of a city street, and was about to turn right. But after initially moving to the right side of the lane, it moved back to the center of the lane to avoid sand bags that had been placed around a storm drain. The bus, coming from behind, hit the left side of the car. ”**

**““From now on, our cars will more deeply understand that buses (and other large vehicles) are less likely to yield to us than other types of vehicles, and we hope to handle situations like this more gracefully in the future,” said the company. ”**

# Prediction

- .... they are part of a 10-year plan to make the need to own a car obsolete.

# Facts II

- **mini-drone fleet: Perdix**  
[http://adevarul.ro/international/statele-unite/video-ultima-arma-pentagonului-roiu-drone-mici-dimensiuni-perdix-pregatit-lupta-1\\_5874fa115ab6550cb8513c7b/index.html](http://adevarul.ro/international/statele-unite/video-ultima-arma-pentagonului-roiu-drone-mici-dimensiuni-perdix-pregatit-lupta-1_5874fa115ab6550cb8513c7b/index.html)  
<https://www.defense.gov/News/News-Releases/News-Release-View/Article/1044811/departament-of-defense-announces-successful-micro-drone-demonstration>
- **home protection: Sunflower Home Awareness System**  
<http://www.digitaltrends.com/cool-tech/sunflower-home-awareness-system/>
- <http://money.cnn.com/2016/11/03/technology/drone-home-alarm-system/>
- **self-driving bus: OLLI**  
<http://www.cnn.com/2016/10/20/world/ollis-electric-bus/>  
**helsinki:** <http://www.curbed.com/2016/8/31/12691516/self-driving-bus-vehicles-finland-helsinki-transportation>  
**singapore:** <http://www.cnbc.com/2016/10/19/all-aboard-singapore-now-to-try-out-self-driving-buses.html>  
**tokyo:** <http://www.wsj.com/articles/japans-dena-says-get-on-the-self-driving-bus-1467884109>  
**usa; michigan, Ann Arbor:** <http://www.nbcbayarea.com/on-air/as-seen-on/Self-Driving-Shuttle-Bus-Makes-its-Debut-406048596.html>  
**las vegas: olli jan 7 |** <http://www.reviewjournal.com/business/self-driving-bus-olli-still-its-way>  
**germany:** <https://www.dezeen.com/2016/07/19/mercedes-benz-self-driving-future-bus-autonomous-vehicle/>

# Ideas | Starting points

**Separation** - avoid crowding neighbors (short range repulsion)

**Alignment** - steer towards average heading of neighbors

**Cohesion** - steer towards average position of neighbors (long range attraction)

In flocking simulations, there is **no central control**; each bird behaves autonomously. In other words, each bird has to decide for itself which flocks to consider as its environment. Usually environment is defined as a circle (2D) or sphere (3D) with a certain radius (representing reach).

# On flocking: birds vs. drones

## Birds:

- **Group behavior vs. Individual behavior**
- **Environmental observation**
- **Security distance vs. movement parameters**

## Fleets:

- **Flocking rules**  
or/and
- **Leader-based coordination**  
or/and
- **Central coordination**

# Panelists

## Moderator

Petre Dini, IARIA, USA

## Panelists

- Knud Thomsen, Paul Scherrer Institut, Switzerland  
Mutual communication and understanding
- Yuji Iwahori, Chubu University, Japan  
Vision | Moving Objects
- Petre Dini, IARIA, USA  
Driverless fleets

**Open discussion**

# **Open discussion**



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K. Thomsen for Panel ADAPTIVE / COGNITIVE :

# “Mutual Understanding”

To take full advantage of a fleet of drones or cars requires the **autonomic mutual coordination** between the individual entities. Examples can be seen in nature, they range from bacterial communities to insects and to human organizations. Mutual **communication** and **understanding** (as the goal on the top) are essential.

**Consciousness**  
Every step along the cycle of expectation - action - evaluation - expectation. To the extent that every activated entity at a certain time is included, the total mental flow is funneled into one stream. A new quality arises as soon as information about the pattern of the process is self-reflexively available, and an evoked affect representation is embodied in a specific context. When the action is over, the system has a new state. In this sense, the self-reflection and self-relevant nonlinear re-actively logging activity in the brain is our personal experience including the feeling of "qualia".

**Free Will**  
Every concept is absorbing. Its constituent features and simultaneously it imposes its structure on all ongoing (and future) brain activity, over longer time it unduly leads to an action at the level of neurons and their connections. Just as physical constraints, cultural ones exert their power, basing some alternatives. There can be no freedom without some order. This is relevant for the freedom of choice (otherwise), but also for the clear ownership of an action. The recursive and non-linear basic algorithm of the consumption analysis thus cannot mean that actions might be predictable in the time. Consumption analysis is above all an efficient means of steering a system towards general consistency, a thereby assured freedom, accepted freedom is as real as anything else influencing our actions, nothing is less and nothing is more than an idea.

