ISO 29990:2010

nicf NATIONAL INFOCOMM COMPETENCY FRAMEWORK
Jointly developed by IMDA and SSG

NUS National University of Singapore | ISS INSTITUTE OF SYSTEMS SCIENCE

DEMYSTIFY ARTIFICIAL INTELLIGENCE & COGNITION

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OVER **5,900** GRADUATE ALUMNI

OFFERING OVER **130** ENTERPRISE IT, INNOVATION & LEADERSHIP PROGRAMMES

TRAINING OVER **130,000** DIGITAL LEADERS & PROFESSIONALS

Pre-reading Materials

Pre-reading 1

The Rise and Fall of Thinking Machines

Gary A. Taubes

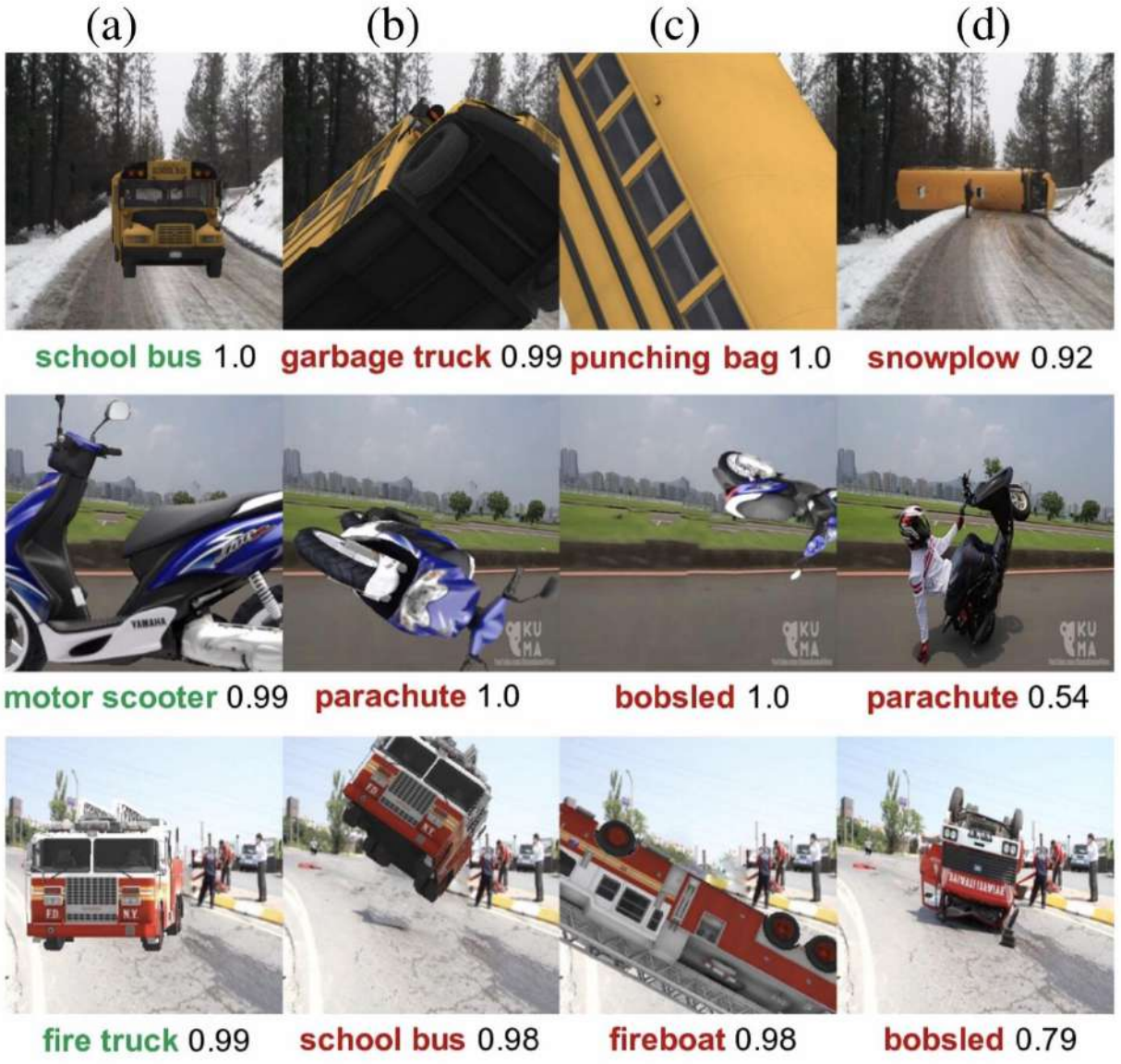
https://www.inc.com/magazine/19950915/2622.html

Pre-reading 2

The Deepest Problem with Deep Learning

Gary Marcus

https://medium.com/@GaryMarcus/the-deepest-problem-with-deep-learning-91c5991f5695



Pre-reading 3

How Your Mind Can Amaze and Betray You

- We used to think that the human brain was a lot like a computer: using logic to figure out complicated problems. It turns out, it's a lot more complex and, well, weird than that. This video discusses thinking & communication, solving problems, creating problems, and a few ideas about what our brains are doing up there.

Source https://courses.lumenlearning.com/wsu-sandbox/chapter/video-cognition-how-your-mind-can-amaze-and-betray-you/

