

From Human Intelligence To Machine Intelligence

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What is intelligence

???

???

What's intelligence?

“Intelligence measures a human/AI’s **ability** to achieve **goals** in a wide range of **environments**.”

A Universal Measure of Intelligence for Artificial Agents, Legg & Hutter 2007

Examples?

- Goals in school environment?
- Goals in work environment?
- Goals in home environment?

The screenshot shows a Google search interface. The search bar at the top contains the query "how to pass exam". Below the search bar is a dropdown menu with several suggestions, including "how to pass exam without studying", which is highlighted. To the right of the search bar, there is a "Sign in" button and a "More" icon. The main search results page below the suggestions shows a snippet from "www.careerindia.com" titled "12 Study Hacks To Pass Exams Without Studying - Careerindia". The snippet includes a link to the article and some text. Below the snippet is a "People also ask" section with three questions: "How can I get good score in exam without studying?", "Is it possible to pass a test without studying?", and "How can I pass university without studying?". Each question has a dropdown arrow next to it. At the bottom of the page, there is a link to "www.wikihow.com" and a snippet from "5 Ways to Pass an Exam Without Studying - wikiHow". A large orange arrow points from the text "To achieve goal in school environment..." to the highlighted suggestion in the dropdown menu.

To achieve **goal** in school environment...

Different agents' **ability** indicated by:

- more/less effort spent?
- higher/lower exam score?

4

[All](#)[Images](#)[Videos](#)[Shopping](#)[News](#)[More](#)[Settings](#)[Tools](#)

About 1,520,000 results (0.60 seconds)

[www.themuse.com › advice › how-to-pay-someone-a-c...](http://www.themuse.com/advice/how-to-pay-someone-a-c...)

How to Pay Someone a Compliment Without ... - The Muse

... boss to your co-workers to your direct report—and sound like you genuinely mean ... How to Pay Someone a Compliment Without Sounding Like an Insincere ...

Missing: [dissed](#) | Must include: [dissed](#)

People also ask

A recommender system !

How can I flatter my boss?	▼
How do you politely tell a coworker to back off?	▼
Can you refer to your boss as a colleague?	▼
What to do if your boss belittles you in front of others?	▼

Feedback

[bitesizebio.com › 6-types-of-bad-boss-and-how-to-han...](http://bitesizebio.com/6-types-of-bad-boss-and-how-to-han...)

5 Types of Bad Boss and How to Handle Them – Bitesize Bio

The problem is that this type of **boss** may not be looking out for your best interest but ... In a way this feels like a **compliment** because you are taking care of so much and feel ... I only listed a few personality types that I have seen during my working years or as reported to me by **colleagues**. ... I'm so **insulted** I want to leave...

[www.businessinsider.com › Careers › Strategy](http://www.businessinsider.com/careers-strategy)

What you should never say to your coworkers - Business Insider

To achieve **goal** in work environment...

Different agents' **ability** indicated by:

- more/less secrecy?
- bigger/smaller bonus?

All

Images

Videos

News

Maps

More

Settings

Tools

About 2,640,000,000 results (0.54 seconds)

15 Ways to Make Your Wife Happy Without Spending Much Money

1. Buy her a cupcake.
2. Invite Her Parents home.
3. Encourage Her Passion.
4. Cherish the smallest of memories.
5. Grow a plant for her.
6. Plan a Low-Cost Family Trip.
7. Go for a coffee date.
8. Present her with handmade gifts.

[More items... • Apr 30, 2017](#)[www.theclever.com › 15-ways-to-make-your-wife-happy...](http://www.theclever.com/15-ways-to-make-your-wife-happy/)[15 Ways to Make Your Wife Happy Without Spending Much ...](#)

About Featured Snippets

Feedback

People also ask

[How can I be romantic without spending money?](#) [How can I make myself happy without money?](#) [How can I surprise my boyfriend without spending money?](#)

To achieve **goal** in home environment...

Different agents' **ability** compared by:

- more/less money spent?
- more/less quarrels?

We all are intelligent agents in daily life...

- The **environment** is analogical to **industry domain**:
E.g. Retail; Education; Finance;
- The **goal** is analogical to perform **job role**:
E.g. Salesperson; Lecturer; Ah Long (Loan shark);
- The **ability** is analogical to **KPI (for the job role)**:
E.g. Larger sales volume; Better student feedback; More graffiti & interest \$;



Creating an AI is analogical to **defining goal & designing KPIs** for an employee to **behave autonomously** (through learning and reasoning using domain knowledge) **without** the boss/designer's **micro-management** (explicitly programmed).

