JST MIRAI 未来社会創造事業

eAI

“Engineerable AI” Project

Engineerable AI Techniques for
Practical Applications of High-Quality
Machine Learning-based Systems

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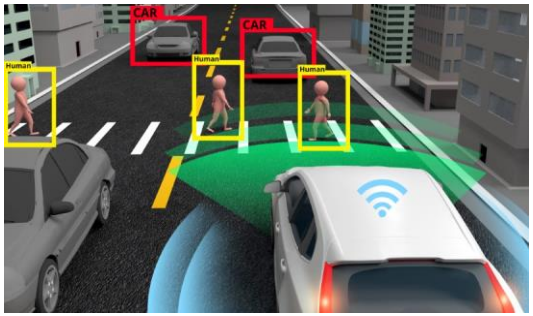
Background

- Active investigation for industrial applications of machine learning (ML)-based AI systems
- ➡ Increasing demands for quality assurance
  - Not only “higher accuracy for the given dataset”
  - Quality-sensitive application domains and customers



Autonomous Driving

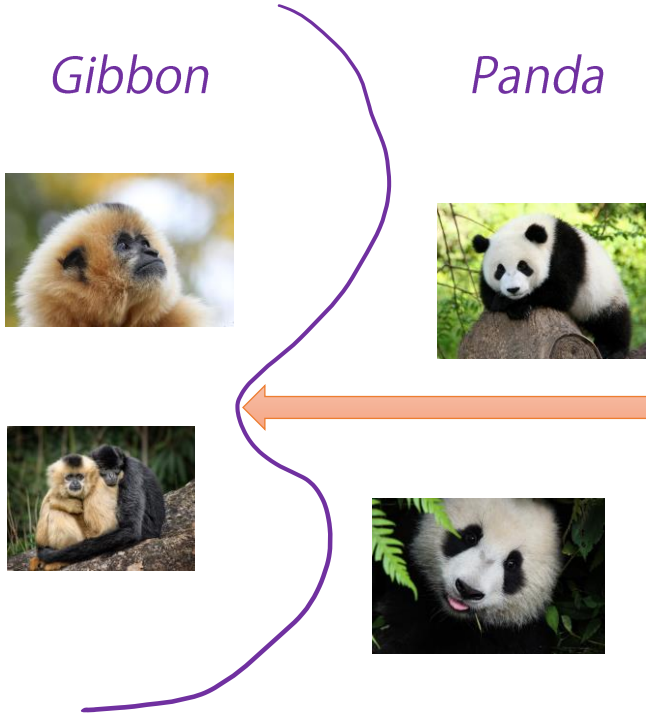

Medical Diagnosis

Process Automation

Background

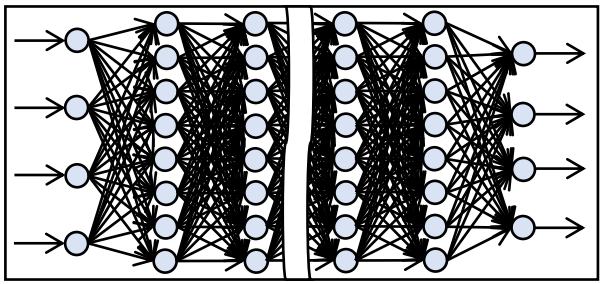
- Unique difficulties in ML :

  data-driven behavior and uncertainty



Behavior (classification this time) is generated from training data

Software 2.0 as a collection of enormous parameters in deep neural networks



- *Unclear boundary of functionality*
- *Unpredictability of quality to be achieved*
- *Weakness against noisy inputs*
- *…*

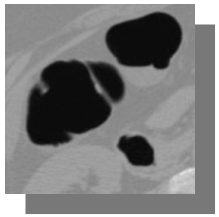
[http://free-photos.gatag.net/]

Problems

From discussions/surveys with 200+ practitioners

Medical Diagnosis

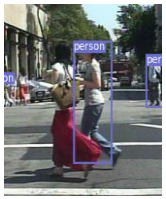
Want AI to detect cases overlooked by human doctors!



Failure with polyps at specific locations

Autonomous Driving

Want to ensure safety of AI under various situations!



Failure with pedestrians under specific situations

Difficult with very few data!

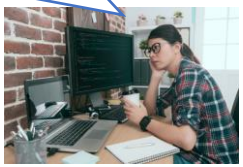
Rare cases more difficult for AI

Years for collecting data necessary in using deep learning

Difficulty with unstable assurance activities!

Enormous target situations

Trial-and-error for fixing something, then others broken



Our Vision

- "Hard to Engineer" problems, why?

  By building the whole functionality only with data

  - Dependency on large data
  - Uncontrollability of detailed behavior

- Towards **"Engineerable AI"**

  Effectively tailored for quality requirements

  By incorporating "knowledge" not only data

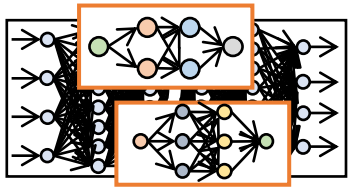
  - Knowledge-incorporated construction
  - Knowledge-driven improvement

AI Techniques
+
Software Engineering

Technical Approach

(1) Knowledge-incorporated construction

- Design models to reflect domain requirements

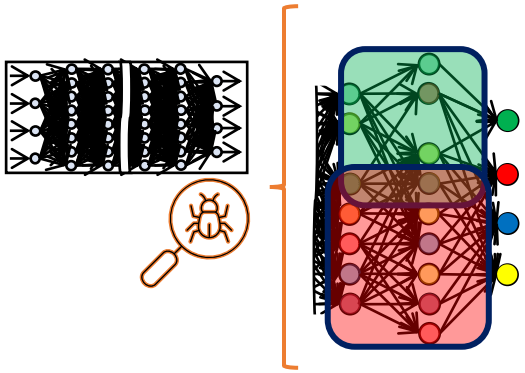


Example:
design modules to deal with individual types of cases

Achieve high performance with fewer data with more controllability and accountability

(2) Knowledge-driven debugging

- Improve models by identifying causes of success/failure



Example:
identify parts responsible for successful behavior and those for undesirable behavior

Controlled fix for targeted issues without unexpected degradation

Proof-of-Concept

(1) Knowledge-incorporated construction

- Design models to reflect domain requirements

Medical Diagnosis

Want AI to detect cases overlooked by human doctors!