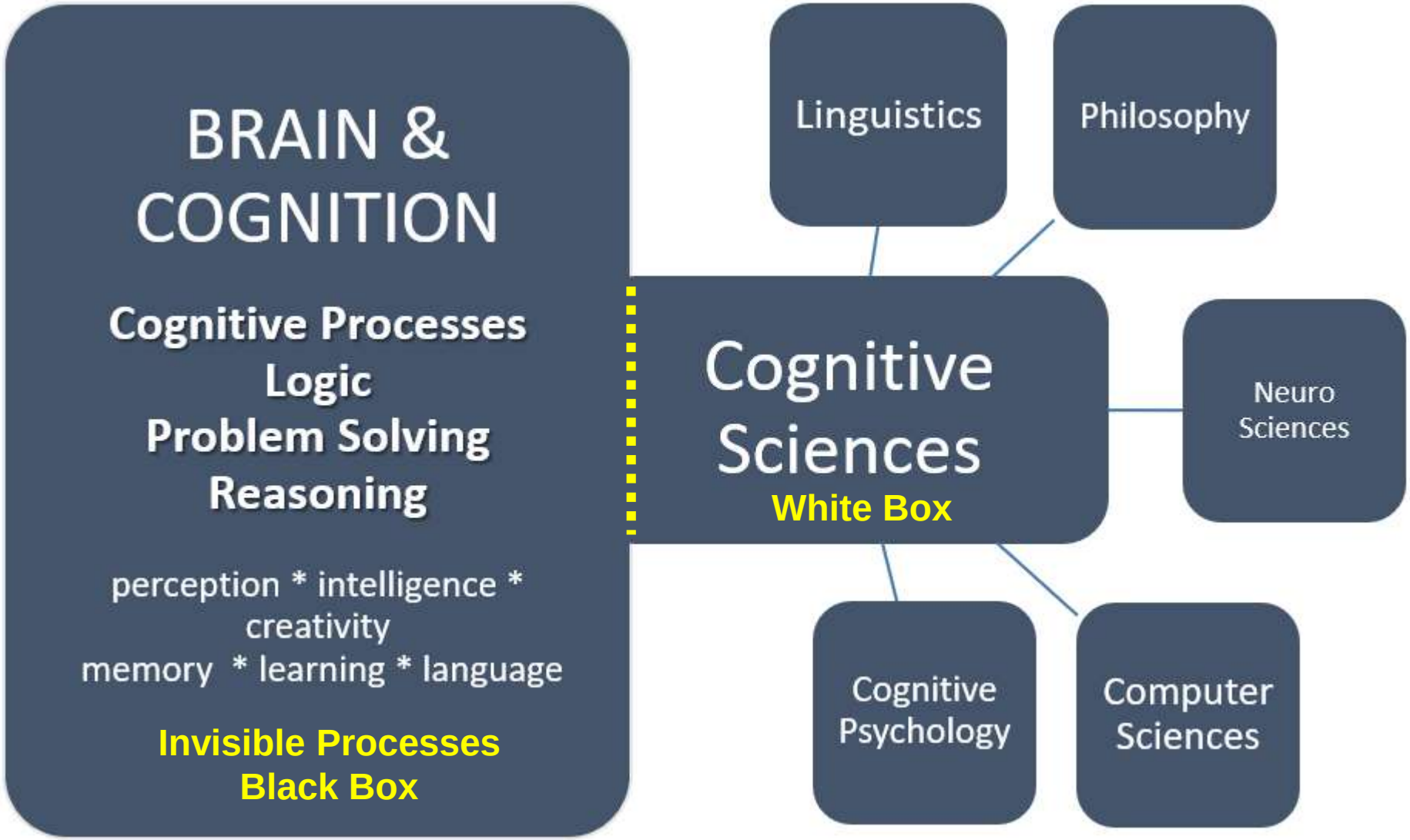
Human Intelligence vs. Artificial Intelligence

A lifelong learning advocate

issgz@nus.edu.sg

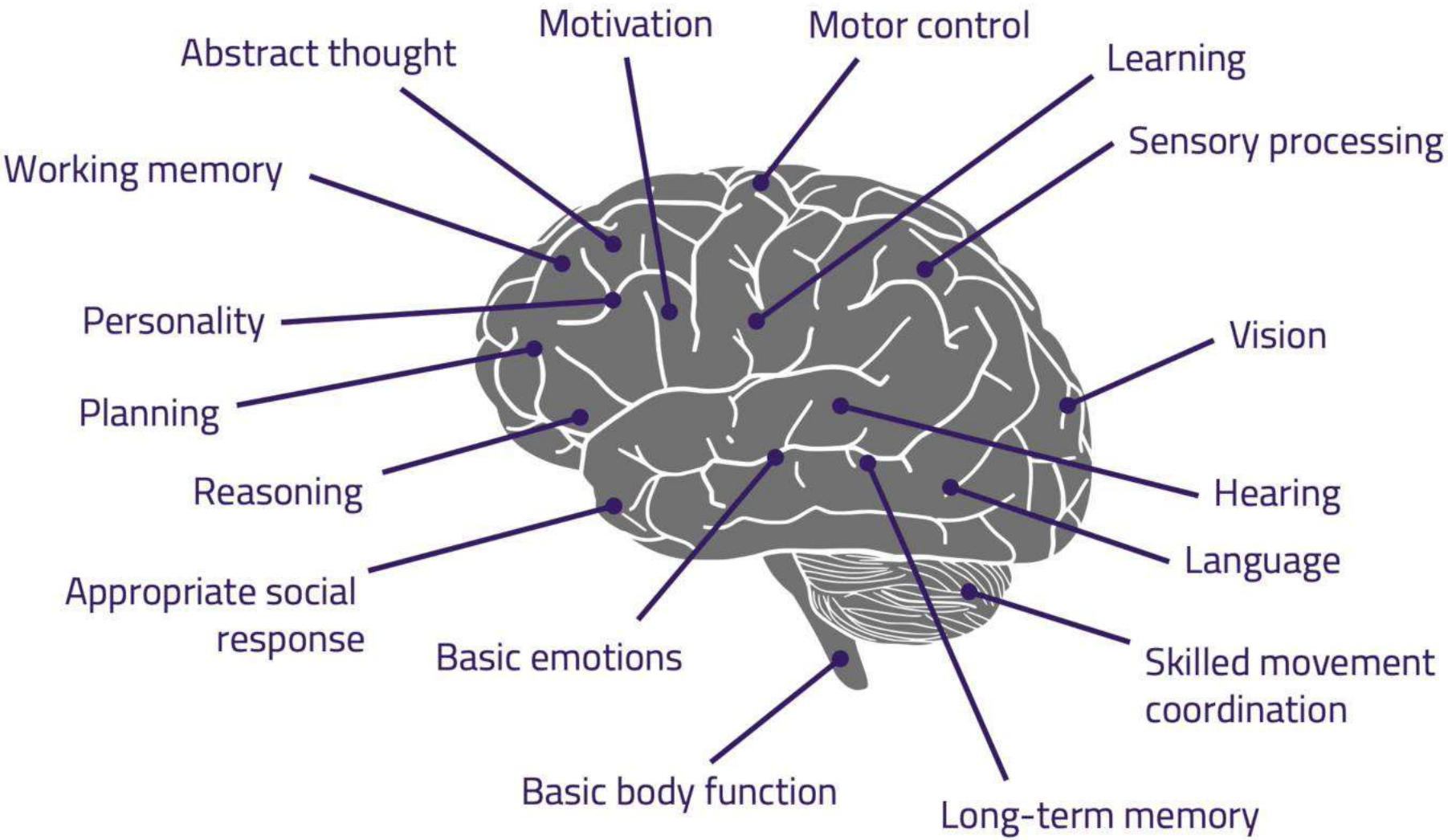
- GU Zhan 顾瞻 (Sam) lectures Master of Technology programme in the areas of data science, machine intelligence, and soft computing. Prior to joining ISS, he was in New Zealand running start-up, delivering artificial intelligence training programs. Sam had also spent many years in financial and engineering sector wearing versatile hats: data scientist, project manager, consultant, system manager and software engineer.
- He devotes himself into pedagogy, and is very passionate in inspiring next generation of artificial intelligence lovers and leaders.