**Rational Thought**  
The process of abstraction and remoteness. In any rational prudent action all available pertinent information has to be brought to bear. The system has to be able to expect next. Many of short-term consumption analysis highlights the most urgent issues, directs attention and provides feedback. It is not between good and not so good. Emotions are thus no a tentative but a prerequisite for truly rational thought.

**Consumption Analysis**  
Every mental content is destined to be organized into a frame. The process of consumption analysis is a recursive application of a bottom-up process. A feature activates (bottom up) associated frames, which in turn has further affiliated features (top down). A feature activates (bottom up) associated frames, which in turn has further affiliated features (top down). Available (available) is a certain extent activated concepts is determined at short intervals. Starting from primitive percepts, concepts at one level form the features for the next higher level entities. The process of checking how well features (any building blocks) are "consumed" into higher ranking concepts is termed consumption analysis.

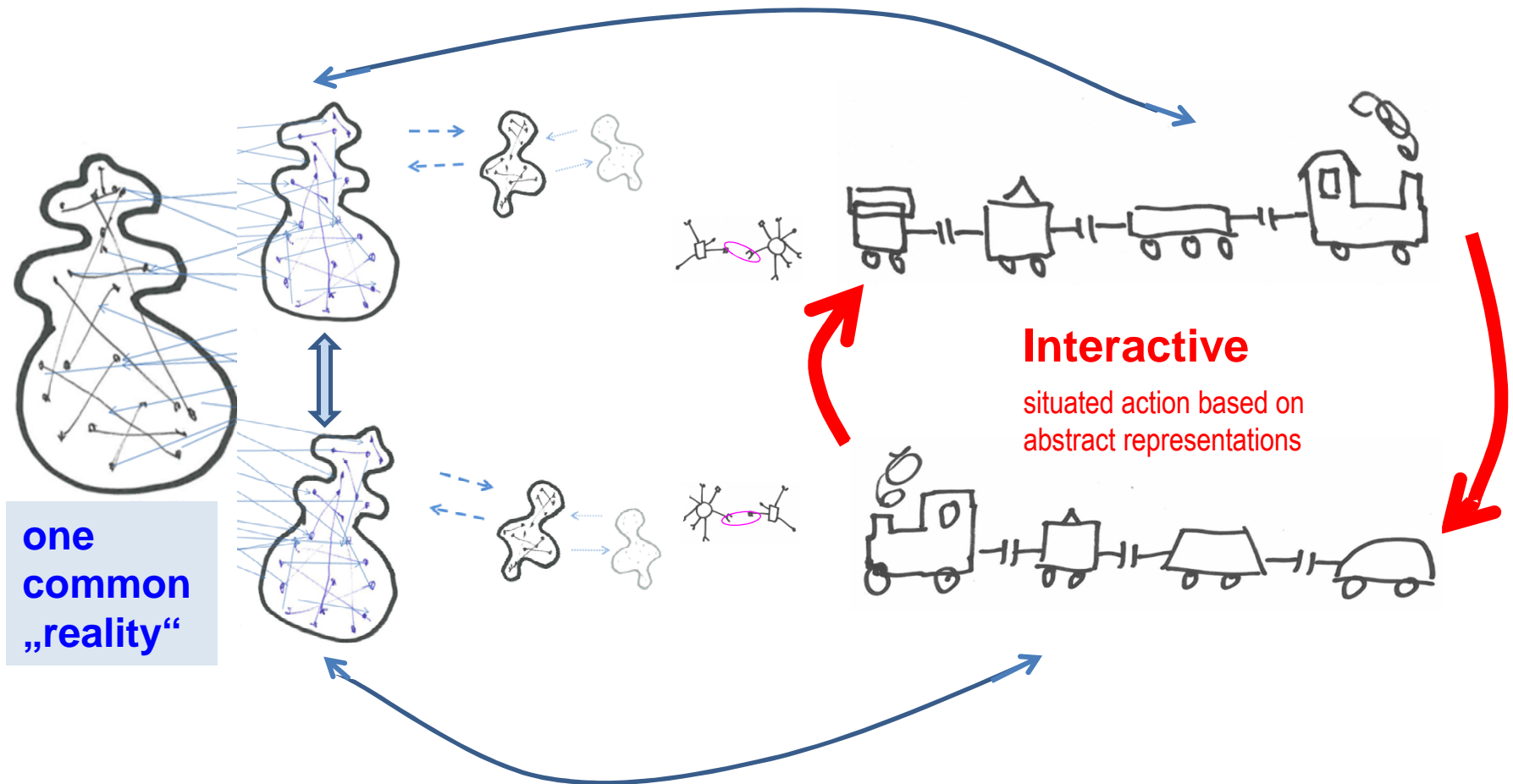
**Sleep & Dreams**  
In a trade off between accuracy and revolution of concepts will thus be left over or vice versa. In the activated superior concepts will not be filled completely or completely. Over time, the system and related variables will accumulate. It is asserted that one of the functions of sleep and dreams is to reorganize the system and related variables. The system and related variables will accumulate. It is asserted that one of the functions of sleep and dreams is to reorganize the system and related variables.