An hopefully intelligent lifelong learning human



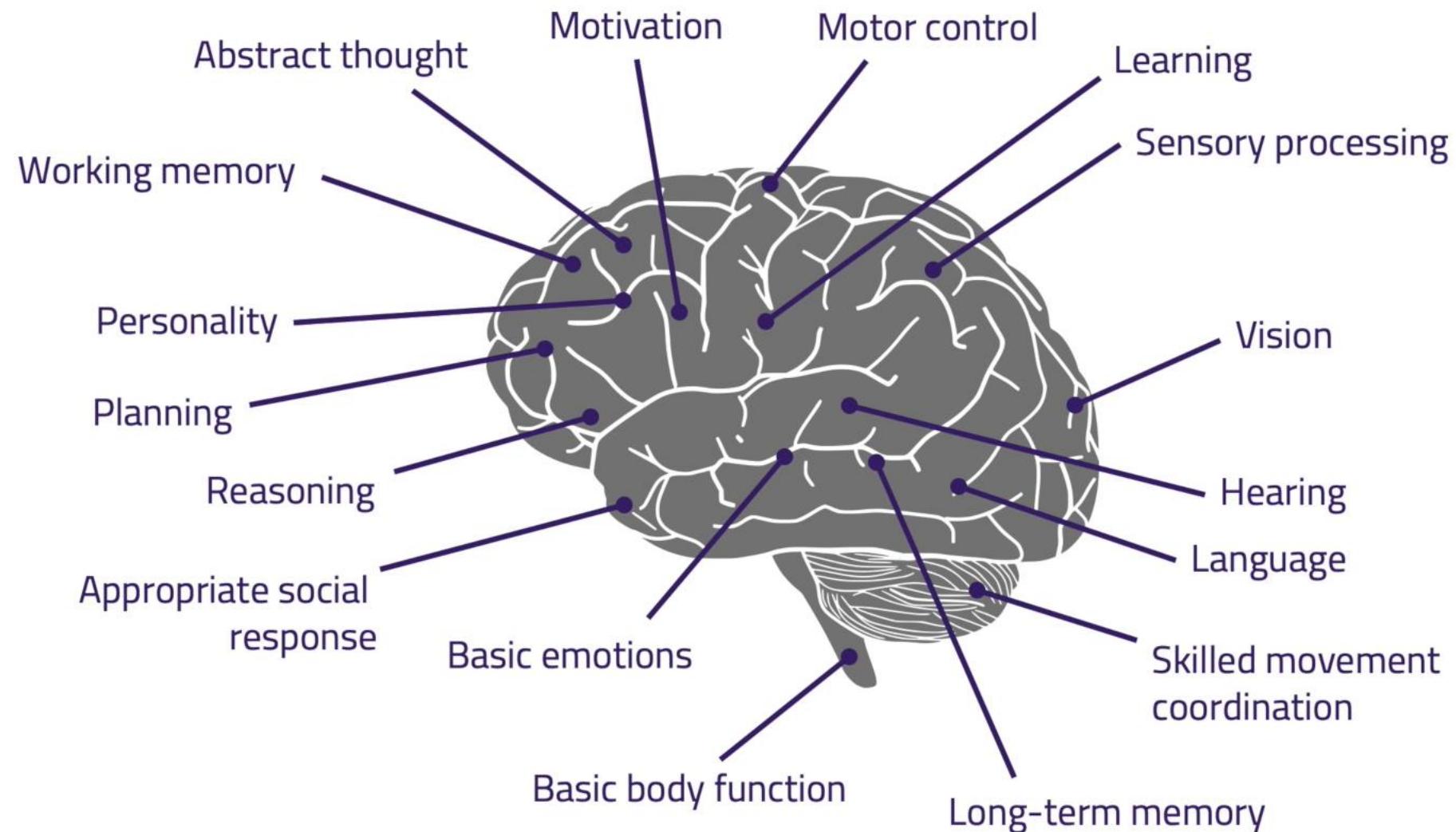
issgz@nus.edu.sg

GU Zhan 顾瞻 (Sam) lectures Master of Technology programme in the areas of data science, machine intelligence, and soft computing.

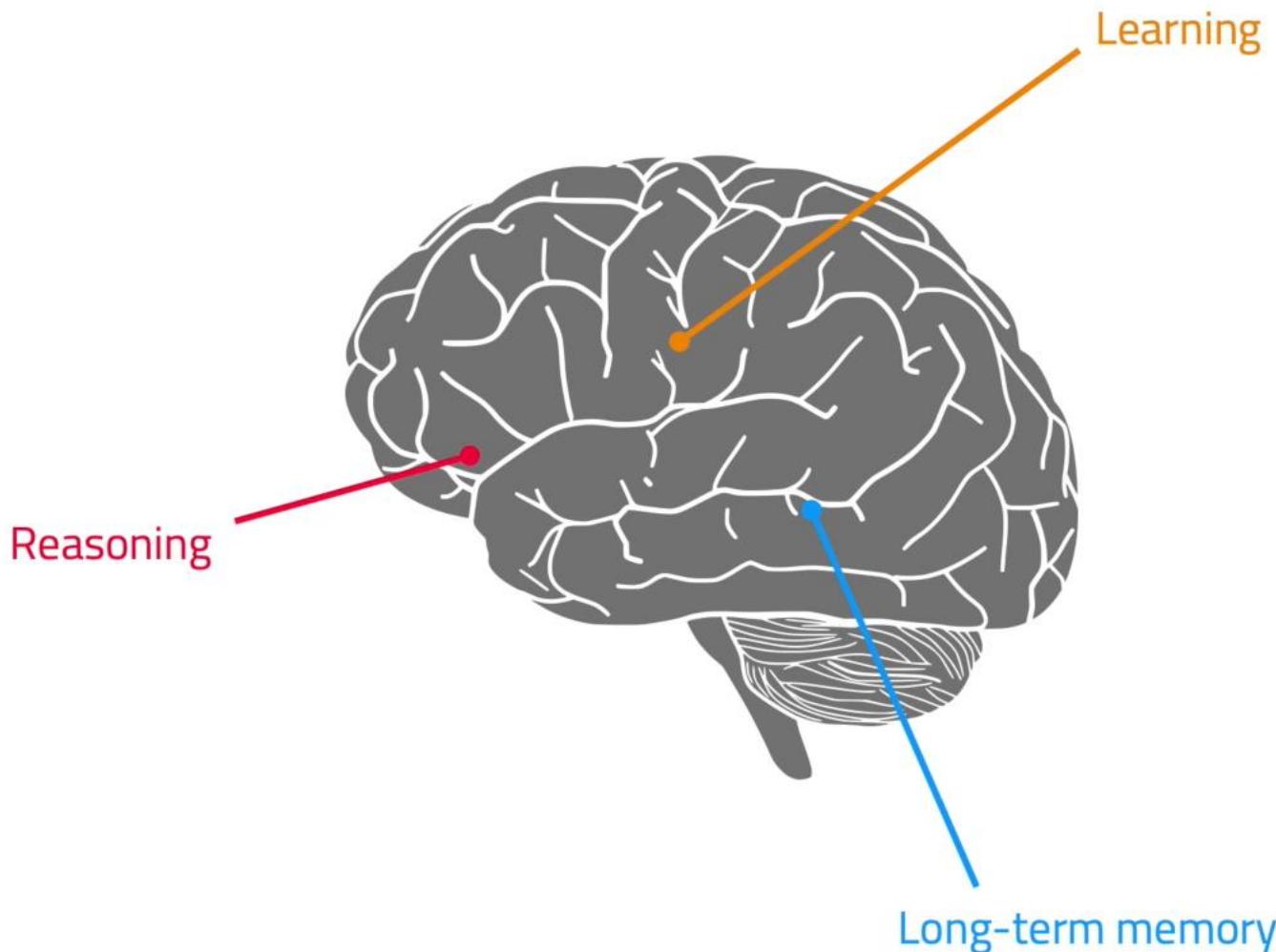
- MTech Intelligent Systems
- MTech Enterprise Business Analytics
- Professional Conversion Program - AI