Done: higher performance diagnosis with only 100 data

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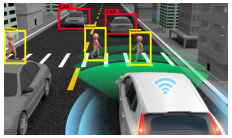
Difficult cases with less data

(2) Knowledge-driven debugging

- Improve models by identifying causes of success/failure

Autonomous Driving



Want to ensure safety of AI under various situations!

Done: controlled fix with little degradation in significant situations

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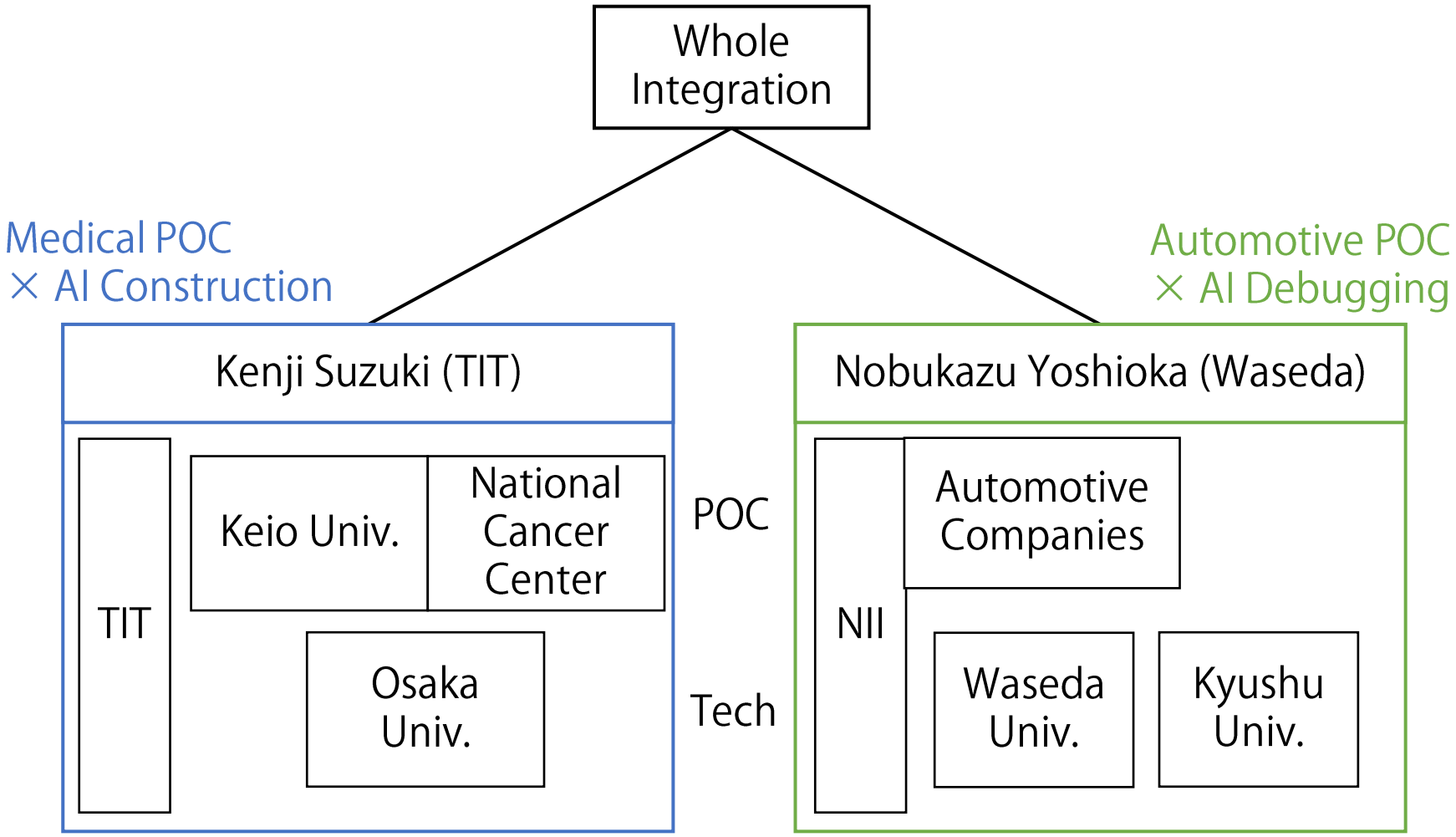
Safety with enormous situations

Project Teams



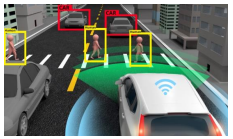
Summary

- Engineerable AI project
  - For high-quality ML-based systems
  - Tackling difficulties in dependency on large data and uncontrollability of deep learning

Medical Diagnosis

Want AI to detect cases overlooked by human doctors!

Autonomous Driving



Want to ensure safety of AI under various situations!

Engineerable AI techniques

Knowledge-incorporated construction
Knowledge-driven debugging