Human Intelligence/Cognition



Source https://medium.com/womeninai/human-cognition-and-artificial-intelligence-a-plea-for-science-21a2388f6e7e

Human Capabilities

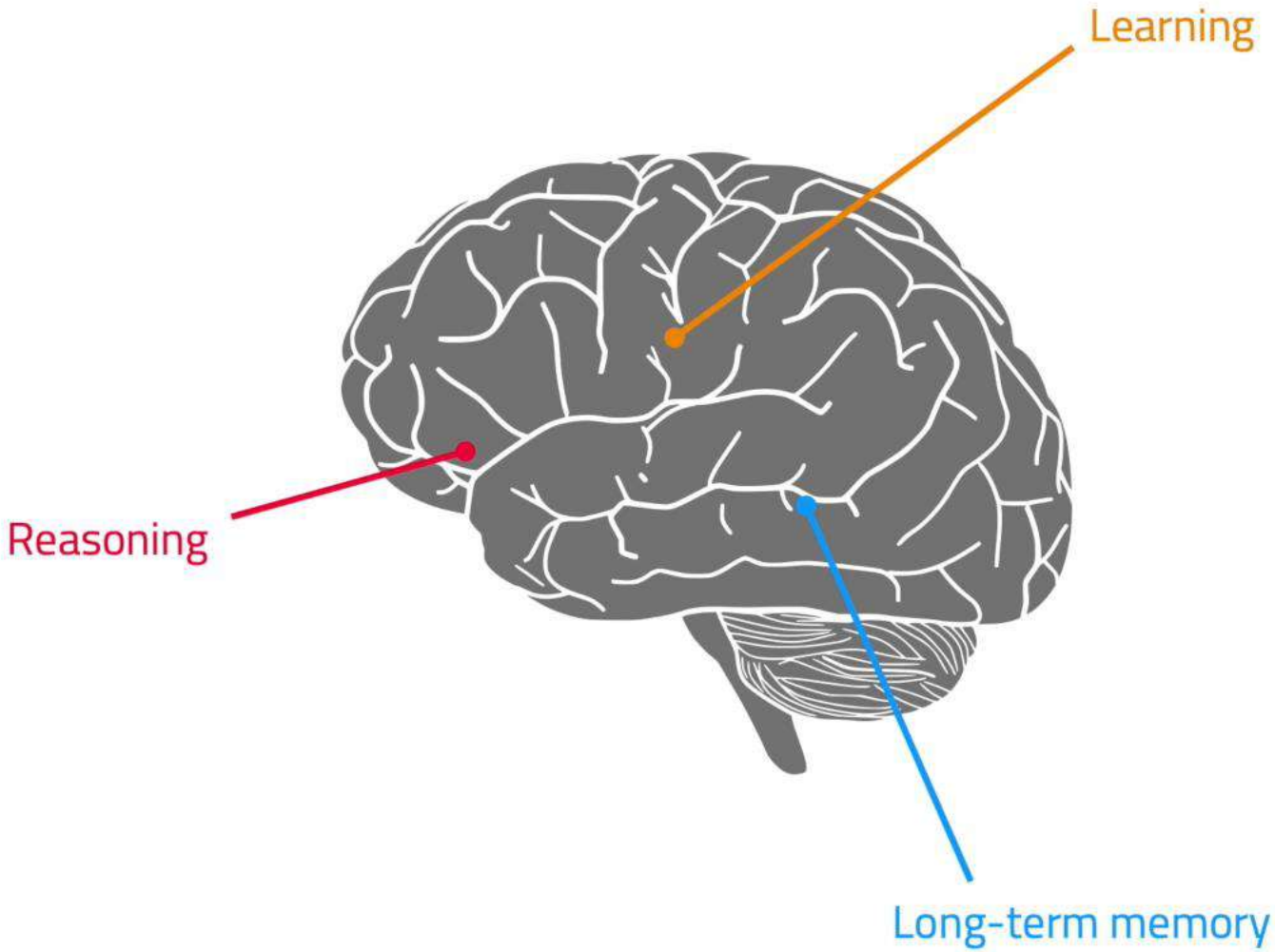


Source https://youtu.be/JlcGfwb6CDE

GRAKN.AI

Follow us @GraknLabs

Human Capabilities



Source https://youtu.be/JlcGfwb6CDE

Human Long-term Memory

to **store** knowledge data