**Grounding**  
The state of affairs is a most fundamental task that every active and self-controlled system has to perform. At the most basic physiological level the situation with respect to nutrition has to be monitored, e.g. hunger or thirst are the output signal of a control loop when the actual status deviates from a set point. Most of the time, the system is in a state of equilibrium. The signal (pleasant / unpleasant) in the context of the system is determined by the system's internal state. The signal (pleasant / unpleasant) in the context of the system is determined by the system's internal state. The signal (pleasant / unpleasant) in the context of the system is determined by the system's internal state. The signal (pleasant / unpleasant) in the context of the system is determined by the system's internal state.

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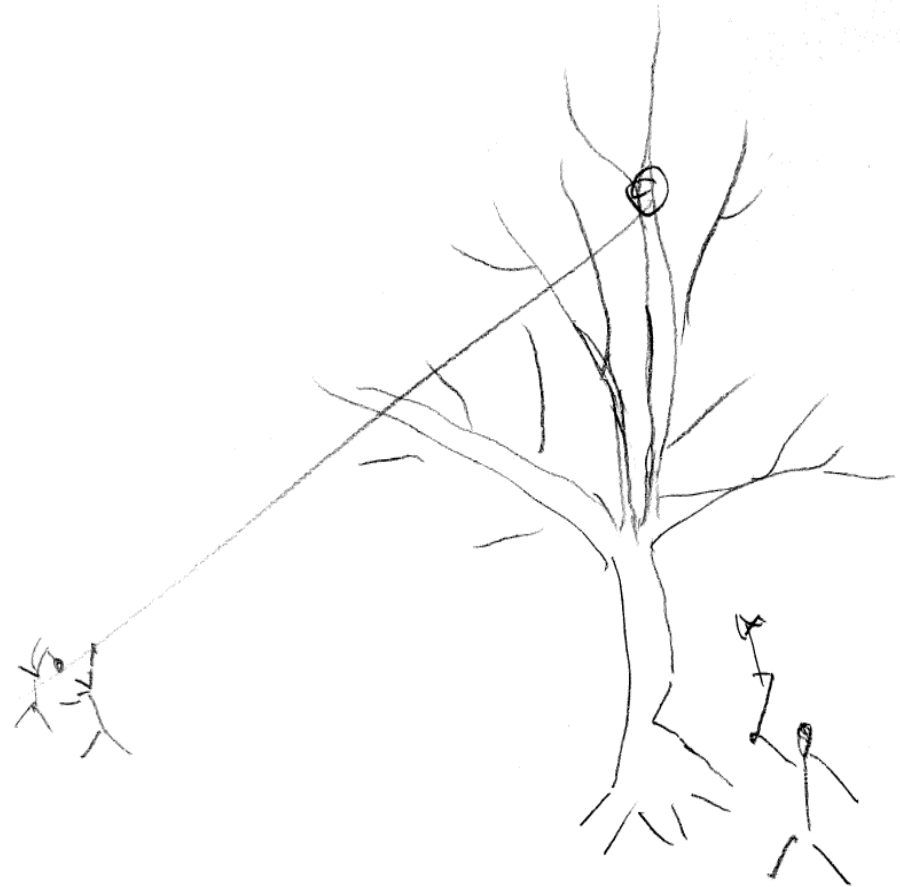
# Communication as sketched by the Ouroboros Model:



**All discourse relies on some shared content, it cannot work without a minimum of common reference (and grounding)**



A lack in self-awareness can easily become costly to an agent in the real world.



Clever is, who applies an understanding as wide as possible, chooses appropriate tools as available and accepts help from friends.

K. Thomsen, Stupidity and the Ouroboros Model, in: Bach, J., Goertzel, B., and Iklé, M. (Eds.): Artificial General Intelligence, Lecture Notes in Computer Science Vol. 7716, (pp. 332–340). Berlin, Heidelberg, Springer, 2012.

