NM500

nepes Neuromorphic Technology Overview

(Practical Artificial Intelligence Enabler)

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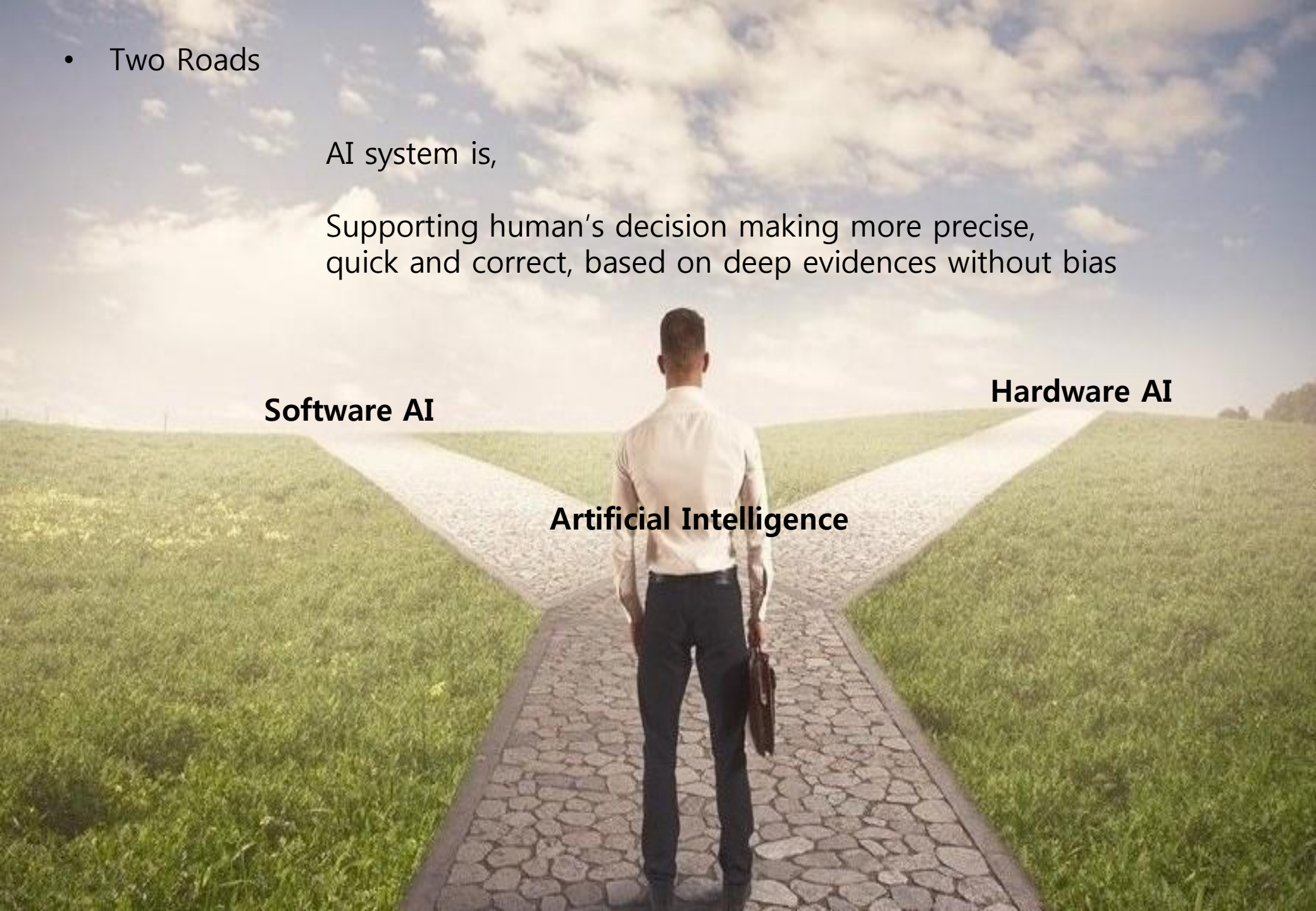
Table of Contents

- Two Roads

AI system is,

Supporting human's decision making more precise,
quick and correct, based on deep evidences without bias



0. nepes Core Technology

NM500

Market Trend

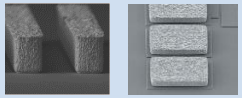
Smaller form factor
(Based on Wafer-Level Platform)

Highly integrated
Wafer-Level System in Package

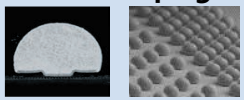
Packaging Technologies

Flip-Chip Bumping

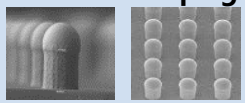
- Gold Bumping



- Solder Bumping



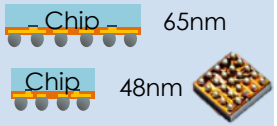
- Cu Pillar Bumping

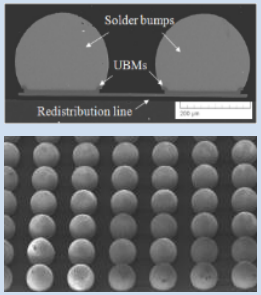


- Cu/Ni/Au Bumping (Wire bondable)

WLP

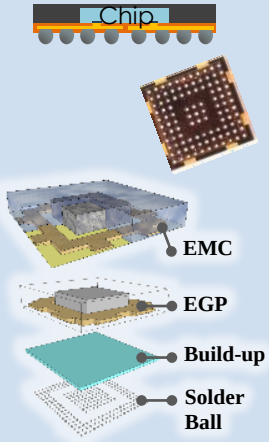
- Fan-in WLP



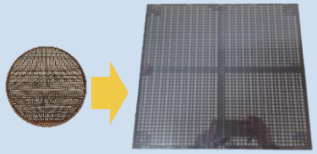


Fan-out WLP

- Fan-out WLP



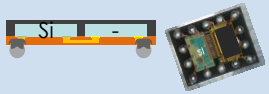
nPLP



nPLP ™
(600x600mm)

SiP (Module)

- Multi-Chip Packaging



- One Package Module

- System in packaging

  - AP, PMIC
  - Flash Memory
  - **Neuromorphic**

Future Intelligence

Neuromorphic chip

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0. nepes Core Technology

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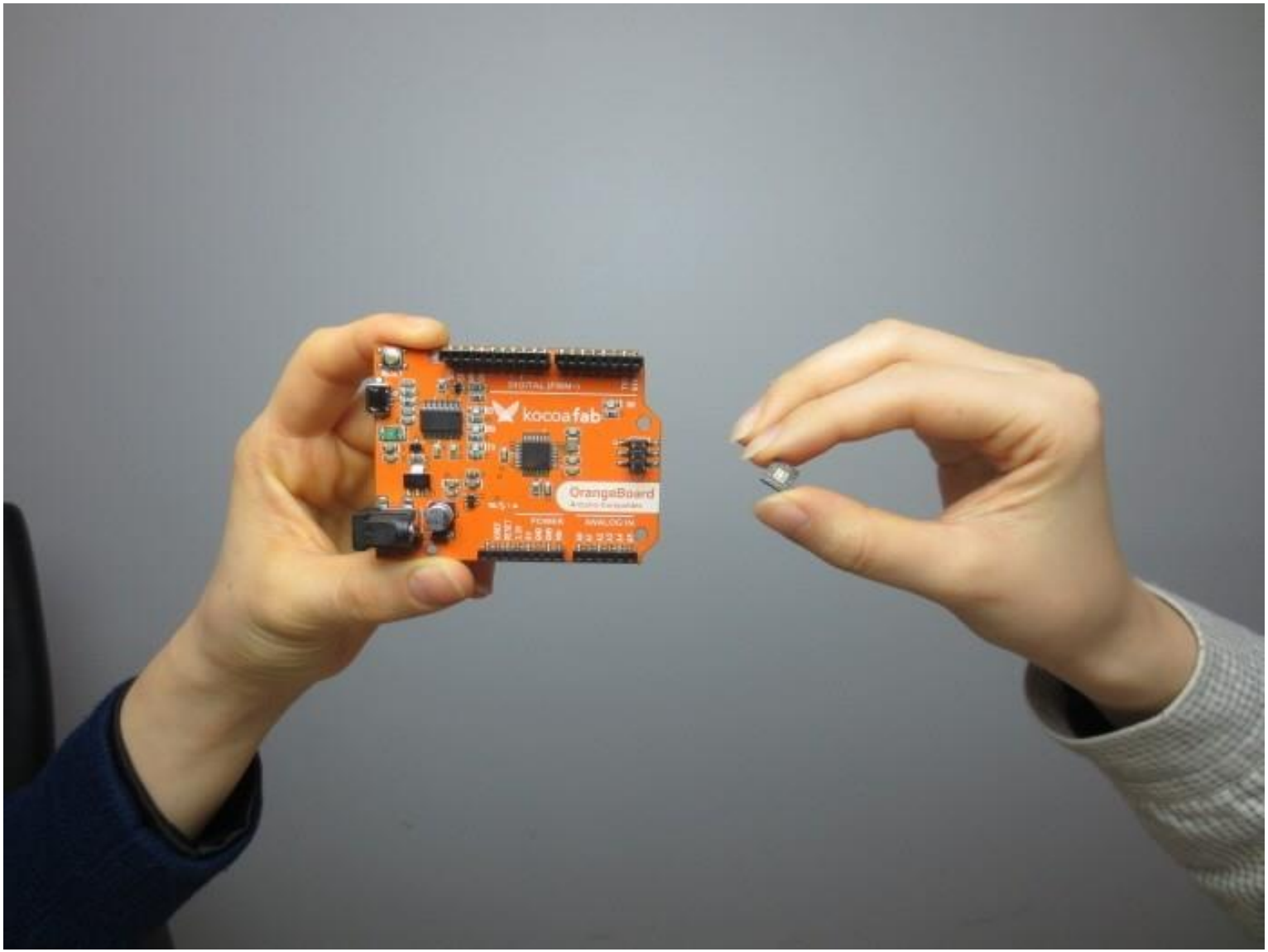