Human Working/Sensory Memory

to **store** raw/sensory/interim data

Information Processing Model

Maintenance rehearsal

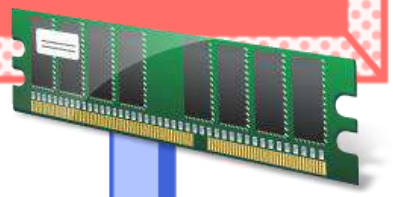
Sensory input

Attention

Encoding

SENSORY MEMORY

SHORT-TERM MEMORY



LONG-TERM MEMORY

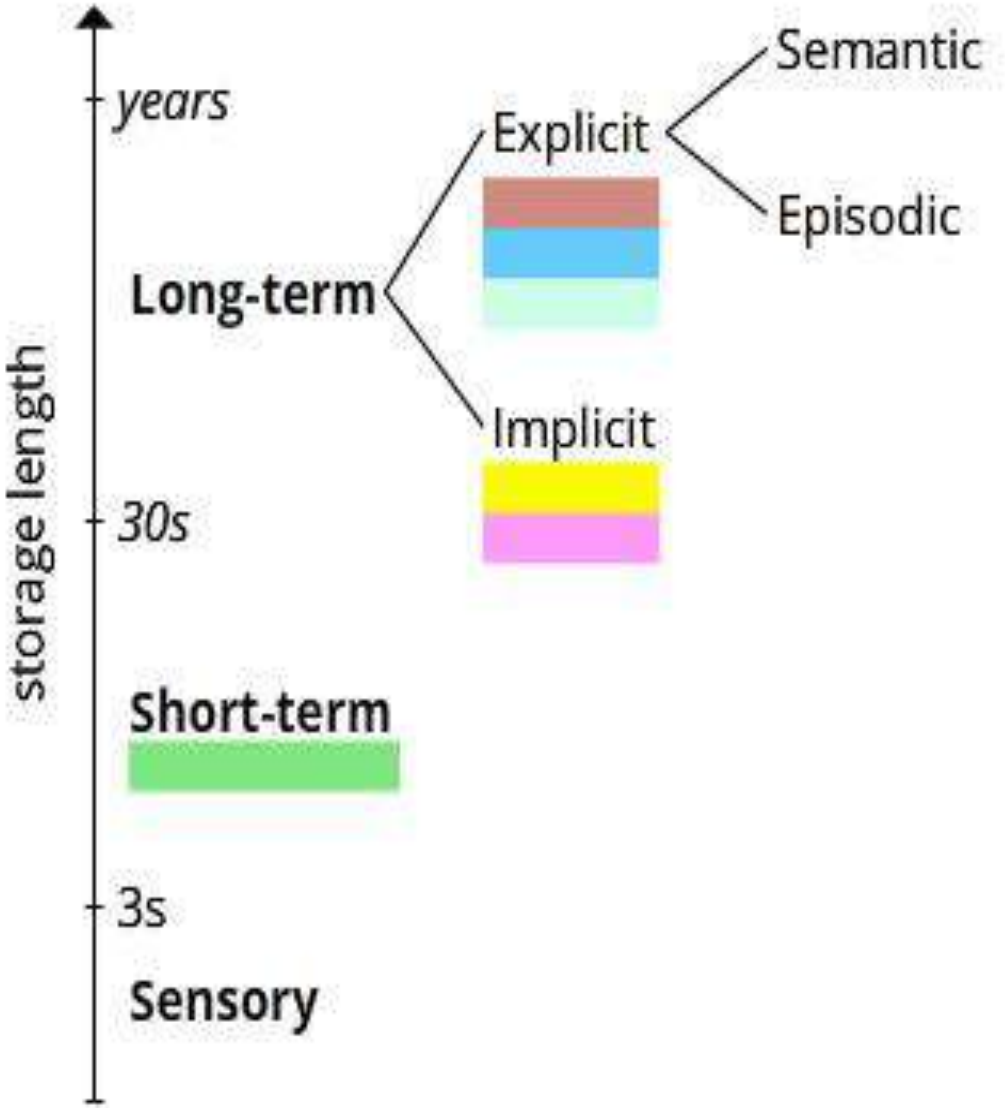
Retrieval

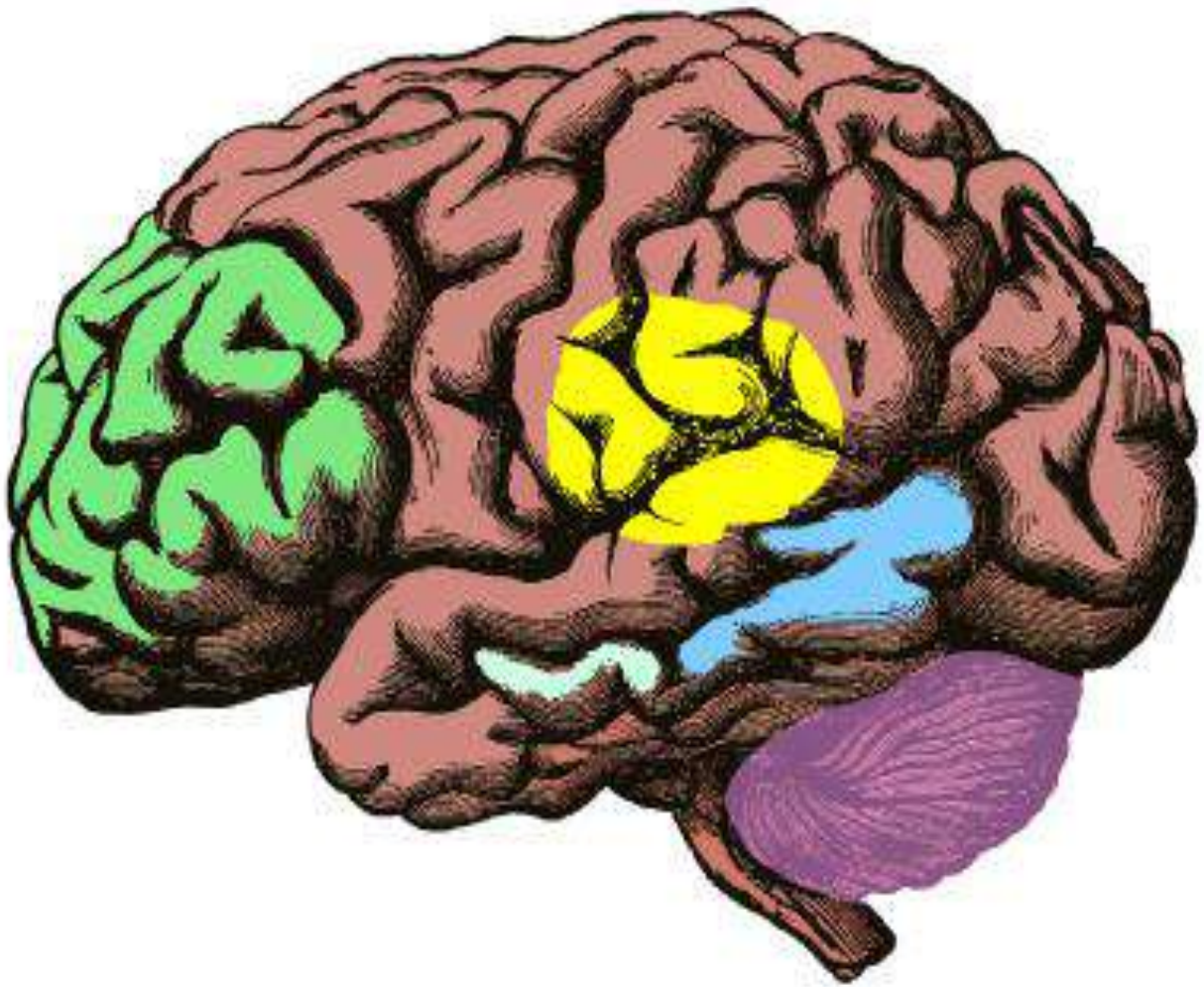
Unattended information is lost.