Human Capabilities



Human Capabilities



[Source](https://youtu.be/JlcGfwb6CDE) <https://youtu.be/JlcGfwb6CDE>

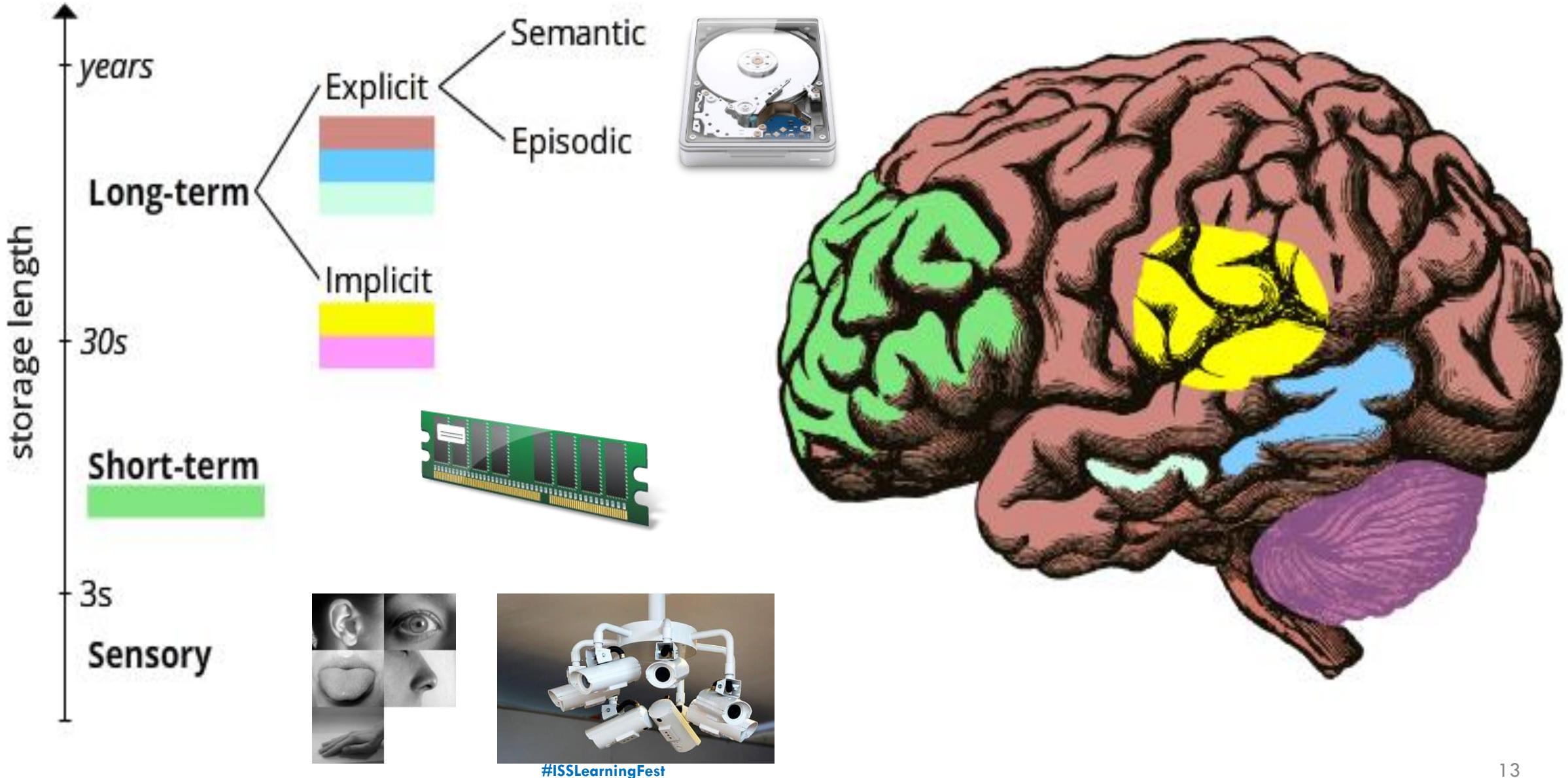


GRAKN.AI

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Human Memory

to store data, e.g. abstract knowledge, sensory information, experiences, etc.
and this ISS learning festival session as well.



Human Learning

to generate new knowledge

E.g. acquired understanding, behaviours, skills, values, useful to memorize & reuse

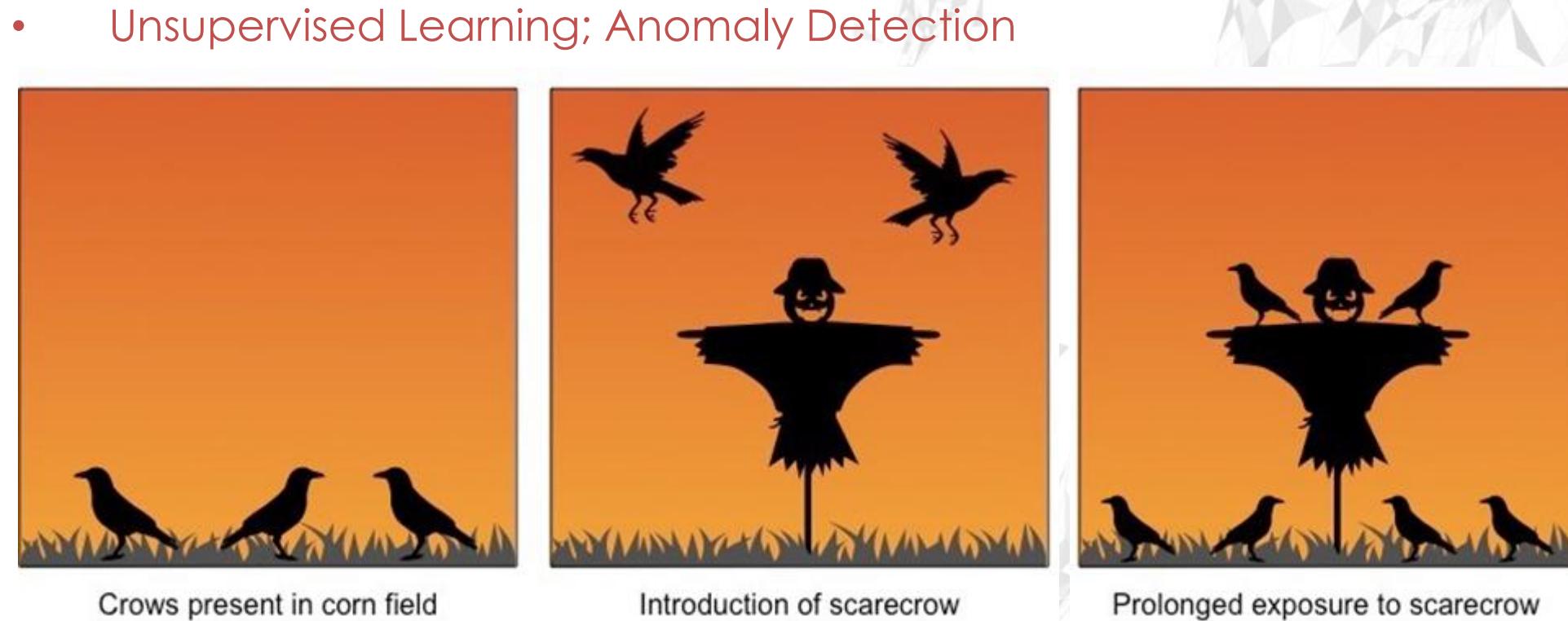
Model:
Learn

Model:
Recognize

Common Forms of Learning

1. Habituation

习惯化

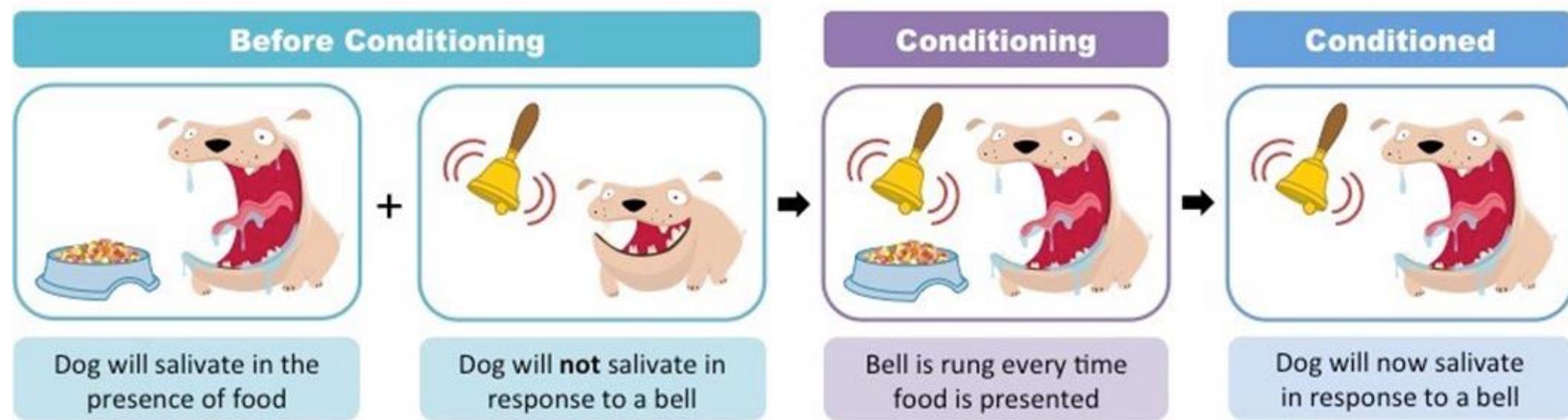


- Bird learned the knowledge/behaviour to ignore the fake threat;