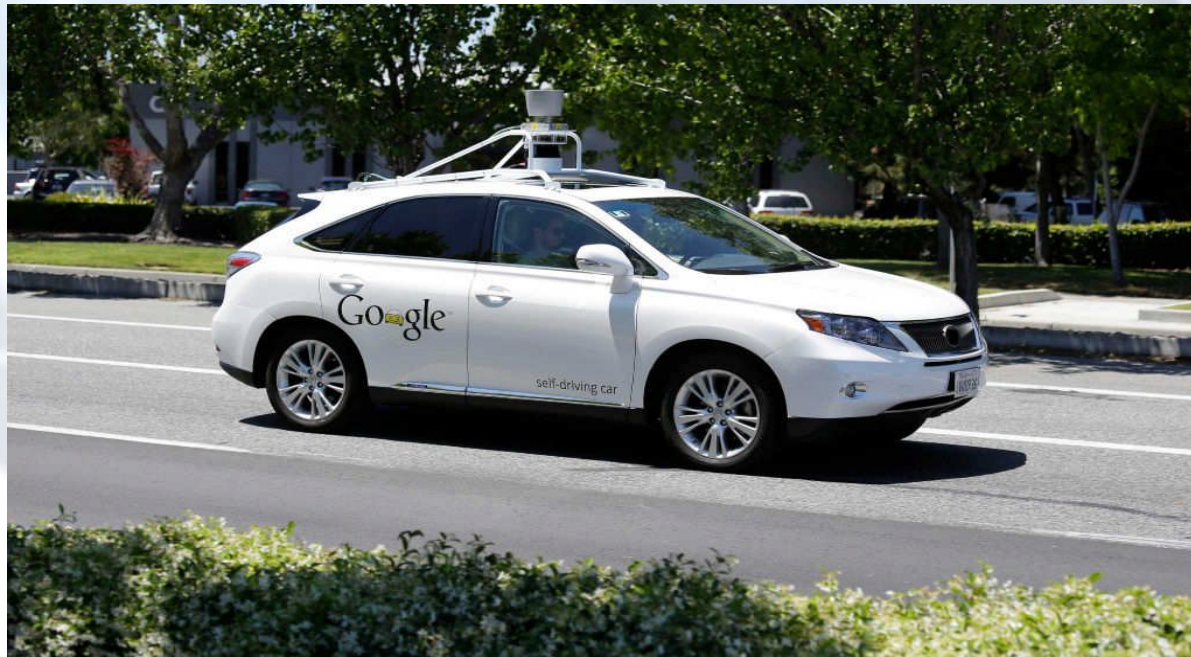
**Petre Dini - Panelist**

**Issues and Achievements on  
Driverless Cars**

Petre Dini, Concordia University, Canada | IARIA, USA

# Self-driving | *Legal aspects*

- **Driverless car journey starts in Las Vegas**
- **Published 7:59 pm, Friday, May 30, 2014**
- <http://www.timesunion.com/business/article/Driverless-car-journey-starts-in-Las-Vegas-5517869.php#photo-6379150>
- **The Nevada Legislature and the Department of Motor Vehicles** have enacted legislation and regulations to enable the testing and operation of autonomous vehicles in the Silver State. Currently, the **DMV is accepting applications for testing only**. Autonomous vehicles are not available to the general public.
- <http://www.dmvnv.com/autonomous.htm>



# Self-driving II | *Partnership and Incentives*

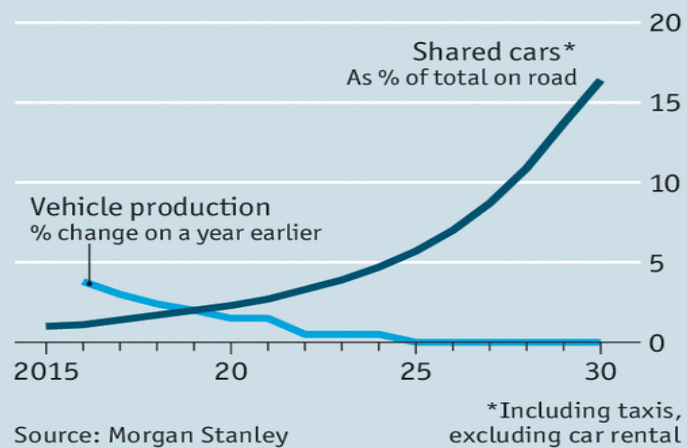
## Partnership

<http://www.economist.com/news/business/21685459-carmakers-increasingly-fret-their-industry-brink-huge-disruption>

“A rumored tie-up between **Ford and Google** to produce driverless cars failed to materialize at the show, but even the rumors underlined the disruption that tech firms are bringing to the motor industry. And other partnerships were announced: **Ford is teaming up with Amazon** to connect its cars to sensor-laden smart homes. It was also revealed at CES that **Toyota would adopt Ford’s in-car technology**, which is a competitor to **Apple’s CarPlay and Google’s Android Auto**, to access smartphone apps and other features.”

## Sharing, not growing

Worldwide forecast



Source: Morgan Stanley

\*Including taxis, excluding car rental

Economist.com

2016

“So when will the fully autonomous car hit the showrooms? **Google**, whose cars have done 1.3m test miles (2.1m km) on public roads, once promised 2018, whereas most analysts reckoned the 2030s more plausible as carmakers introduced automated-driving features in stages.

**Barclays**, another bank, forecasts that the fully driverless vehicle will result in the average American household cutting its car ownership from 2.1 vehicles now to 1.2 by 2040. A self-piloting car may drop off a family’s breadwinner at work, then scuttle back to pick up the kids and take them to school. The 11m or so annual sales of mass-market cars for personal ownership in America may be replaced by 3.8m sales of self-driving cars, either personally owned or part of taxi fleets, Barclays thinks.