Unrehearsed information is lost.

Some information may be lost over time.

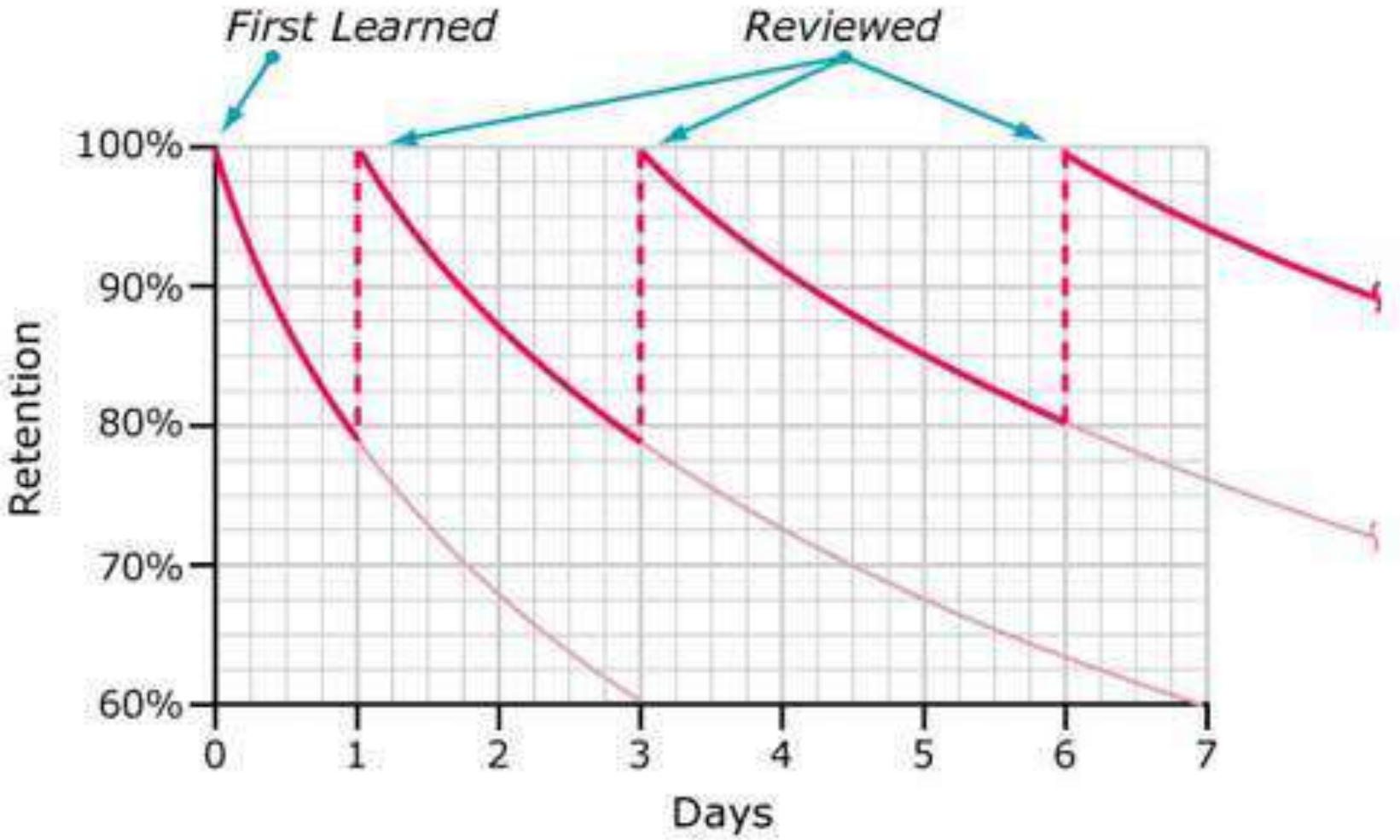
Source https://www.learnupon.com/blog/what-is-information-processing-theory/

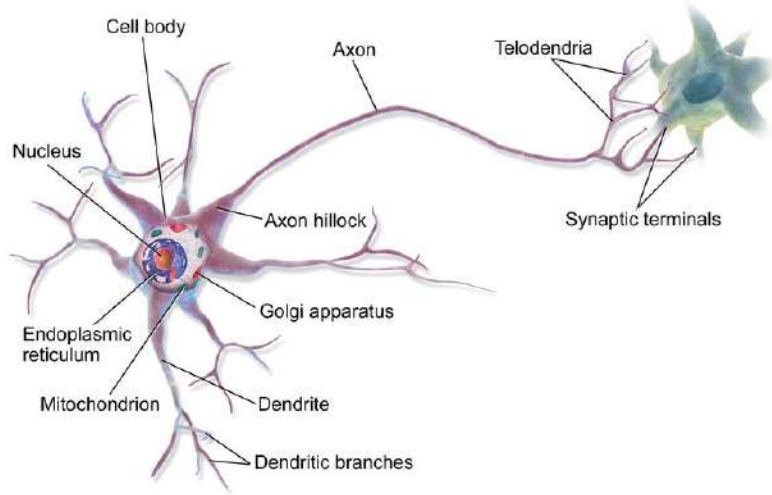




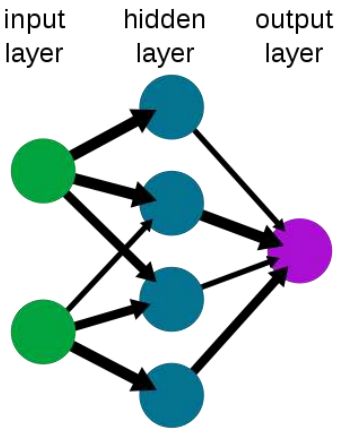
Memorizing requires repetition;
Memorizing enables Learning.