Common Forms of Learning

2. Classical (Reflex) conditioning 经典条件反射

- Association (between stimuli or events); Supervised Learning



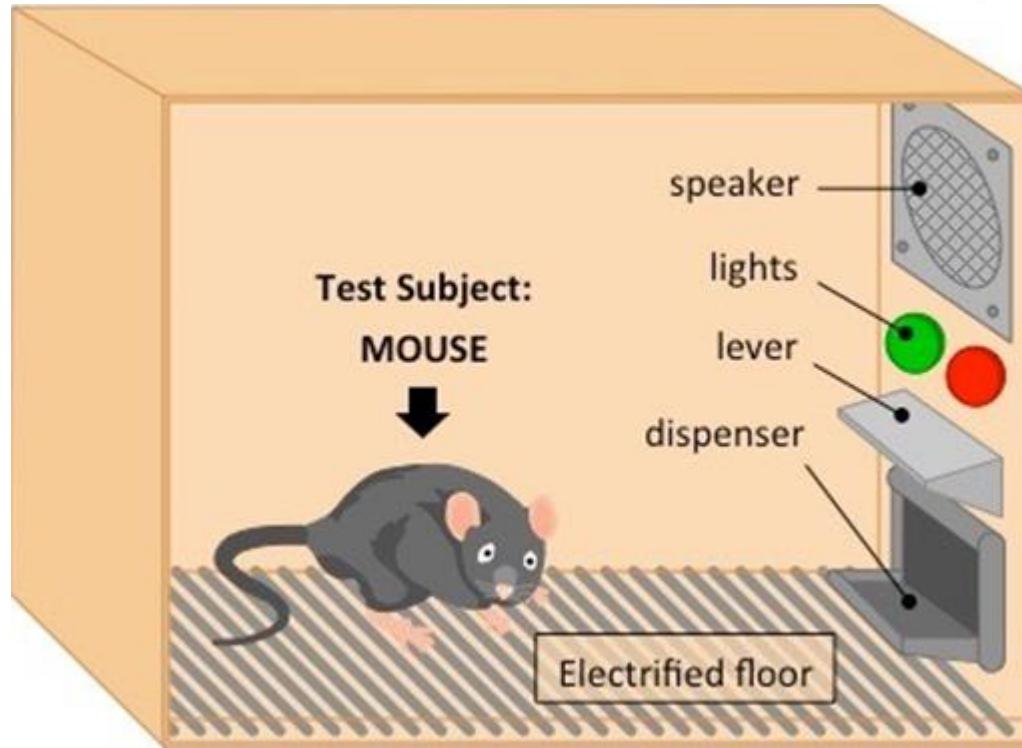
- Dog learned the knowledge of association/correlation: between food & bell ring;
- Dog learned the knowledge/behaviour of causation: food/bell ring → saliva;

Common Forms of Learning

3. Operant conditioning

操作性条件反射

- Reinforcement Learning; Generate & Test; Simulation



- Mouse learned the knowledge of button functions & steps to obtain food;

Source <https://ib.bioninja.com.au/options/option-a-neurobiology-and/a4-innate-and-learned-behav/conditioning.html>

Subject /
Reinforcement
Learning Agent

- **Agent:** Mouse
- **Environment:** Cage
- **Goal:** Survive longer
- **Random Series of Actions**
- **Best Series of Actions** leading to survival & welfare

Common Forms of Learning

3. Operant conditioning

操作性条件反射



AlphaGo
from
Google/DeepMind

Generate & Test
during self playing:
AlphaGo vs. AlphaGo

Common Forms of Learning

3. Operant conditioning

操作性条件反射



- DiDi :
- A Reinforcement Learning Agent
- **Agent:** DiDi
 - **Environment:** NUS
 - **Goal:** Unblock/Move scooter
 - **Random Series of Actions**
 - **Best Series of Actions** leading to goal

Common Forms of Learning

4. Observational learning 观察学习

- Imitation Learning; Unsupervised Learning; (copycat learning)



Source <https://courses.lumenlearning.com/wsu-sandbox/chapter/observational-learning-modeling/>