Driverless cars still have problems in bad weather. They may struggle to recognize that light shining off a puddle is harmless or guess that a pedestrian is about to step into the traffic without looking. But sophisticated systems for hands-free driving on motorways, and for automated parking, are already available on a number of manufacturers’ models. Fully driverless cars will ferry workers round **GM’s technical centre in Detroit in late 2016.**”

# Self-driving III | Drones + IoE

- **CES 2016: drones, driverless cars and smart brewers**
- <http://www.telegraph.co.uk/technology/ces/12081995/CES-2016-drones-driverless-cars-and-smart-brewers.html>
- Beyond the **Internet of Everything**, drones took centre-stage. The Telegraph's picks of drones on the showfloor include winner of the CES 2016 Innovation Award, **Lily Robotics** which makes a "throw-and-shoot camera" – a 2.8 pound camera drone (\$799, shipping begins in February 2016), which follows the user via a tracking device.



“Chinese drone giant **DJI** showcased its new Phantom 3 4K – its first-ever sub-\$1000 drone with a 4K camera and WiFi transmission upto 1.2km. And finally, popular drone-maker **Parrot** showed its giant Disco Drone – a 50-miles-per hour sleek fixed-wing aircraft with a 1080p camera onboard, weighing just 700 grams. When the show opens officially on Wednesday, there will be an Unmanned Systems marketplace, with 26 different exhibitors.”

# Self-driving IV | Computing for vehicles

## Connected cars

<http://www.telegraph.co.uk/technology/ces/12081995/CES-2016-drones-driverless-cars-and-smart-brewers.html>

- That prophecy has already started to fulfill itself – GPU chip maker **Nvidia** kicked off the week's keynote speeches with the announcement of its “supercomputer” for driverless cars. This new system apparently has power equivalent to 150 Macbook Pros, squeezed into a lunchbox-sized case and can tell apart cars, humans and street signs.
- Its supercomputer is already being tested in cars by companies ranging from **Volvo to BMW, Daimler, Ford and Audi**, which managed to train its cars to read German road signs better than any other computer, and even humans could.
- **Nvidia wants to supercharge the self-driving car phenomenon by launching a supercomputer designed specifically for the vehicles.**



The Faraday Future Zero 1 concept car was unveiled at the Consumer Electronics Show in Las Vegas, Jan. 4, 2016.  
Photo: David Gilbert



# Drive and Steer by Web / e-Vehicle

<http://www.altreonic.com/content/steer-web-kurt>

**Altreonic** has demonstrated for the first time "steer by web" capability for **its KURT vehicle**.

Using a camera input and a smartphone, the vehicle was remotely steered over **Internet using a web application**. Even with the application server and the vehicle being widely apart (about 3000 km) and **using a standard ADSL connection**, the control was with minimal delay.

This brings KURT in the domain of **Internet of Things**, enabling **semi-autonomous driving** for a fleet of **KURT vehicles**.

events (March 2016)

<http://www.citycarsummit.com/>

<http://www.autotechnica.be/en>

- **urban mobility (uncontrolled behavior of the pedestrian crowd, driverless, drones,...)**
- **driverless cars, e-vehicle, exceptions handling**
- **special regulations**

# To be done

- **Legal back-up and regulations**
- **Social acceptance**
- **Cognition/adaptation advanced theory/algorithms**
- **Encouraging partnership/incentives**
- **Specialized/high performance computing devices**
- **Appropriate monitoring/surveillance infrastructures**
- **Urban computing to be carefully supported**
- **Continuously revisiting progress/issues**
- **Governmental enforced regulations**