Typical Forgetting Curve for Newly Learned Information



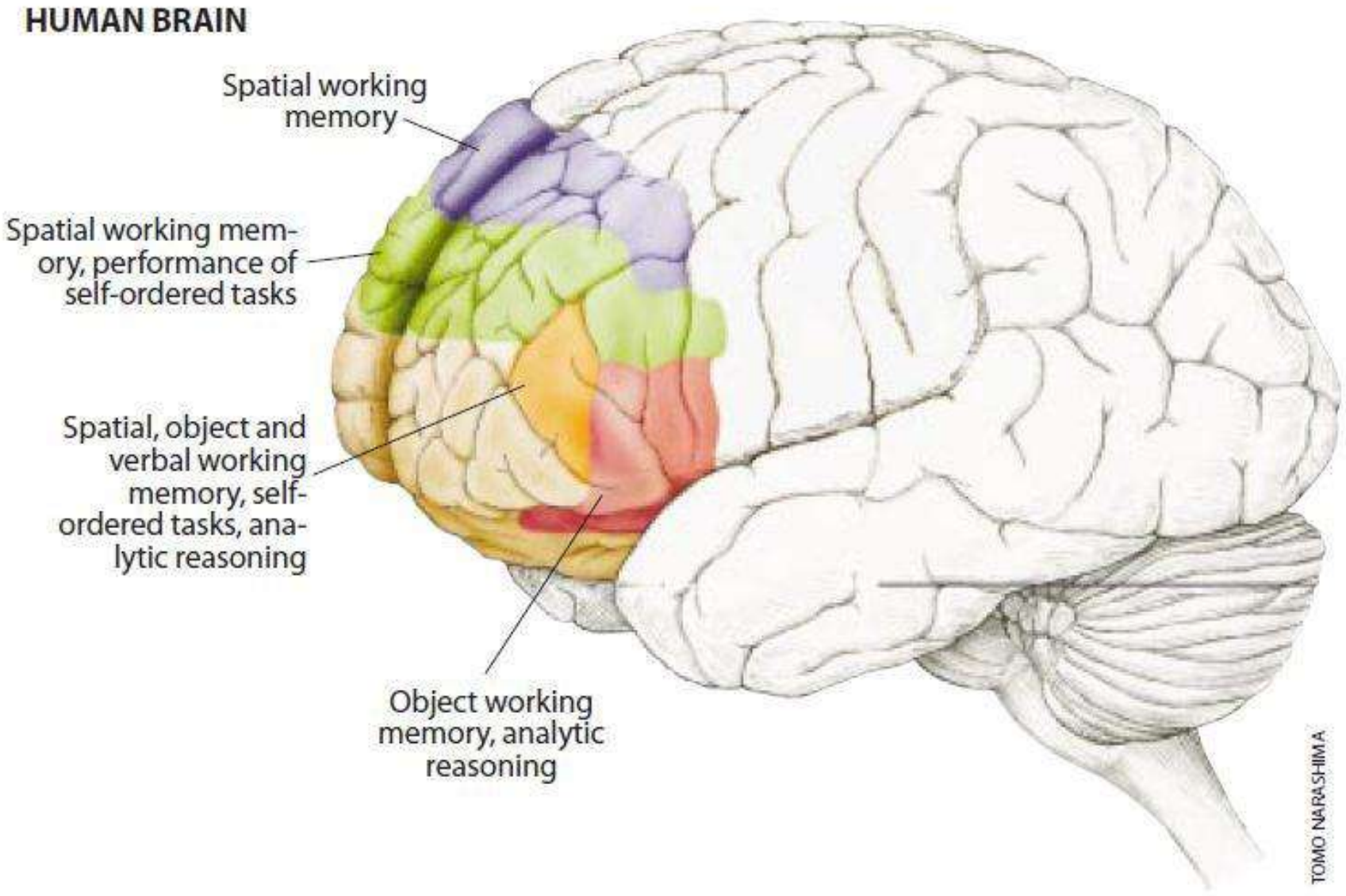


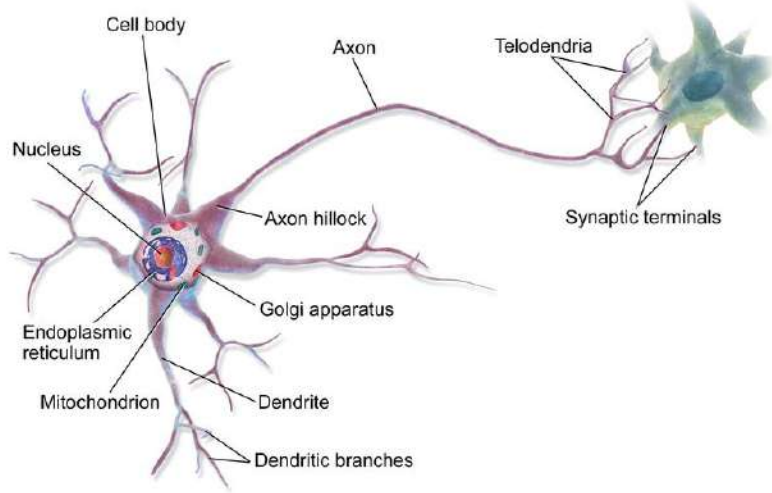
A simple neural network



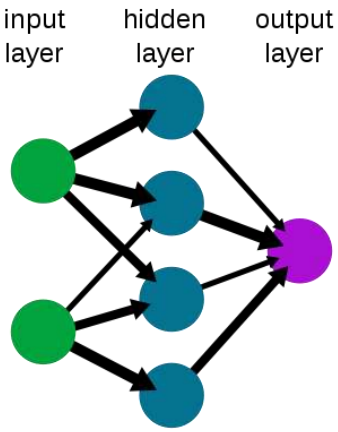
Source https://teachlikeachampion.com/blog/using-now-retrieval-practice-update-alex-laney/

Memorized/Learnt knowledge/data are represented as black box storage in brain.