Human Reasoning

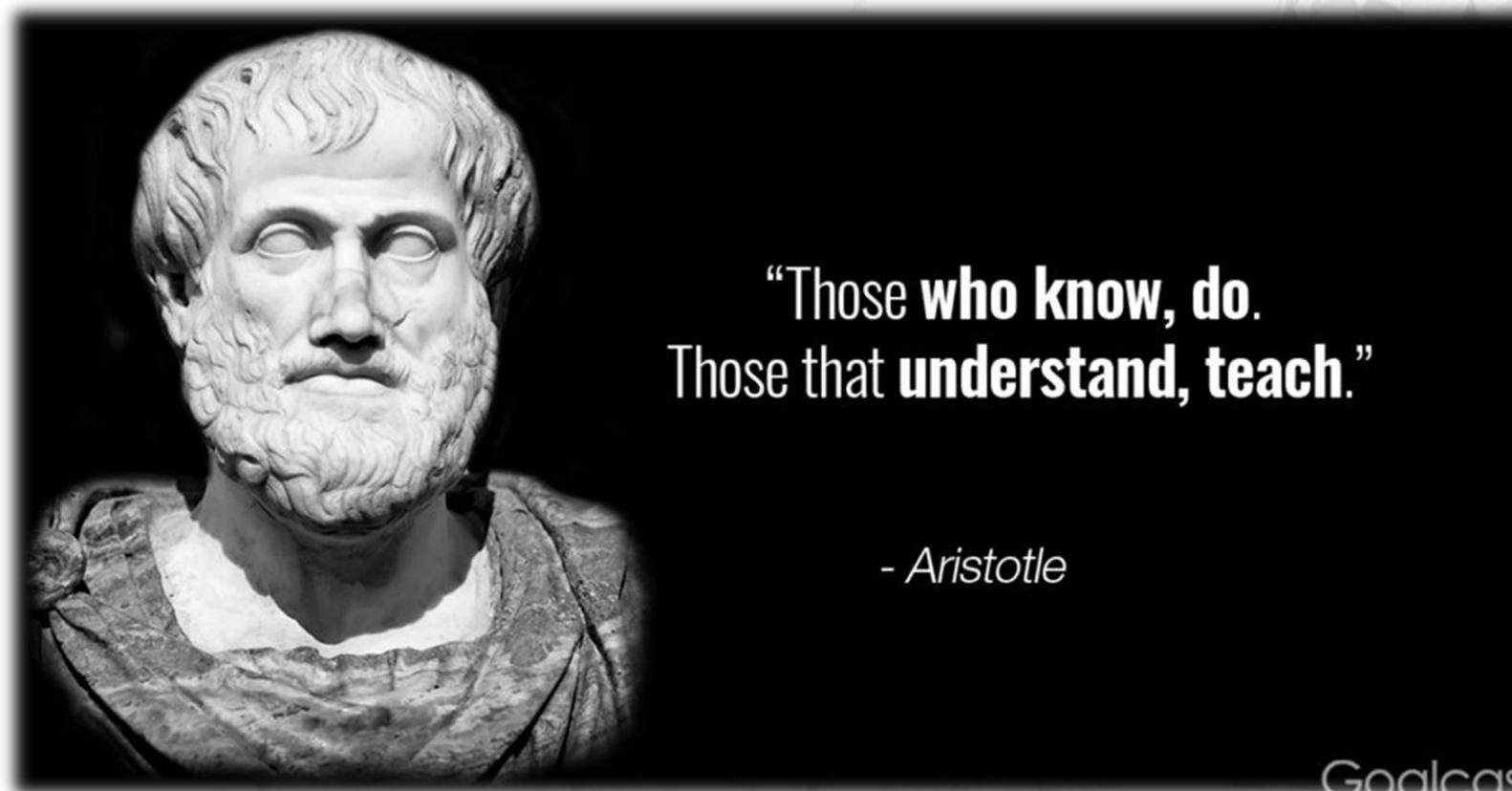
to use existing knowledge

Model:
Reason/Think

Common Forms of Reasoning

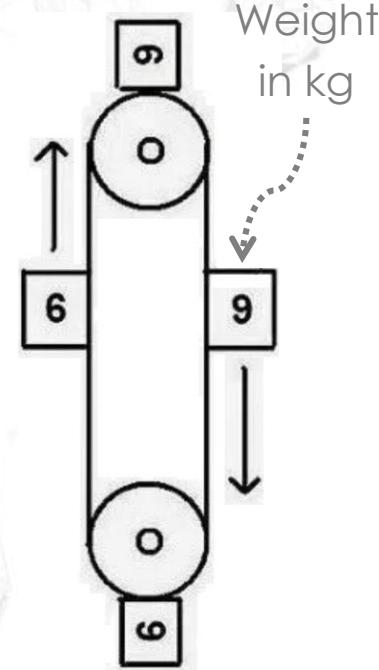
1. Deductive Reasoning

- Aristotle's syllogism; Formal logic; Knowledge Graph; If-Then business rules; Declarative programming language like SQL; (Universal → Individuals)



Goalcast

#ISSLearningFest



Sam's perpetual motion machine on sale! \$0.99 only!

Common Forms of Reasoning

2. Inductive Reasoning (aka. learning)

- Use meta knowledge to generate new knowledge using statistical method: learning / pattern recognition algorithms; central limit theorem; regression; (Individuals → Universal)

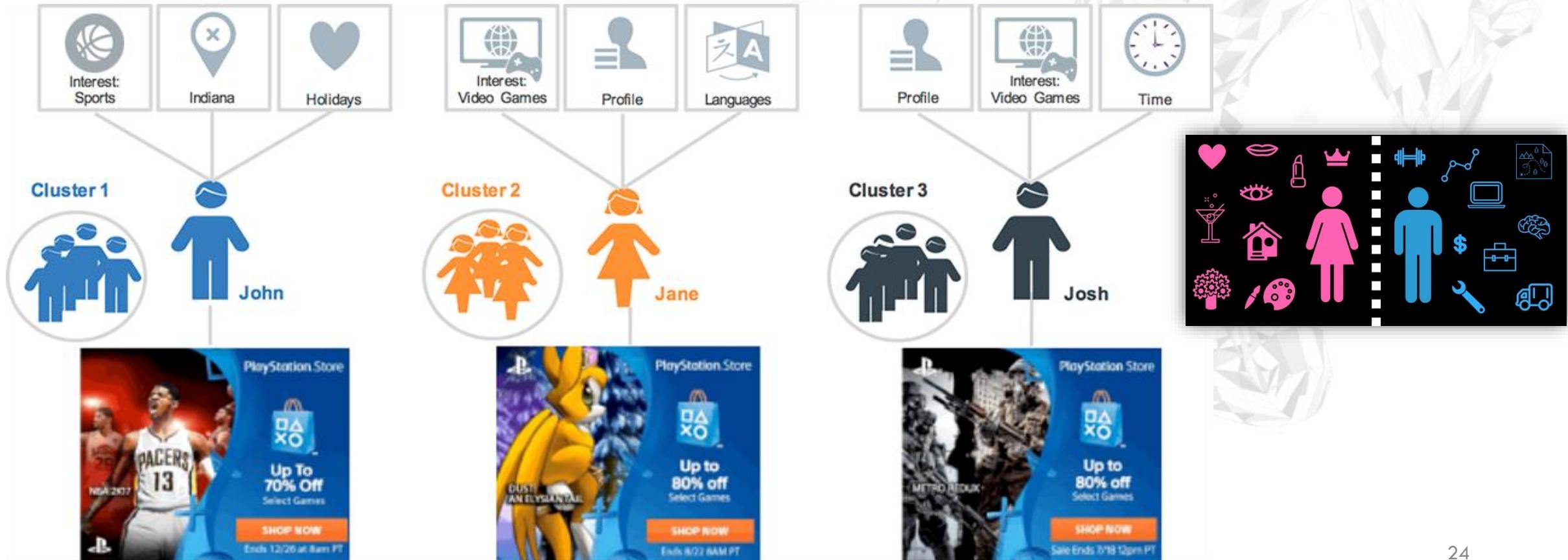
**Black Swans and the Limits
of Inductive Reasoning**



Common Forms of Reasoning

3. Analogical Reasoning

- Similarity based reasoning; Case based; K nearest neighbour; (including customer profiling for recommendation; even stereotyping)



Common Forms of Reasoning

4. Abductive Reasoning

- Probabilistic calculation; Prior/Conditional/Joint probability; Bayesian network; (Hypothesis ~ Evidence)



Would you prefer a **reasoning doctor** or a **learning doctor** during your medical consultation?

Common Forms of Reasoning

Other Reasoning Forms, e.g. Fuzzy Reasoning/Logic

- Lack of precise definition of vocabulary; Subjective to individuals



This is a human.



human or cat?



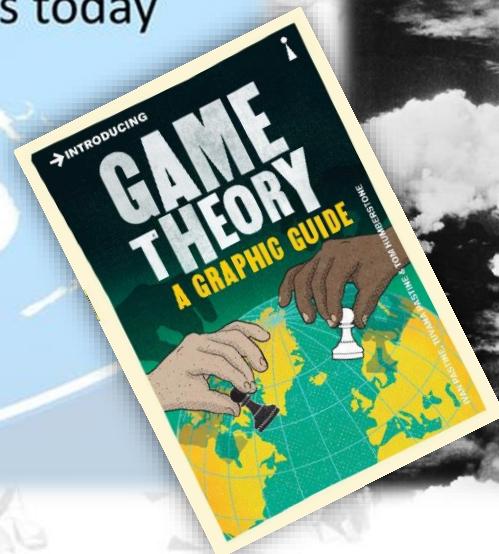
This is a cat.

Common Forms of Reasoning

Other Reasoning Forms, e.g. Irrational Logic?