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Jeffrey Hinton


Yann Lecun


Andrew Ng


Yoshua Bengio


Demis Hassabis


Ian Goodfellow

Who is this guy?


John Von Neumann

1. What is Neuromorphic

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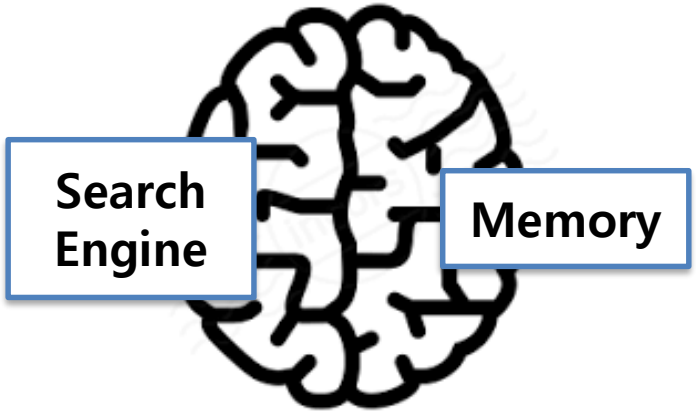

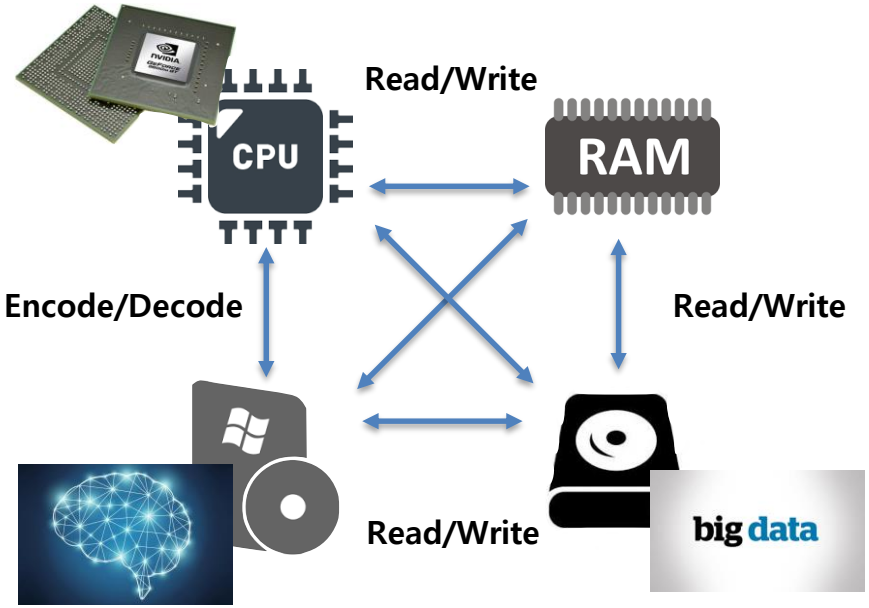

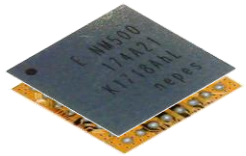

Think the way as we do

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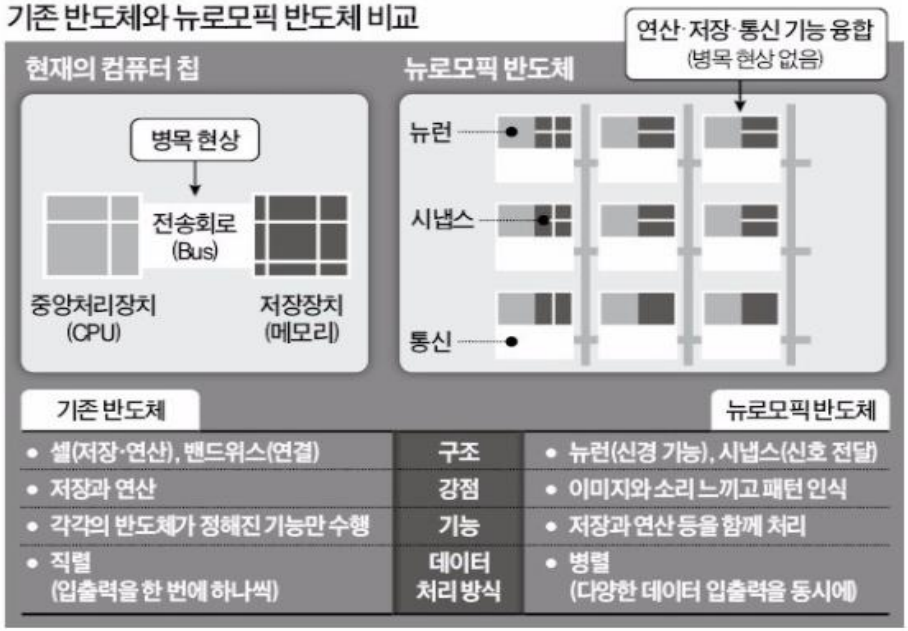
삼성·SK하이닉스·서울대·KAIST·ETRI

'뉴로모픽 반도체' 프로젝트
1만6000개 CPU 역할을 손톱 크기 칩 하나로 처리
상용화까지 10년 예상…성공 땐 '제2 반도체 혁명'

삼성전자와 SK하이닉스, 서울대, KAIST, 한국전자통신연구원(ETRI) 등이 뉴로모픽(neuromorphic·뇌 신경 모방) 반도체 개발을 위해 힘을 합친다. 뉴로모픽 반도체는 기존 반도체 대비 1억분의 1에 불과한 초저전력으로 딥러닝 등 인공지능(AI) 기능을 구현할 수 있는 반도체다. 상용화까지는 10년 이상 걸릴 것으로 예상되지만 일단 시장에 나오면 메모리와 비메모리(시스템LSI) 간의 벽을 무너뜨려 시장 판도를 크게 바꿔놓을 전망이다.

기존 반도체와 뉴로모픽 반도체 비교



기존 반도체		뉴로모픽 반도체
• 셀(저장·연산), 밴드위스(연결)	구조	• 뉴런(신경 기능), 시냅스(신호 전달)
• 저장과 연산	강점	• 이미지와 소리 느끼고 패턴 인식
• 각각의 반도체가 정해진 기능만 수행	기능	• 저장과 연산 등을 함께 처리
• 직렬 (입출력을 한 번에 하나씩)	데이터 처리 방식	• 병렬 (다양한 데이터 입출력을 동시에)

출처:한국경제신문 2017.04.07

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1. What is Neuromorphic

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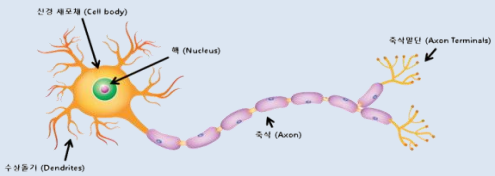
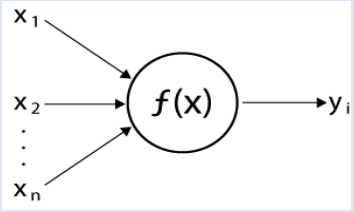
Inspiration from biology to design hardware models of neural and sensory systems.