A simple neural network



Source https://www.researchgate.net/figure/Prefrontal-Cortex-Deeply-Relevant-to-Working-Memory-Beardsley-1997_fig5_327269915

Human Learning

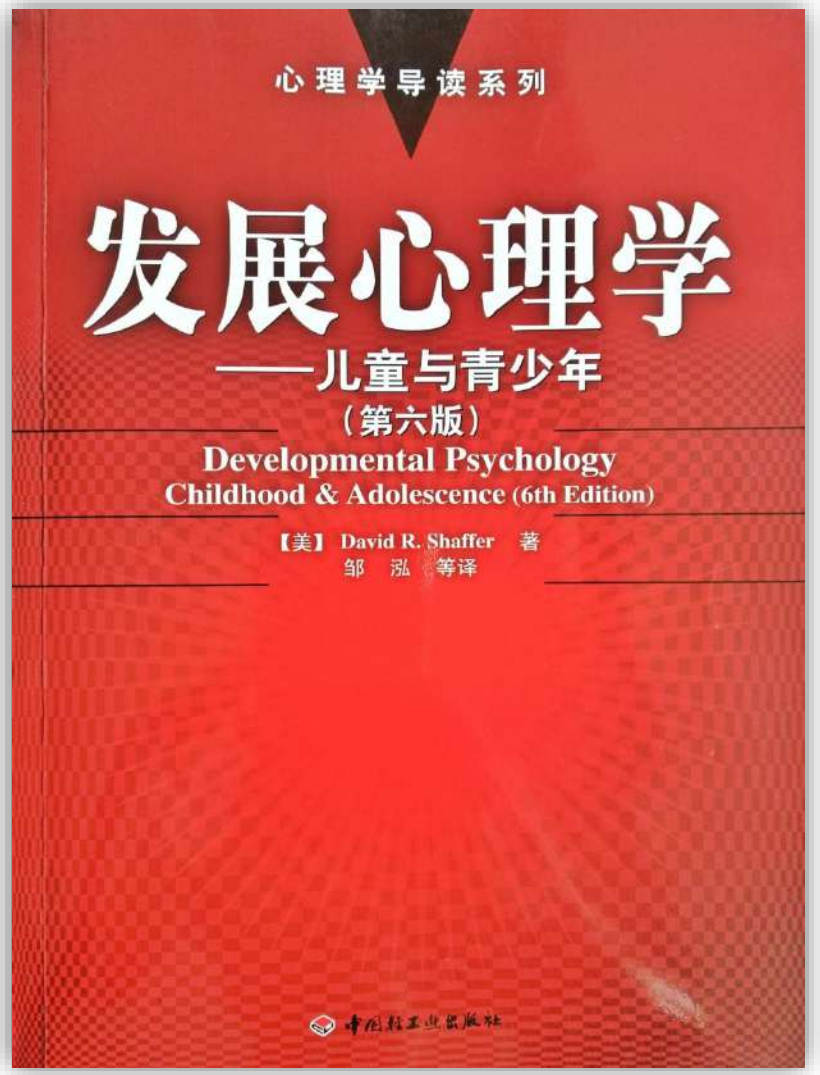
to **generate new** knowledge

Model:
Learn 学(识)

Model:
Recognize 识

Common Forms of Learning

1. **Habituation** 习惯化
   - AI: Unsupervised Learning
   - AI: Anomaly Detection
2. **Classical conditioning** 经典条件反射
   - AI: Association (between stimuli or events)
3. **Operant conditioning** 操作性条件反射
   - AI: Reinforcement Learning
   - AI: Supervised/Semi-Supervised Learning
4. **Observational learning** 观察学习
   - AI: Imitation Learning
   - AI: Unsupervised/Semi-Supervised Learning



Common Forms of Learning

1. Habituation 习惯化

- Unsupervised Learning; Anomaly Detection

Crows present in corn field

Introduction of scarecrow

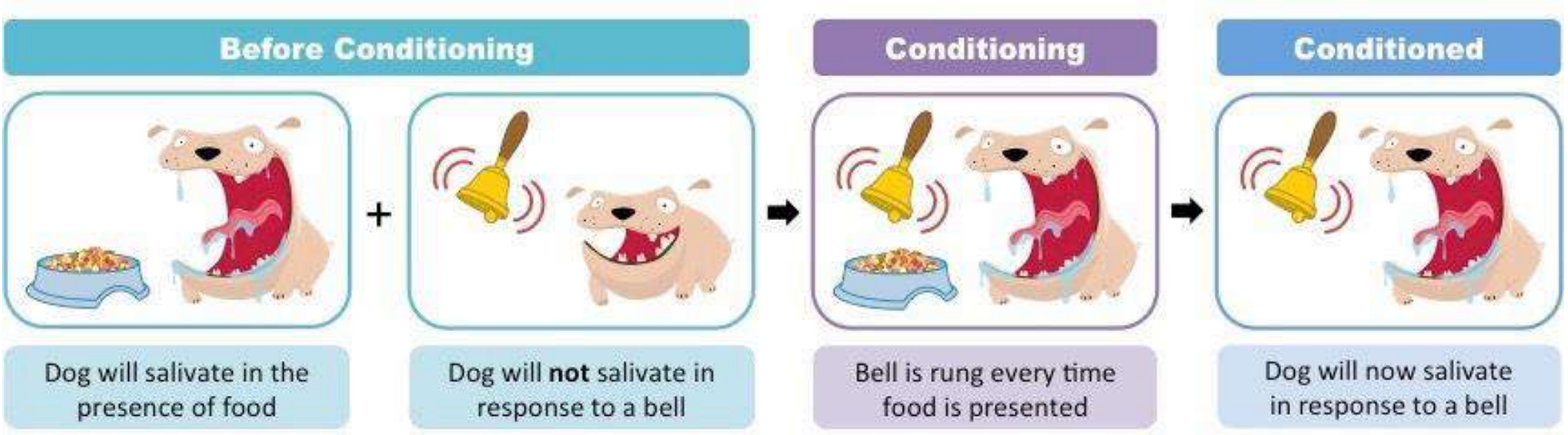
Prolonged exposure to scarecrow

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

Common Forms of Learning

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

- Association (between stimuli or events)