Deterrence

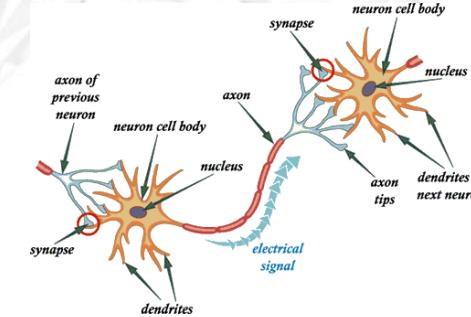
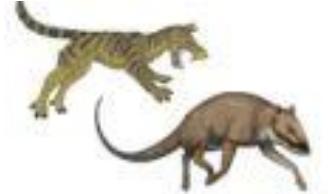
- Nuclear Deterrence:: Mutual Assured Destruction (MAD)
 - Critical to Cold War era security strategy, still applies today among some nuclear states (e.g., U.S. and Russia)
 - Assumes minimal level of rationality
 - Destabilizing nature of first-strike capabilities
 - Importance of survivable second-strike capabilities
 - Impact of missile defense on MAD



Machine / Artificial Intelligence

Major Sub-fields

- Artificial Neural Networks

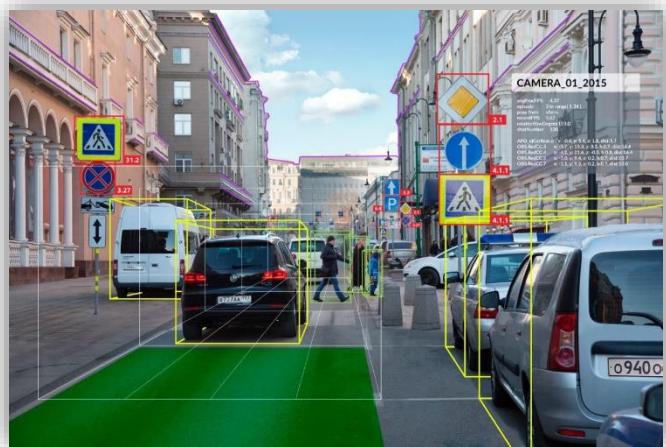


Neuron in our brain.

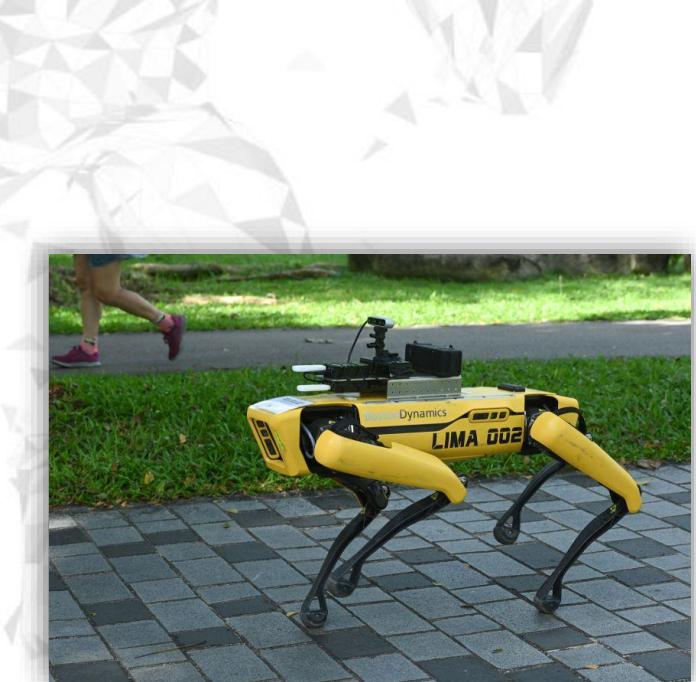
- Evolutionary Computation



- Vision



- Robotics



Machine / Artificial Intelligence

Major Sub-fields

- Expert/Diagnostic Systems; Recommender



- Speech Processing

- Natural Language Processing

Google Translate

Detect language: ENGLISH CHINESE (SIMPLIFIED) ENGLISH

serendipity 机缘巧合

Definitions of serendipity

Noun

① the occurrence and development of events by chance in a happy or beneficial way.
"a fortunate stroke of serendipity"

Route options

Prefer: Bus, Subway, Train, Tram / Light rail

Routes: Best route, Fewer transfers, Less walking, Wheelchair accessible

Send directions to your phone

5:14 PM–6:32 PM 1 h 18 min

5:22 PM from Heng Mu Keng Teri 9 min every 12 min

5:14 PM–6:40 PM 1 h 26 min

5:09 PM–6:50 PM 1 h 41 min

5:14 PM–6:55 PM 1 h 41 min

SCHEDULE EXPLORER

Cognitive Processes To Solve Problem

Aliens



Non Aliens



Which one is alien?

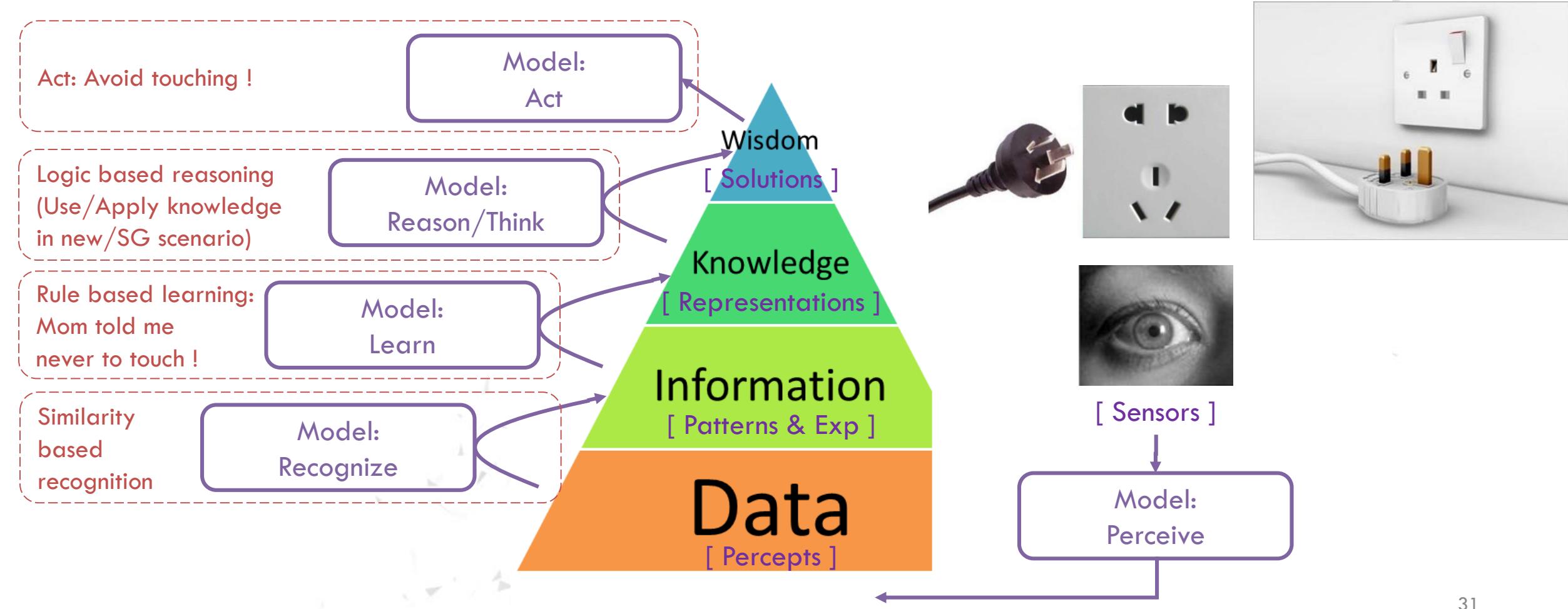


A B C D E

1. **Perceive:** Gather raw observable information, e.g. problem goal, type of known creatures, test creatures, decision/action required.
2. **Recognise:** Recognise patterns and decomposed relevant information, e.g. different colours, triangle#, teeth#, and any more you can recognise?
3. **Learn:** Invent hypothesis / candidate theories, e.g. **hypothesis 1:** alien must has **one triangle** & **not in grey** colour. (Create/retrieve knowledge by statistically generalizing from 8+5 individual observations/creatures & their recognised features.)
4. **Reason:** Use test data (creature A-E) to evaluate all hypotheses / candidate theories to filter out the correct one. (Use learnt knowledge in new scenarios: A-E, to classify/decide creatures into alien/non-alien).
5. **Act:** Make choice, observe/bear consequences (scores).