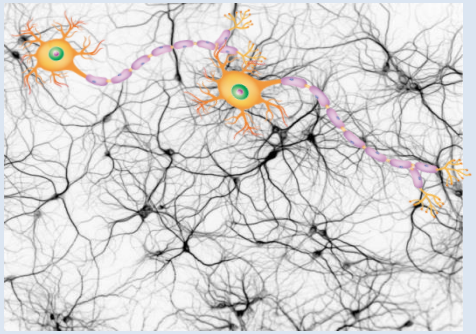
Neuron



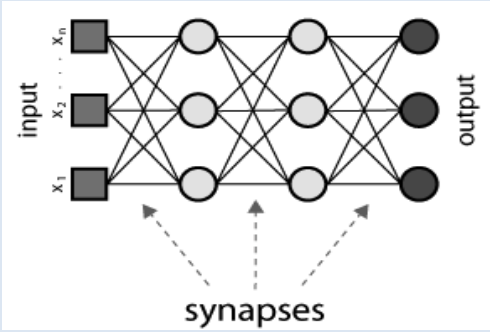
Perceptron



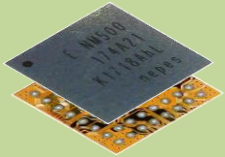
Neural Network



Artificial Neural Network



NeuroMem (Neuromorphic Chip)



- Designed to enable parallel processing of network structure and implemented as semiconductor chip.
- <u>Pattern recognition is possible at low power and high speed.</u>
- Easy to learn in the field to create and apply models

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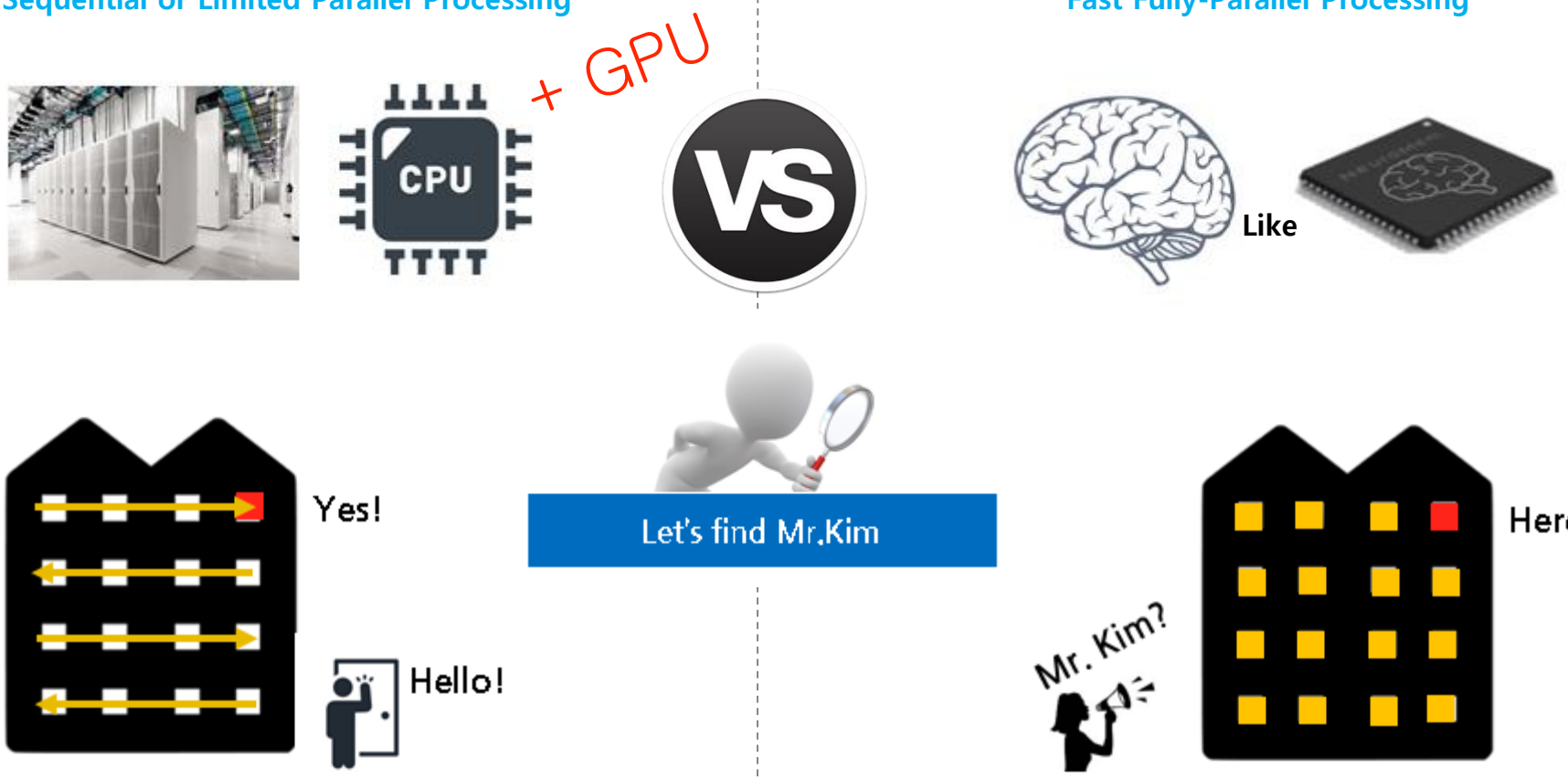
The NeuroMem enables fast pattern recognition using fully parallel processing.

Conventional Computing Architecture

Sequential or Limited Parallel Processing

NeuroMem Computing Architecture

Fast Fully-Parallel Processing



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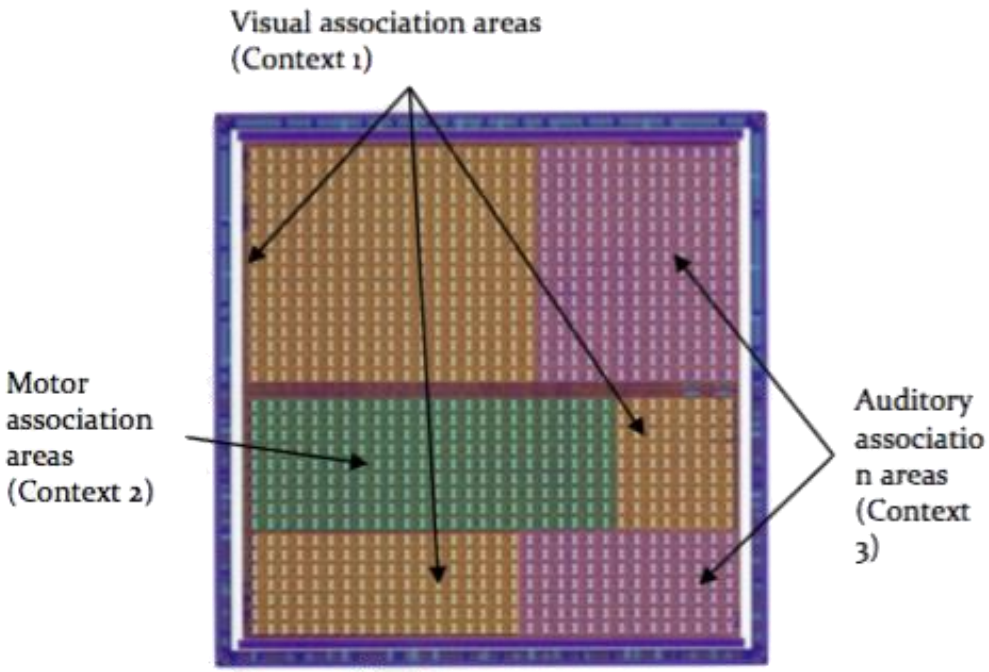
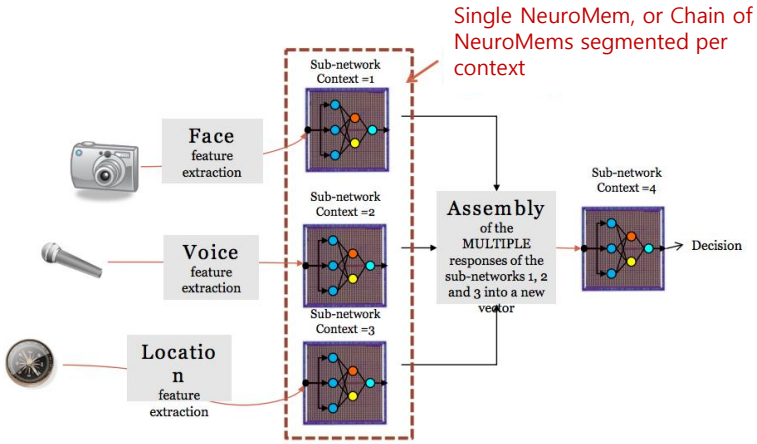
All Implemented in Nepes Neuromorphic