**Thanks**

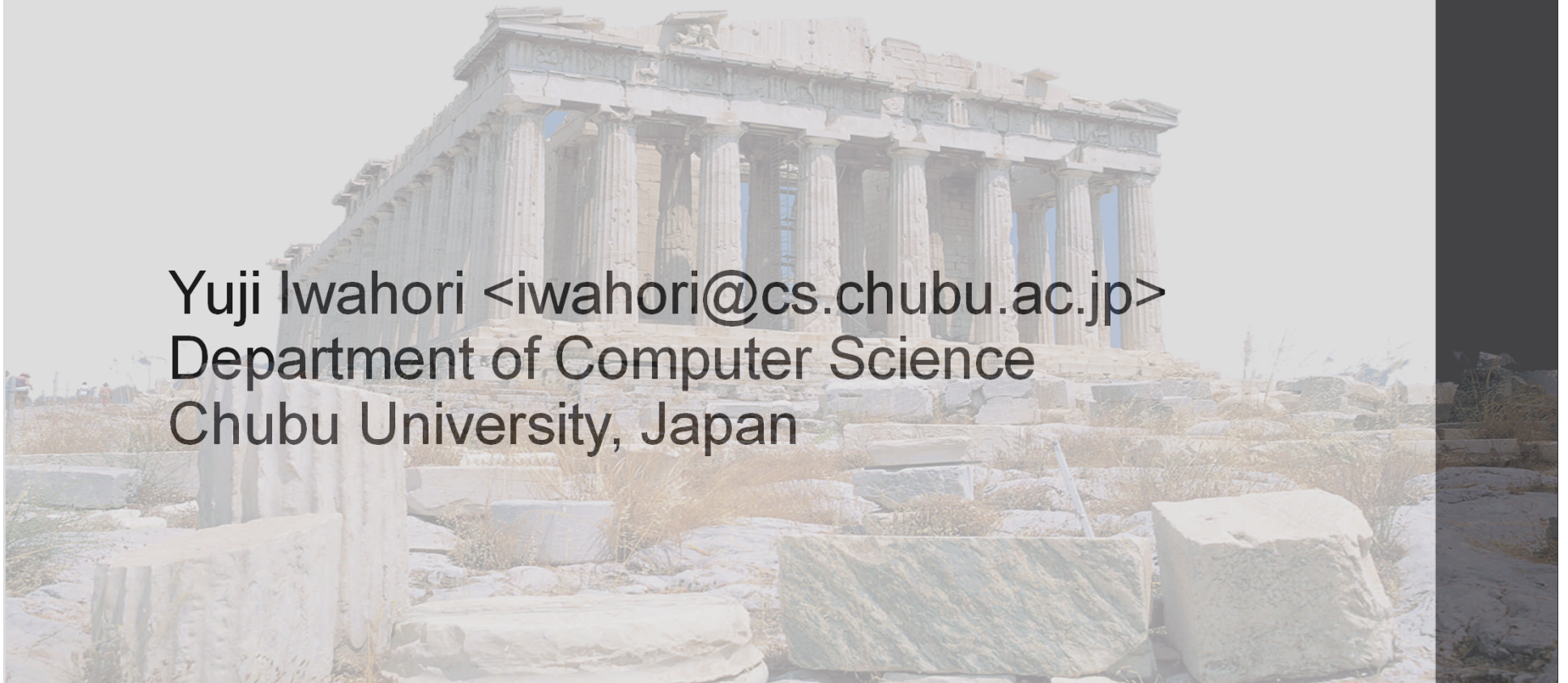
**Thanks**



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# Constructing Background Model to Extract Moving Objects

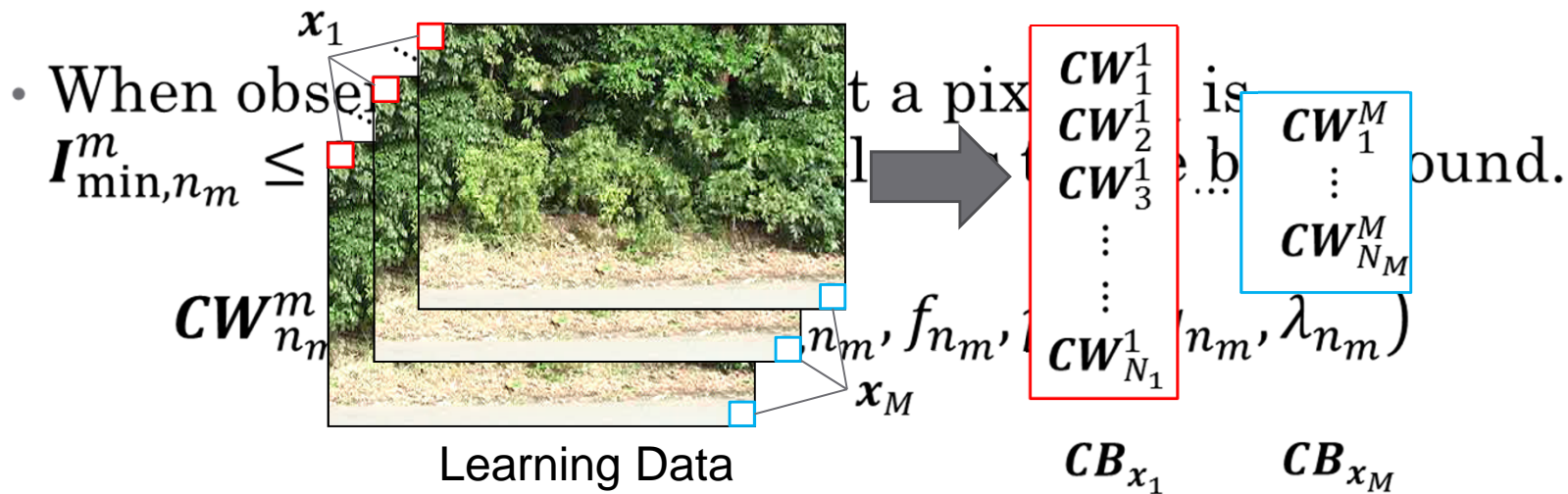
Yuji Iwahori <iwahori@cs.chubu.ac.jp>  
Department of Computer Science  
Chubu University, Japan



# Background Model by Codebook[1]

- Codebook (CB) is generated at each pixel
- CB records observed data to CodeWords (CWs)
- CW is defined by  $(I_{\min}, I_{\max}, f, p, q, \lambda)$

$I_{\min}$  : Minimum Value,  $I_{\max}$  : Max Value,  $f$  : Frequency  
 $p$  : Time when CW is generated     $q$  : Time of last access  
 $\lambda$  : Period during which CW is not used