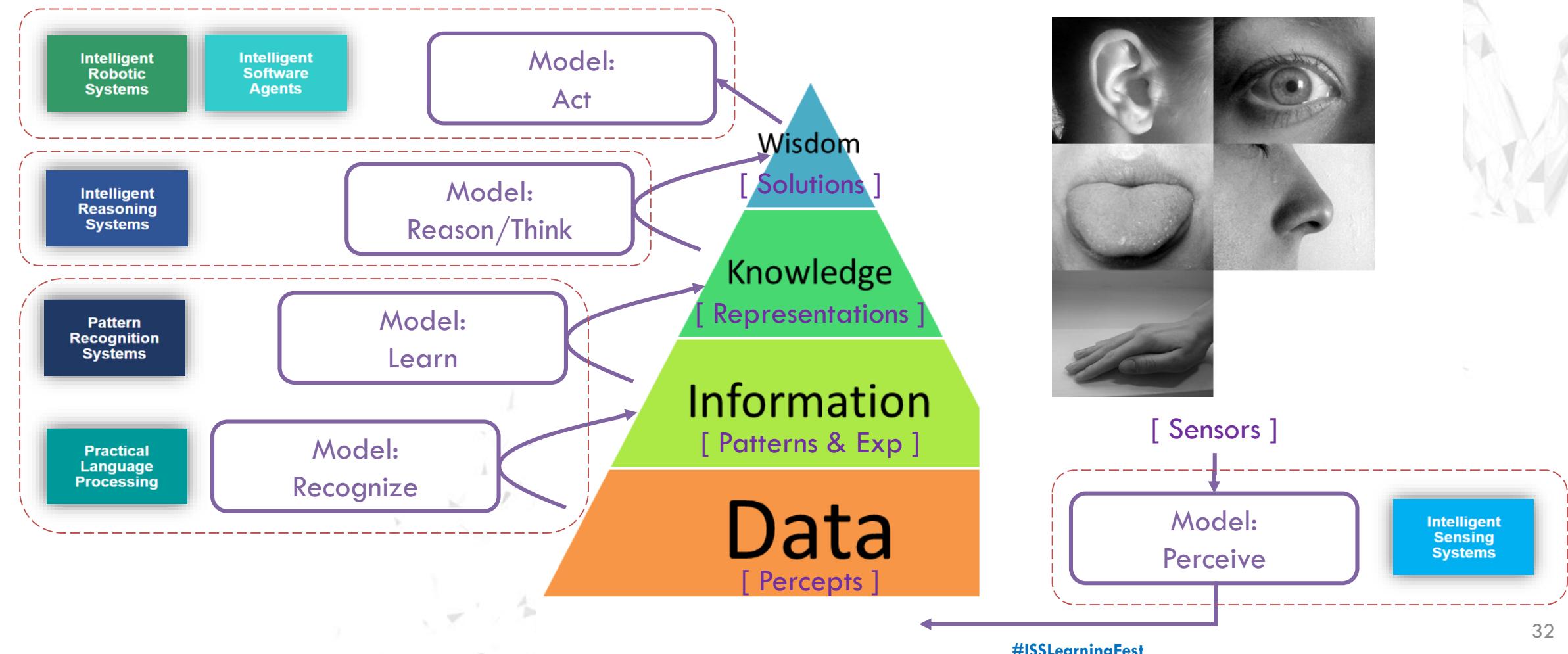
Cognitive Processes/Functions/Models

Functions/Models: Perceive 受; Think/Reason 想; Act 行; Recognize/Learn 识;

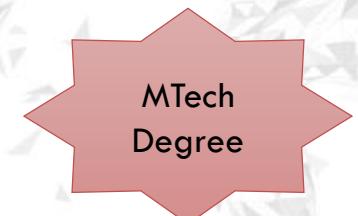
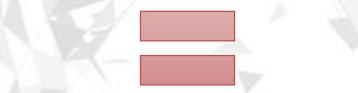


Cognitive Processes/Functions/Models

Functions/Models: Perceive 受; Think/Reason 想; Act 行; Recognize/Learn 识;



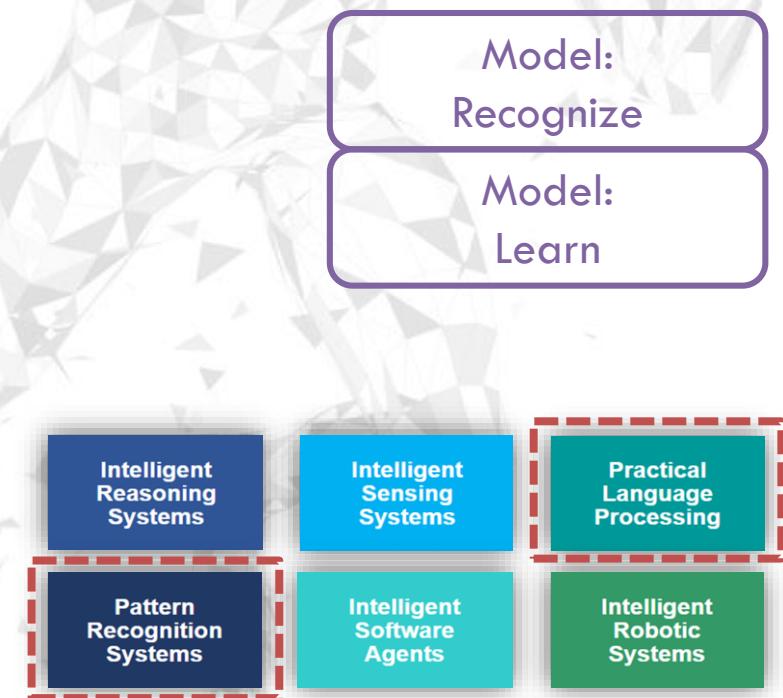
Intelligent Reasoning Systems	Pattern Recognition Systems	Intelligent Sensing Systems	Intelligent Software Agents	Practical Language Processing	Intelligent Robotic Systems
NICF - Machine Reasoning (SF)	NICF - Problem Solving using Pattern Recognition (SF)	NICF - Vision Systems (SF)	NICF- RPA and IPA - Strategy and Management (SF)	NICF - Text Analytics (SF) 3 Days	NICF - Robotic Systems (SF) 5 Days
4 Days	5 Days	5 Days	2 Days	NICF - New Media and Sentiment Mining (SF) 4 Days	Autonomous Robots & Vehicles* 5 Days
NICF - Reasoning Systems (SF)	NICF - Intelligent Sensing and Sense Making (SF)	NICF - Spatial Reasoning from Sensor Data (SF)	NICF- Software Robots - Best Practices (SF) 2 Days	NICF - Text Processing using Machine Learning(SF) 5 Days	Human-Robot System Engineering* 4 Days
5 Days	4 Days	3 Days	NICF- Intelligent Process Automation (SF) 3 Days	NICF- Conversational UIs (SF)* 4 Days	
NICF - Cognitive Systems (SF)	NICF - Pattern Recognition and Machine Learning Systems (SF)	NICF-Real Time Audio-Visual Sensing and Sense Making (SF)	NICF- Self-Learning Systems (SF) 4 Days		
3 Days	5 Days	4 Days			
Practice Module (10 man days)	Practice Module (10 man days)	Practice Module (10 man days)	Practice Module (10 man days)	Practice Module (10 man days)	Practice Module (10 man days)
Graduate Certificate in Intelligent Reasoning Systems	Graduate Certificate in Pattern Recognition Systems	Graduate Certificate in Intelligent Sensing Systems	Graduate Certificate in Intelligent Software Agents	Graduate Certificate in Practical Language Processing	Graduate Certificate in Intelligent Robotic Systems