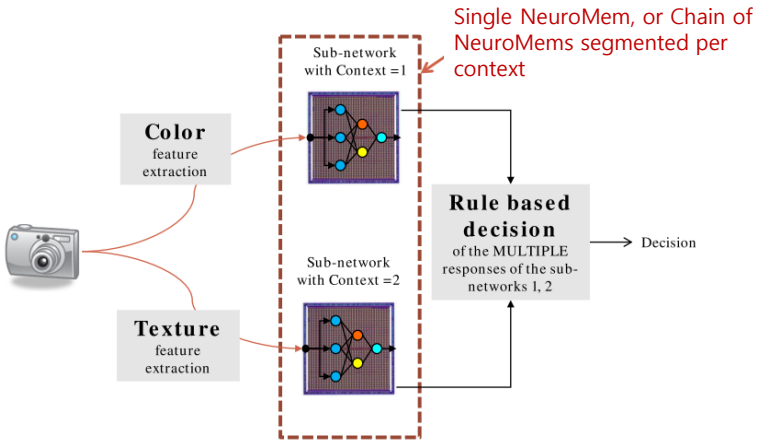
특징	설명
Broadcast Mode	입력 데이터를 모든 뉴런에게 동시 전달이 가능 (빠른 인식/학습 속도, 병렬처리)
Deterministic Search Time	뉴런의 개수가 증가하더라도 응답(인식) 속도는 일정
Winner Take All	가장 반응이 강한 뉴런만이 활성화 되고 낮은 반응을 보이는 뉴런들은 자체적으로 경쟁에서 제외 .
Uncertain Response	뉴런의 반응 정도에 따른 결과 자동 정렬
Unknown Response	새로운 지식(발견)의 동적인 추가 가능 (새로운 것에 대한 Online 학습이 가능)
Back Propagation of Error	잘못된 학습에 대한 자발적 억제 (오류 역 전파, Degeneration)
No fetch and decode of program instruction	소프트웨어적인 구현은 생물학적 모델의 반대 개념으로 시뮬레이션일 뿐 뉴로모픽이 아님
Beyond biology	지식의 확산을 가능하게 하는 빠른 업로드와 다운로드

NM500

The neurons can be assigned to different contexts for sensor fusion, feature fusion and robust decision.







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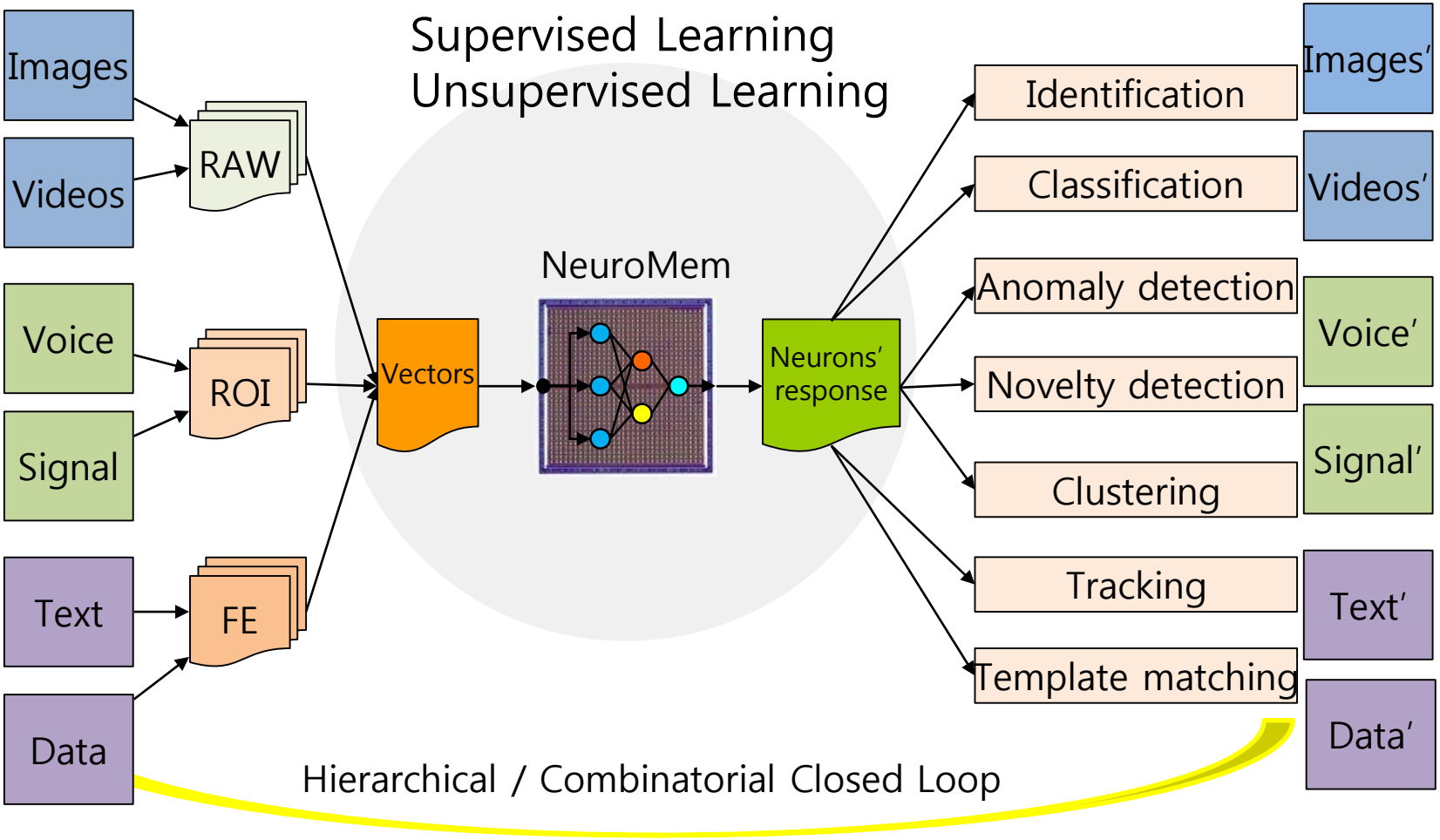
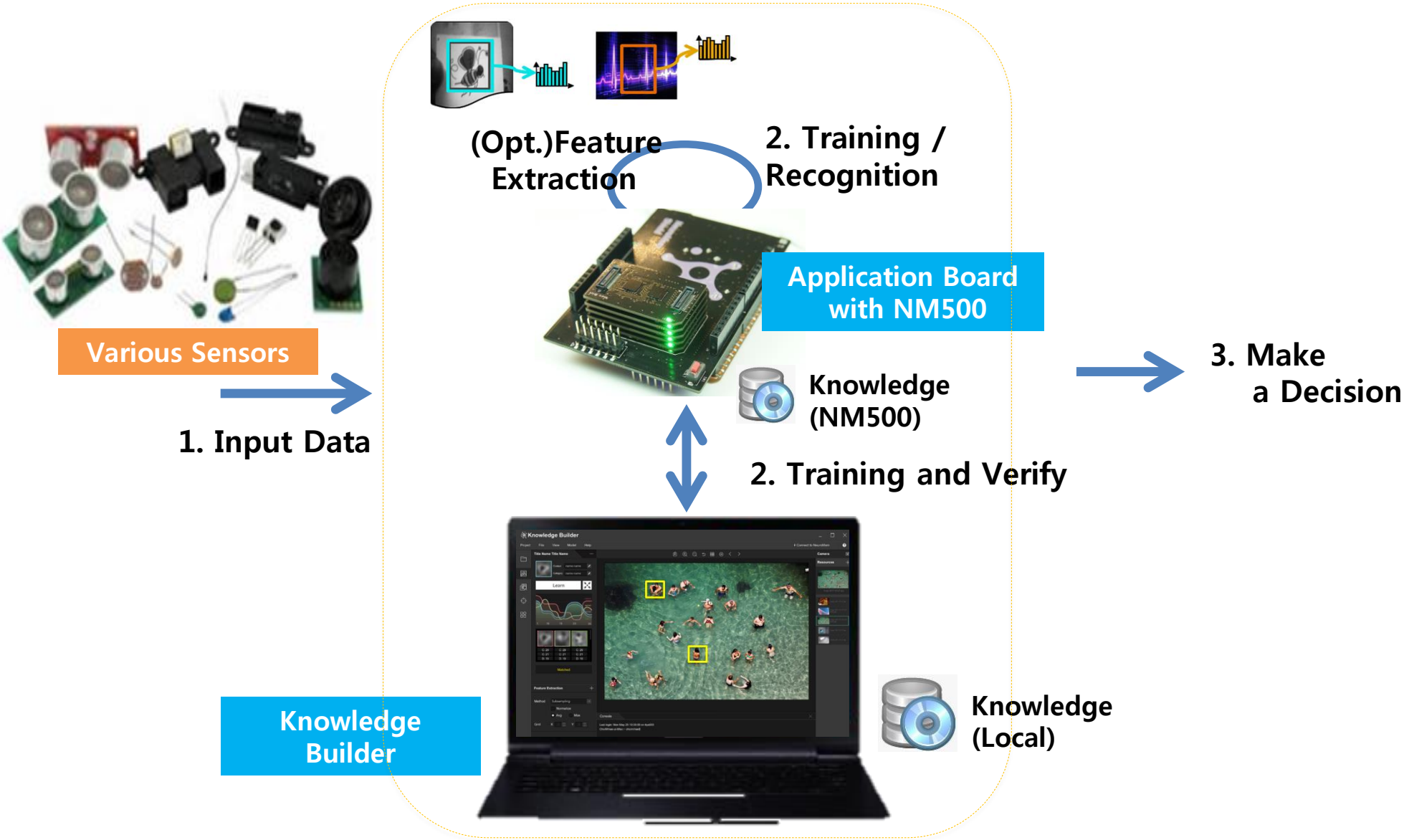