[1] K. Kim, T.H. Chalidabhongse, D. Harwood, L. Davis, "Real-time foreground background segmentation using codebook model," *Real-time imaging*, vol.11, no.3, pp.172-185, 2005

- **Problem**

- Cast shadows of moving objects are obtained as objects

- **Solution**

- Features robust to illumination changes are used
  - Shadows can be regarded as local illumination changes
- Feature is changed depending on the region
  - Shadows usually cast onto still regions (ground, floor, wall, ...)
  - Frame is segmented to still regions and small movement regions by the number of CWs



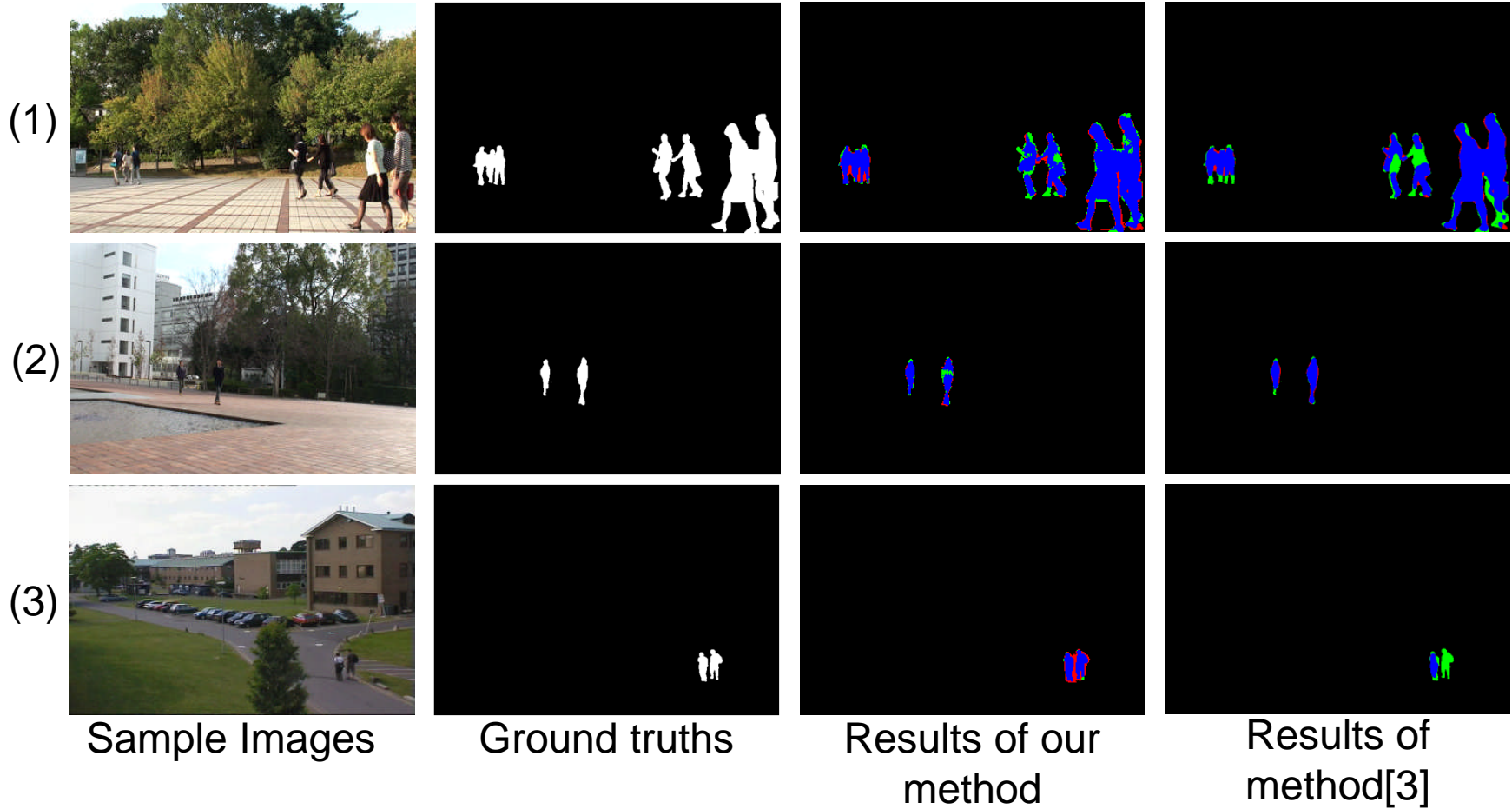
# Our Approach

- UV of YUV and SILTP[2] are used
  - UV are used in small movement regions
  - SILTP is used in still regions
- Procedure
  1. Generation of CWs with SILTP at each pixel
    - $\mathbf{CW}_{SILTP} = (L_{SILTP}, f, p, q, \lambda)$
  2. Segmentation by the number of CWs
  3. Generation of CWs with UV in small movement regions
    - $\mathbf{CW}_{UV} = (U_{min}, U_{max}, V_{min}, V_{max}, f, p, q, \lambda)$
  4. Object Detection
  5. Update of CWs

[2] S. Liao, et al. "Modeling pixel process with scale invariant local patterns for background subtraction in complex scenes," *Computer Vision and Pattern Recognition (CVPR)*, pp. 1301-1306, 2010.