Flexible pathways to NUS master degree in Intelligent Systems (AI) :

- **Stackable (up to 7 years)**
- **Thru-Train (full-timer 1 or part-timer 2 years)**

From Human Learning To Machine Learning



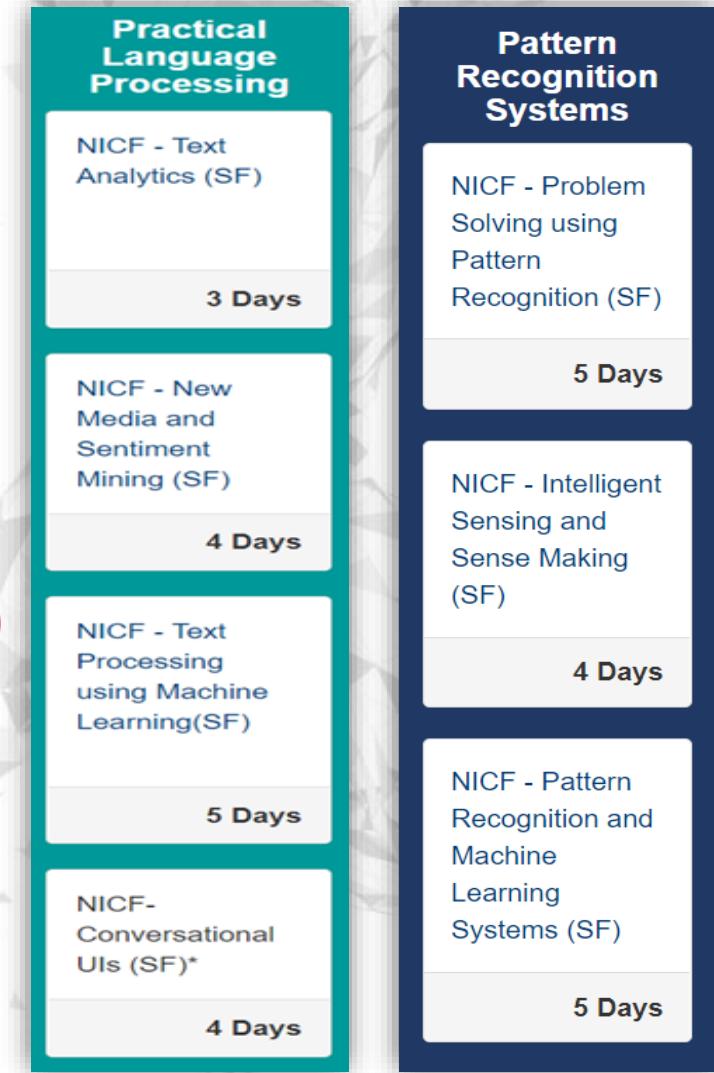
Human Learning → Machine Learning

Practical Language Processing

- Text Analytics (3 days)
- New Media and Sentiment Mining (4 days)
- Text Processing using Machine Learning (5 days)
- Conversational User Interfaces (4 days)

Pattern Recognition Systems

- Problem Solving using Pattern Recognition (5 days)
- Intelligent Sensing and Sense Making (4 days)
- Pattern Recognition and Machine Learning Systems (5 days)



From **Human Reasoning**
To **Machine Reasoning**

Model:
Reason/Think



Human Reasoning → Machine Reasoning

Intelligent Reasoning Systems

- Machine Reasoning (4 days)
- Reasoning Systems (5 days)
- Cognitive Systems (3 days)

PCP-AI program is also available.

Intelligent Reasoning Systems
NICF - Machine Reasoning (SF)
4 Days
NICF - Reasoning Systems (SF)
5 Days
NICF - Cognitive Systems (SF)
3 Days

From **Human Perception**
To **Machine Perception**

Model:
Perceive



Human Perception → Machine Perception

Intelligent Sensing Systems

- Vision Systems (5 days)
- Spatial Reasoning from Sensor Data (3 days)
- Real Time Audio-Visual Sensing & Sense Making (4 days)

Intelligent Sensing Systems
NICF - Vision Systems (SF)
5 Days
NICF - Spatial Reasoning from Sensor Data (SF)
3 Days
NICF-Real Time Audio-Visual Sensing and Sense Making (SF)
4 Days

From Human Action To Machine Action

Model:
Act



Human Action → Machine Action

Intelligent Robotic Systems

- Robotic Systems (5 days)
- Autonomous Robots & Vehicles (5 days)
- Human-Robot System Engineering (4 days)

Intelligent Software Agents

- Intelligent Process Automation (3 days)
- Software Robots - Best Practices (2 days)
- RPA and IPA - Strategy and Management (2 days)
- Self-Learning Systems (4 days)

Intelligent Robotic Systems	NICF - Robotic Systems (SF)	5 Days
Autonomous Robots & Vehicles*	5 Days	
Human-Robot System Engineering*	4 Days	
Intelligent Software Agents	NICF- RPA and IPA - Strategy and Management (SF)	2 Days
NICF- Software Robots - Best Practices (SF)	2 Days	
NICF- Intelligent Process Automation (SF)	3 Days	
NICF- Self-Learning Systems (SF)	4 Days	

Start

How can I use AI to solve my business problem?

Define & Quantify the business problem/opportunity {Goal, KPI}, e.g. {Increase customer satisfaction, Higher rating}; {Get rich fast, More \$ Less time}

Anyone (on Earth) knows how to solve? Or known existing/manual approaches?



Is Reasoning/Inference Task: Use existing knowledge to solve problem at scale and speed. (decision automation; optimization)

End

Is Learning Task: Acquire new knowledge to solve the problem.

Has relevant data collection?



True

Use supervised: classification & regression; pattern recognition; clustering; statistical algorithms to acquire knowledge from data.

Is a special learning task: Reinforcement Learning Task: Use generate & test approach.

Can simulate/generate relevant data? Or conduct experiment?



True

Use reinforcement learning algorithms; simulation techniques to acquire knowledge, e.g. best series of actions to achieve goal.

Currently not solvable by AI (even human)



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learning journey
with us !**

Register now →



Intelligent Reasoning Systems	Pattern Recognition Systems	Intelligent Sensing Systems	Intelligent Software Agents	Practical Language Processing	Intelligent Robotic Systems
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