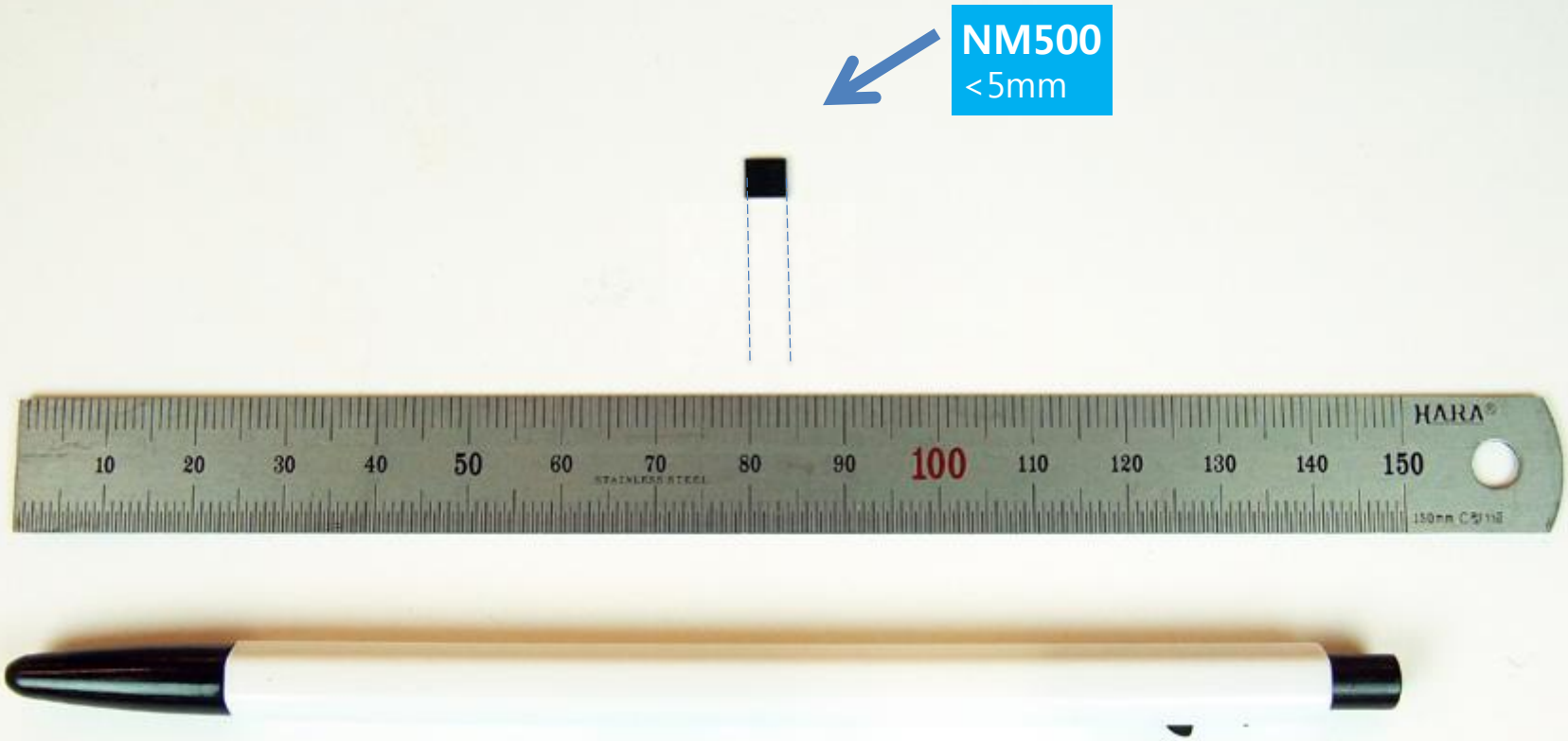
ROI=Region of Interest, FE=Feature Extraction

2. nepes Neuromorphic NM500



2. nepes Neuromorphic NM500 (Small)

NM500



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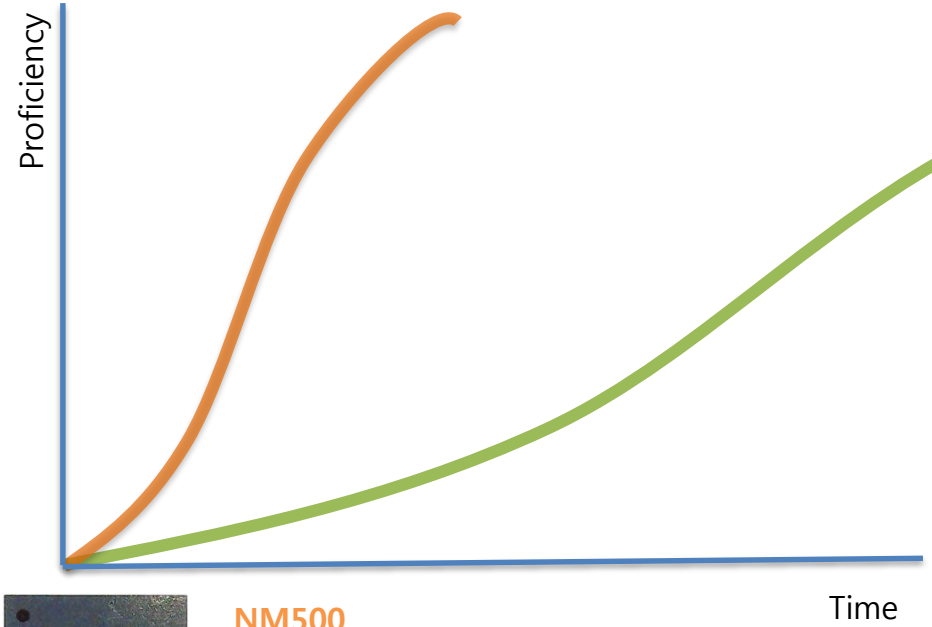
2. nepes Neuromorphic NM500 (Easy to Use)

NM500

Simple and Easy to Understand

The value in NM500 ecosystem is the agility

But, It is also powerful.



NM500

Application Boards (OSHW)

SDK and Knowledge Builder

Caffe BVLC, DL4J Deep Learning for Java, Microsoft CNTK, Spark, theano, torch, TensorFlow, Azure machine learning, dmlc mxnet, H2O.ai