# Results

Blue Pixels: Correct  
Green Pixels: Incorrect (Undetected)  
Red Pixels: Incorrect (Overdetection)



[3] P. L. St-Charles, G. A. Bilodeau and R. Bergevin, "SuBSENSE: A Universal Change Detection Method With Local Adaptive Sensitivity," in *IEEE Transactions on Image Processing*, vol. 24, no. 1, pp. 359-373, Jan. 2015.



Method	Scene	Recall	Precision	F-measure
Our Method	(1)	87.51	84.99	86.23
	(2)	77.98	83.33	80.56
	(3)	88.85	72.83	80.05
Method[3]	(1)	74.20	87.76	80.41
	(2)	94.1	87.23	90.54
	(3)	57.61	91.12	70.59

$$\text{Recall} = \frac{TP}{TP+FN}$$

$$\text{Precision} = \frac{TP}{TP+FP}$$

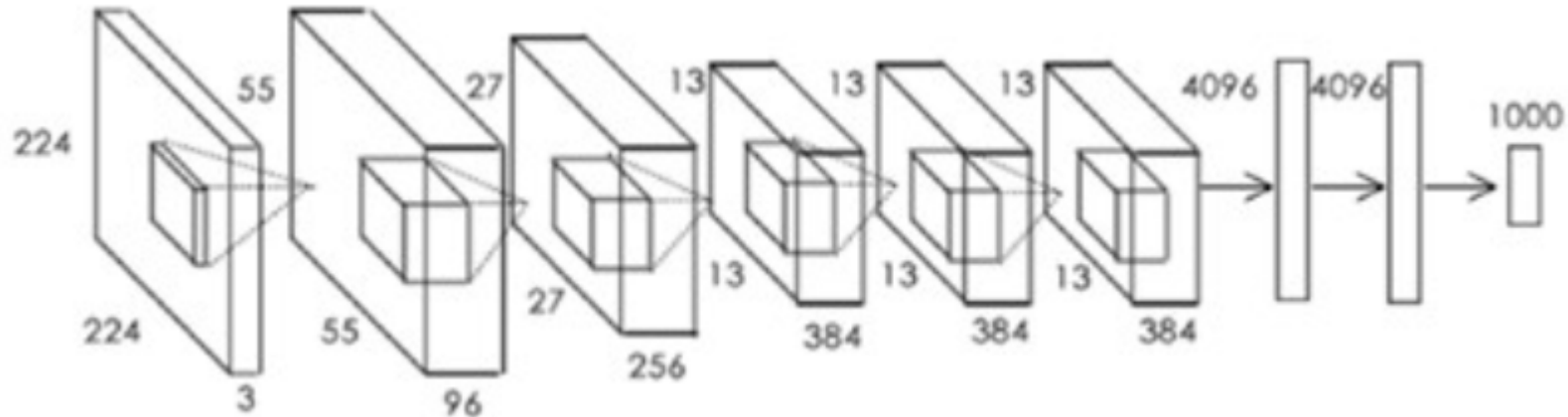
$$\text{F-measure} = \frac{2 * \text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}}$$

*TP* : True Positive

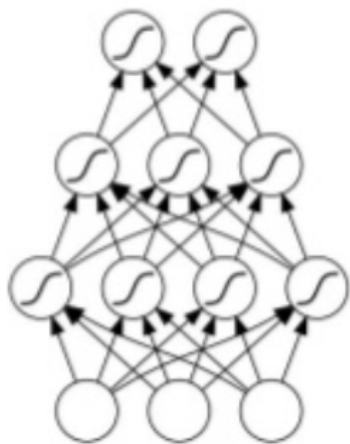
*FP* : False Positive

*FN* : False Negative

# AlexNet (CNN Model)



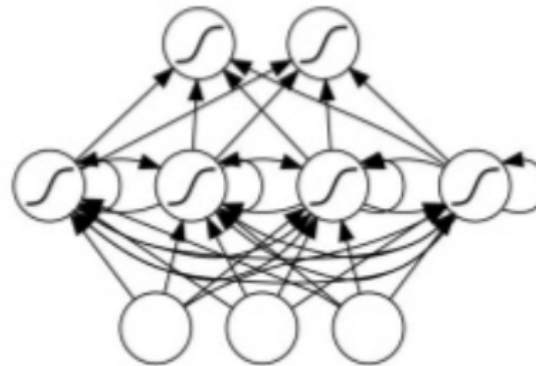
## Feedforward NN vs. Recurrent NN



Output Layer

Hidden Layers

Input Layer



Output Layer

Hidden Layer

Input Layer

# Example of Faster RCNN for Object Recognition

<https://drive.google.com/file/d/0B51wBIYOrV0AN0dTbkIFRHM5Qms/view>

Happy solution is target is also moved with moved background under moving camera. One camera is still available for this solution. This is an example for further solution.