C/C++, Lua, Go, julia, Java, python, R, Scala

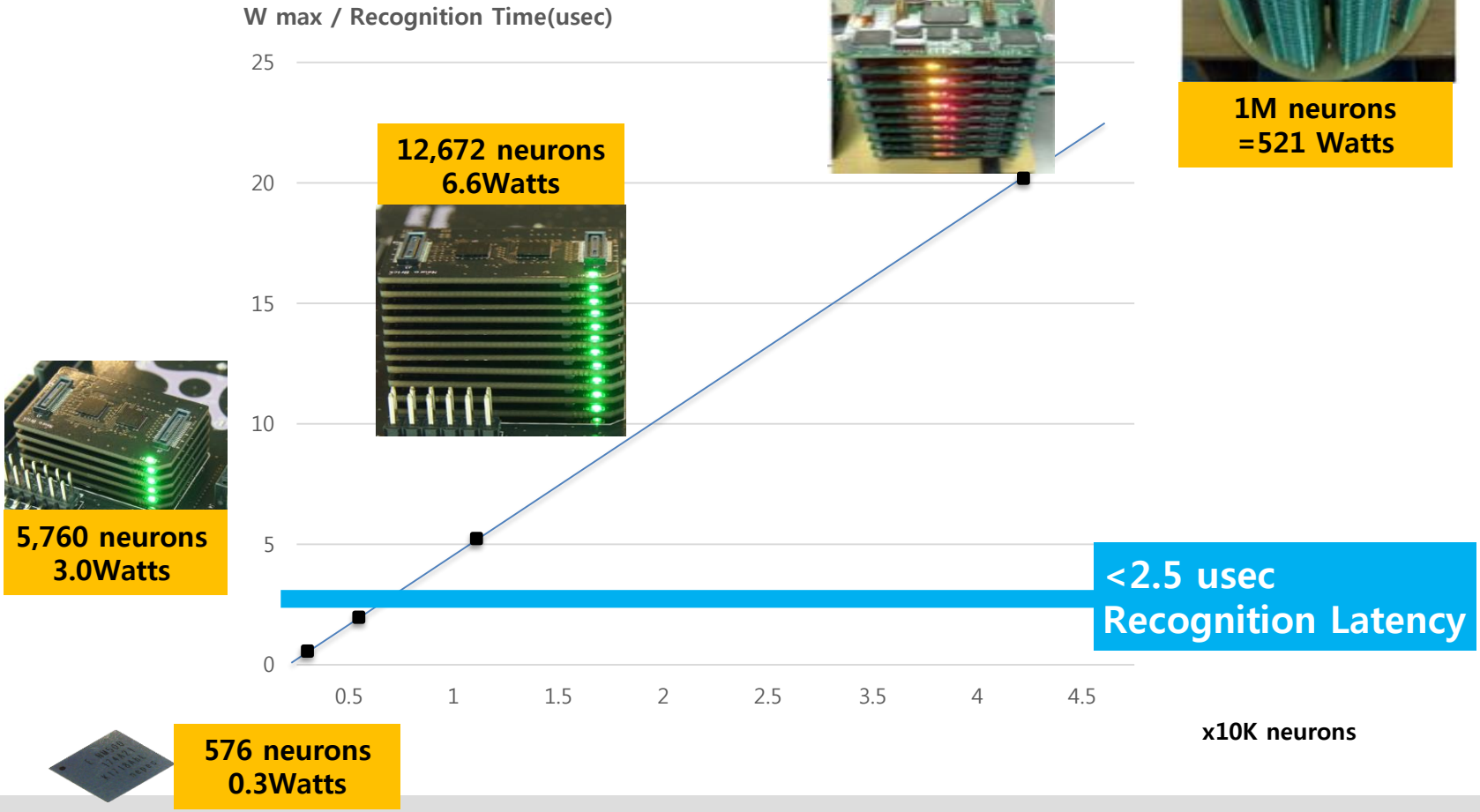
amazon web services, NVIDIA GEFORCE GTX, AMD RADEON GRAPHICS, Microsoft Azure, Google Cloud Platform

2. nepes Neuromorphic NM500 (Performance & Real time)

NM500

Regular latency time

Regardless of the number of neurons



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NM500

The NeuroMem technology is a crucial enabler for cognitive computing and artificial intelligence.

Field Trainable

Learn on the chip, or load models
Previously learned.

Real-time

Recognize patterns in micro-seconds
Regardless of the number of neurons

NeuroMem Technology

Unique Architecture in Neuromorphic Industry

Energy Efficient

100,000 recognitions per second for
milliwatts per 1K neurons

Knowledge Exchange

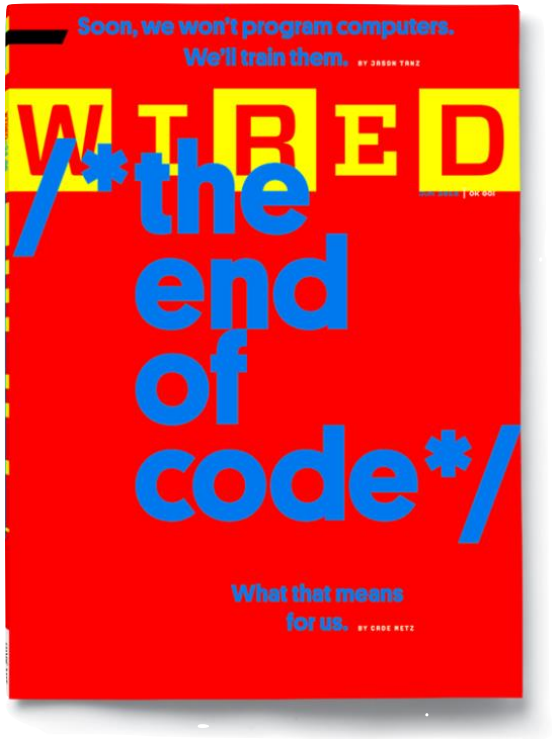
Quick exchange of Tacit Knowledges

JASON TANZ BUSINESS 05.17.16 6:50 AM

SOON WE WON'T PROGRAM COMPUTERS. WE'LL TRAIN THEM LIKE DOGS

The rise of Artificial Intelligence and the End of Code.

Jason Tanz, Wired Magazine, May 2016

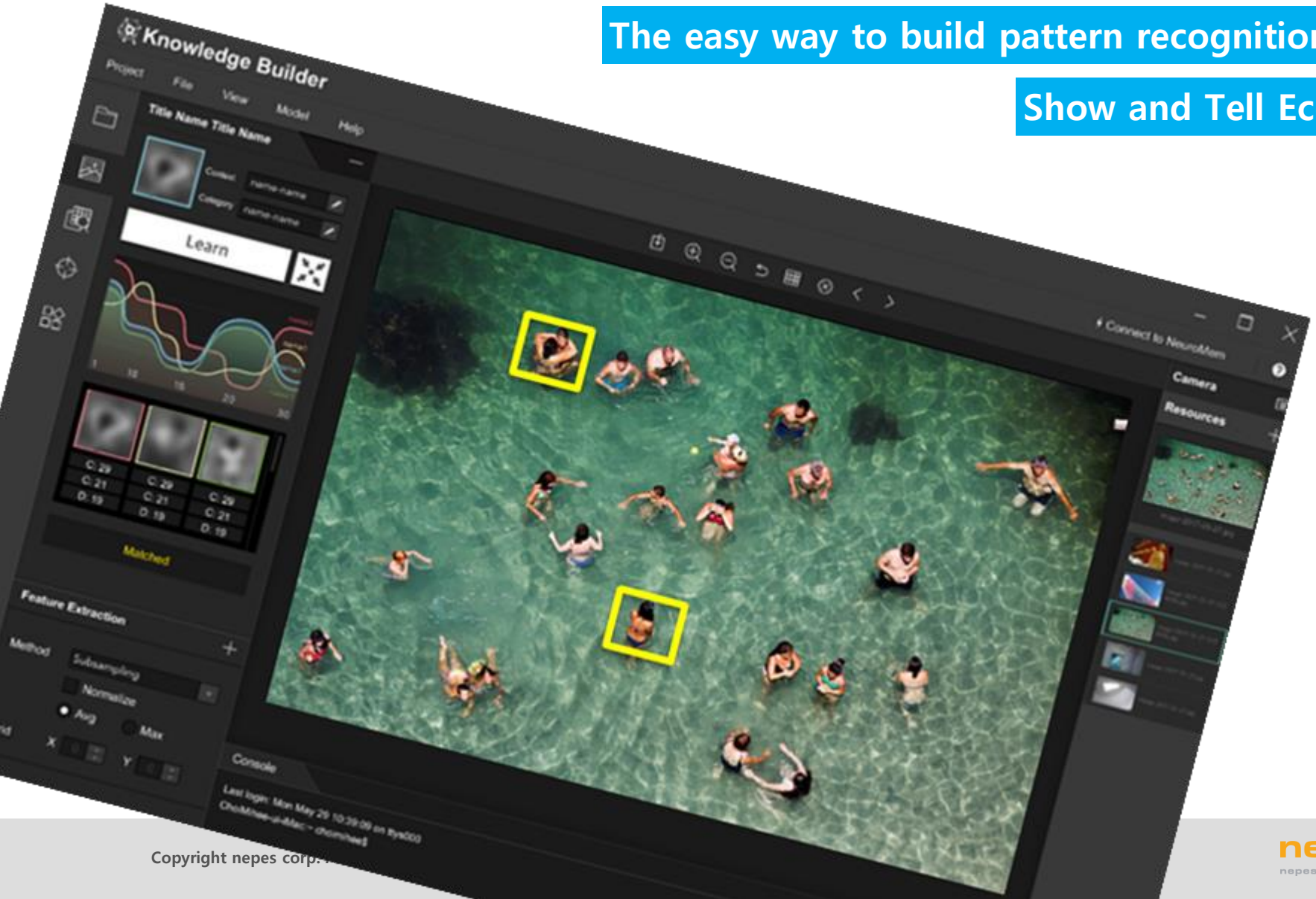


2. nepes Neuromorphic NM500 (Knowledge Builder)

NM500

The easy way to build pattern recognition model

Show and Tell Ecosystem



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Knowledge Builder

Gesture Recognition

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Vision System

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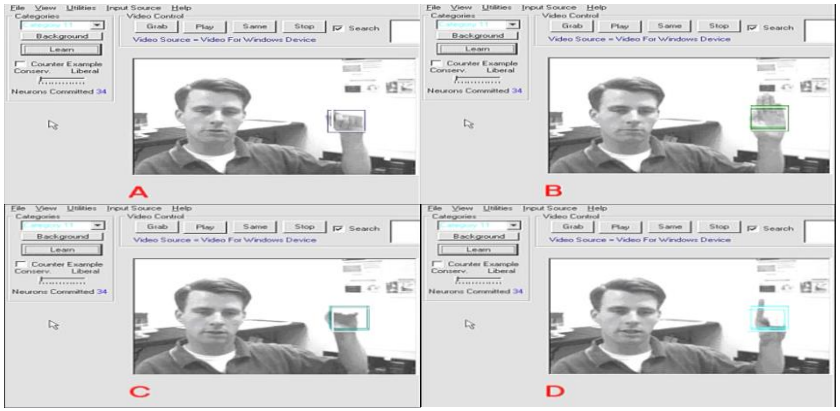
2. nepes Neuromorphic NM500 – Automotive, Face , Gesture …

NM500

Driver vigilance monitoring, gazing tracking

Facial Expression Recognition

Gesture Recognition



Road Trip

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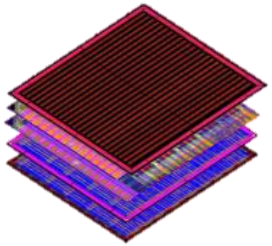
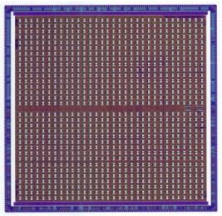
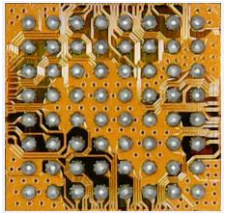
Driver Monitoring Demo
The NeuroMem CM1K chip is trained to recognize eyes. Safety consists of detecting a pair of them!

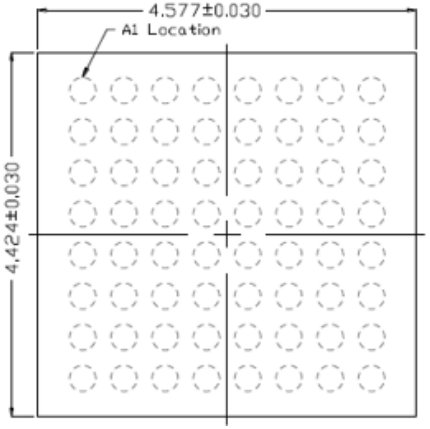
2. nepes Neuromorphic NM500 (Specification)

NM500









- **64pin WLP (0.5mm Pitch)**
- **110ns CMOS Logic Process : 6 Metals**

Electrical and IOs	
Clock frequency	36 MHz for single chip 25 MHz for chain of multiple chips
I/O	Parallel bus (26 lines)
Electrical	3.3 V I/O operation 1.2 V core static 260mA
Power consumption	<300 mW in active mode (CS_ low) at 1.2V and 3.3V
Package	64-pin CSP 4.6x4.5 mm package

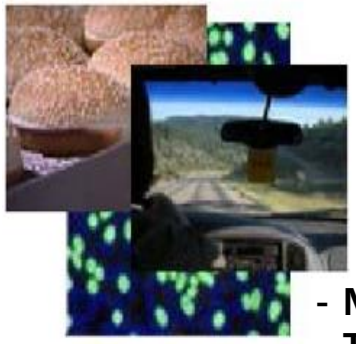
ANN Attributes	
Neuron capacity	576 neurons
Neuron memory size	256 bytes
Categories	15 bits
Distances	16 bits
Contexts	7 bits
Recognition status	Identified, Uncertain or Unknown
Logic Classifiers	Radial Basis Function (RBF) K-Nearest Neighbor (KNN)
Distance Norms	L1 (Manhattan), Lsup

3. NM500 Application Field

NM500

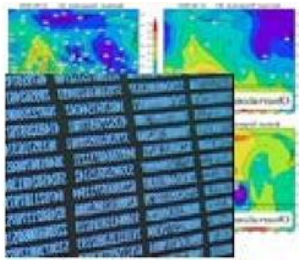
CONSUMER	HEALTH	FINANCE	RETAIL	GOVERNMENT	ENERGY	TRANSPORT	INDUSTRY

Early Adoption



- Machine Vision
- Target Tracking
- Video Monitoring
- Medical imaging
- Smart motion

-Speech Recognition
-Voice Identification
-Sonar ,Radar identification
-EKG,EEG Analysis
-Vibration monitoring



-Bioinformatics
-Fingerprint identification
-Cyber Security
-Sentiment analytics
-...

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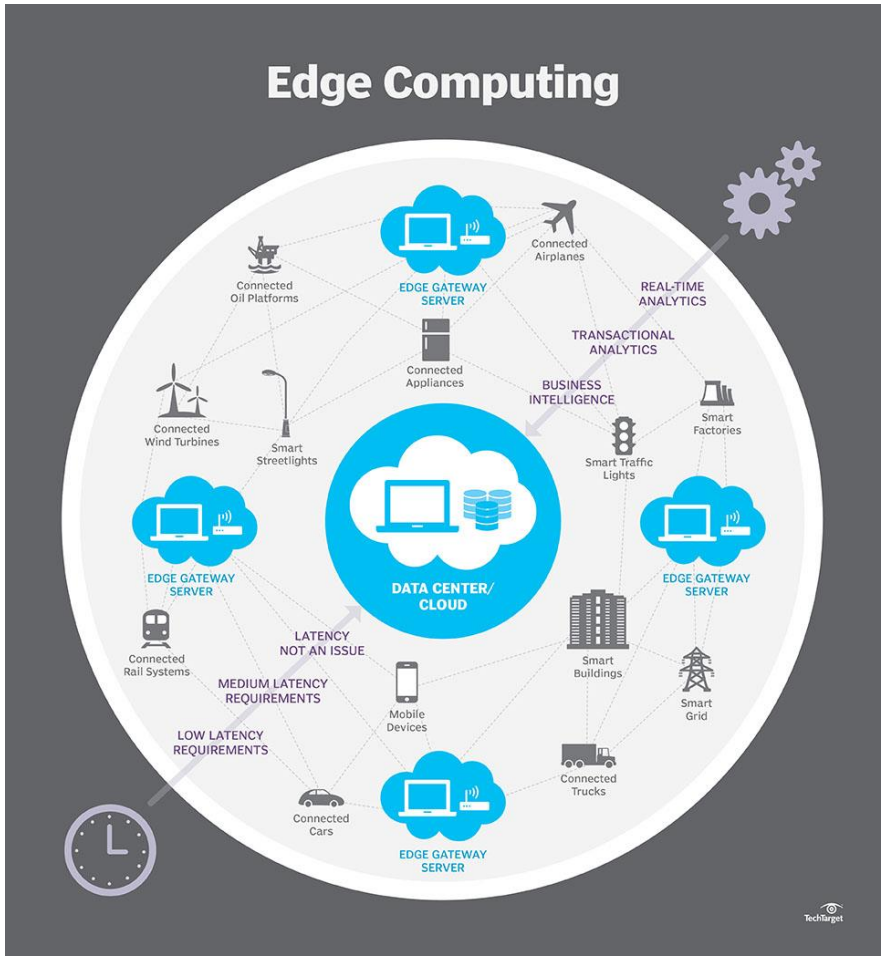
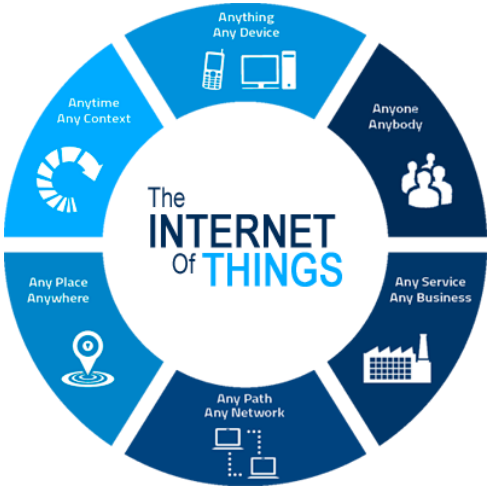
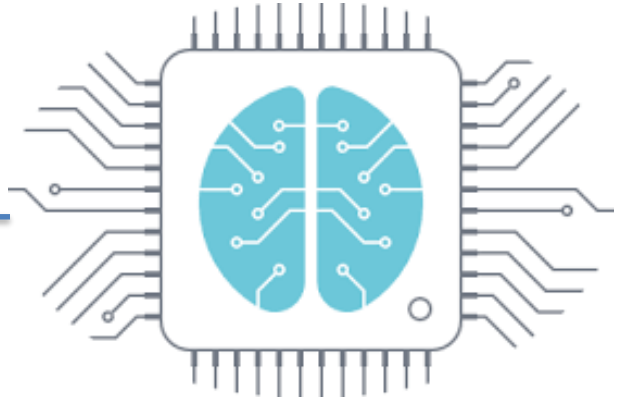
3. NM500 Application Field



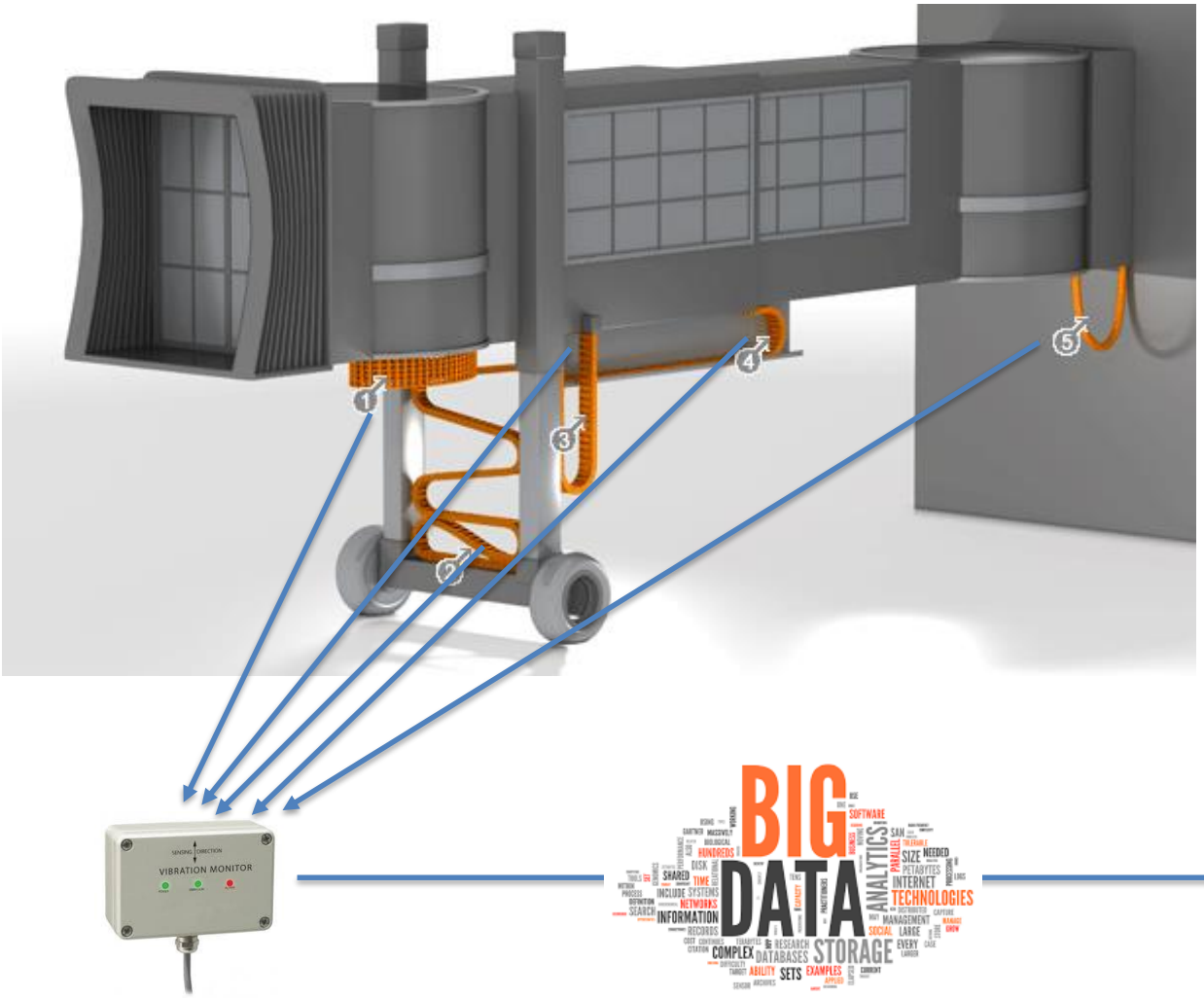
Means…



Meets

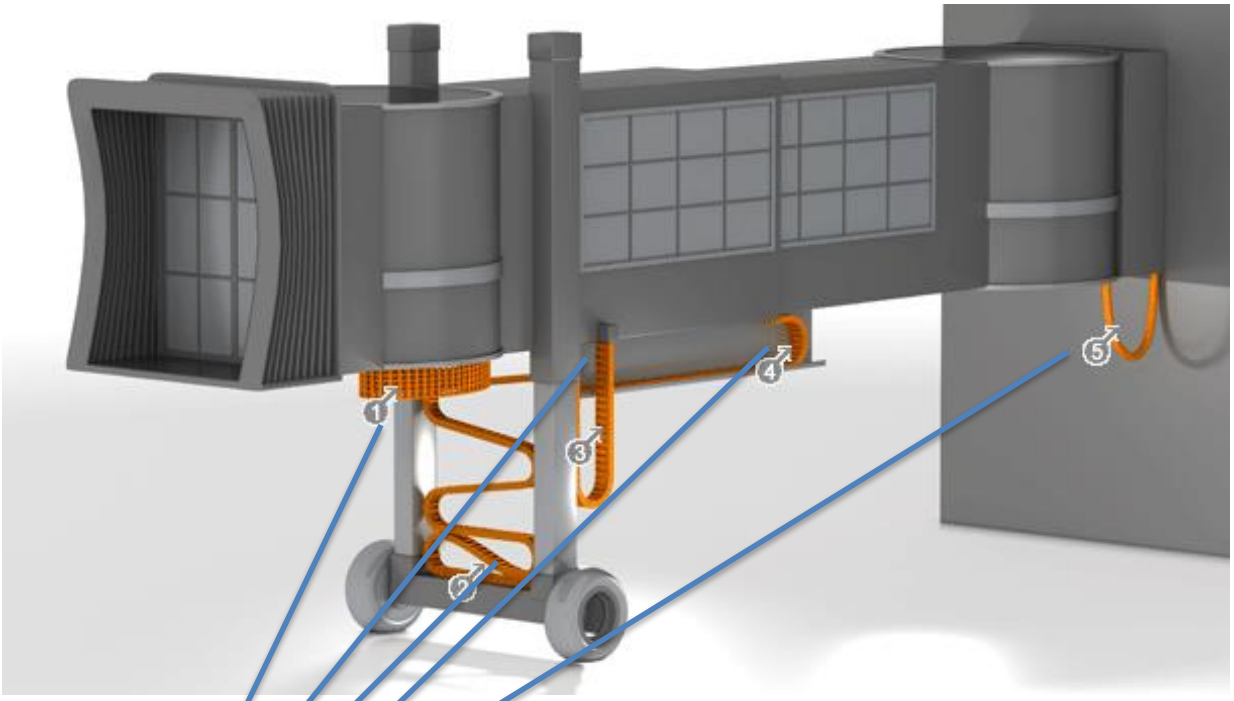


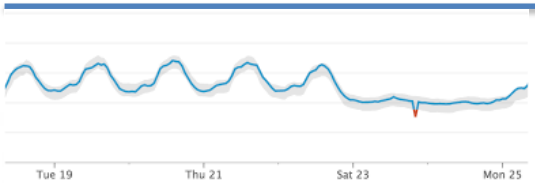
3. NM500 Application Field



Monitoring & Analytics

3. NM500 Application Field

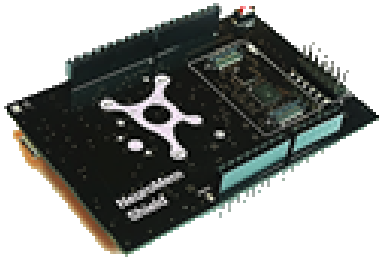




Monitoring & Analytics on the go

NM500

- IC of NM500 (June, 2017)
- Application boards for NM500 (June 2017)
  > NeuroShield and NeuroBrick



NeuroShield

for Proto Evaluation

NeuroBrick

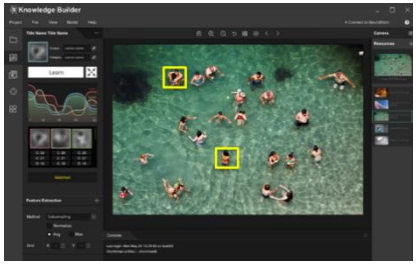
for neuron explanation

Orange BrainCard

for Development (Aug 2017)

With Single Camera

or Stereo Camera



SDK and Knowledge Builder

for Training data and verify

nepes NM500 Launching in July 2017 with SDK

nepes corporation

5. Conclusion

NM500

- ***Practical & Disruptive AI Technology Enabler***
- ***Low and deterministic latency***
- ***In-situ Field Training***
- ***Easy expandable neuron capacity.***
- ***Field Proven Technology***
- ***Ready to supply commercial products right away.***

nepes corporation

Thanks