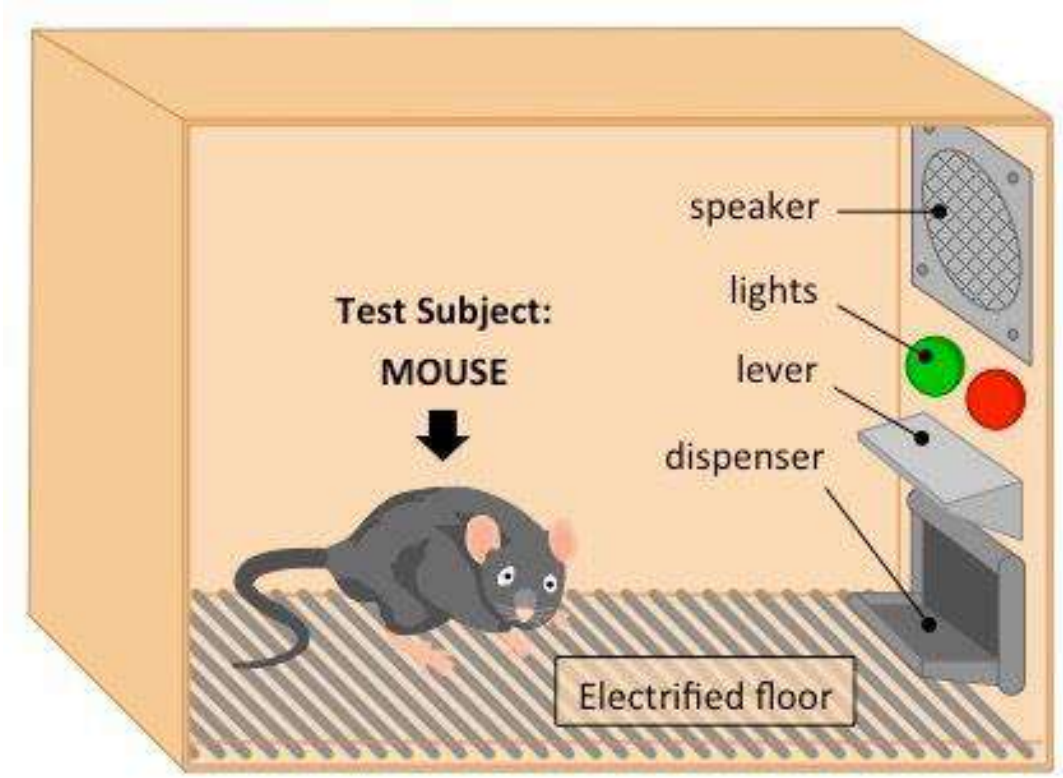


Source https://ib.bioninja.com.au/options/option-a-neurobiology-and/a4-innate-and-learned-behav/conditioning.html

Common Forms of Learning

3. Operant conditioning 操作性条件反射

- Reinforcement Learning; Supervised/Semi-Supervised Learning



	Something **given** to the mouse	Something **taken** from the mouse
Increases likelihood of repeated behavior	**POSITIVE REINFORCEMENT** Mouse given food when lever pressed (after green light)	**NEGATIVE REINFORCEMENT** Loud noise stopped when lever pressed
Decreases likelihood of repeated behavior	**POSITIVE PUNISHMENT** Mouse is shocked when lever pressed (after red light)	**NEGATIVE PUNISHMENT** Not applicable in this scenario

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

Common Forms of Learning

3. Operant conditioning 操作性条件反射

Reinforcement Learning

https://deepmind.com/blog/alphago-zero-learning-scratch/

https://telescopeuser.wordpress.com/

DiDi: A Reinforcement Learning Agent

Reinforcement Learning in Daily Life

[Author: DiDi & GU Zhan (Sam)]

[Tags: MTech IS, AI, Reinforcement learning, Agent, Markov decision process]

Common Forms of Learning

4. Observational learning 观察学习

- Imitation Learning; Unsupervised/Semi-Supervised Learning

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

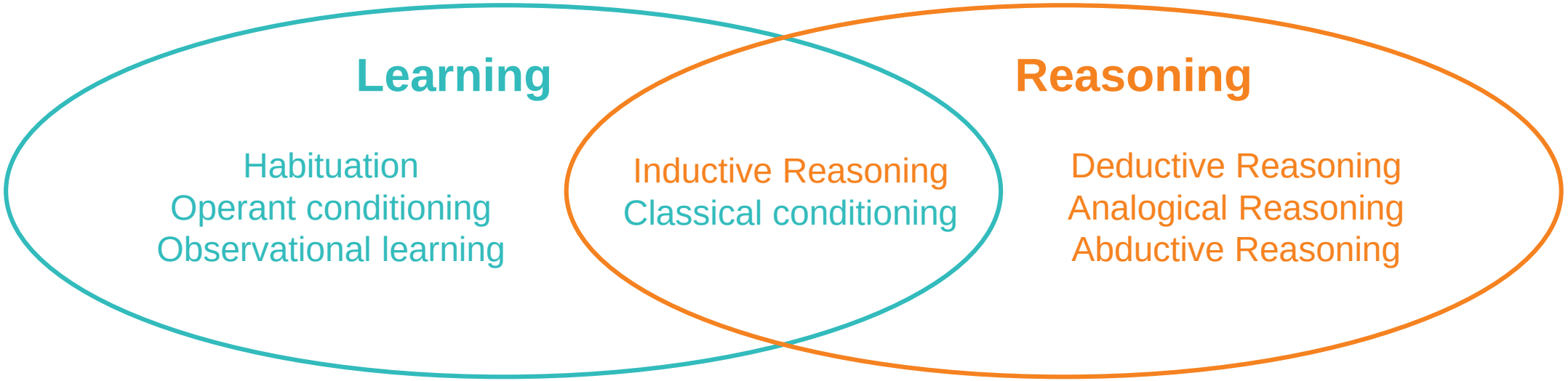
Human Reasoning

to **use existing** knowledge

Model:
Reason/Think 想

Common Forms of Reasoning

1. **Deductive Reasoning** (Formal logic; Aristotle's syllogism)
2. **Inductive Reasoning** (Statistical learning / recognition)
3. **Analogical Reasoning** (Case based reasoning)
4. **Abductive Reasoning** (Hypothesis ~ Evidence; Probability)



Common Forms of Reasoning

1. Deductive Reasoning

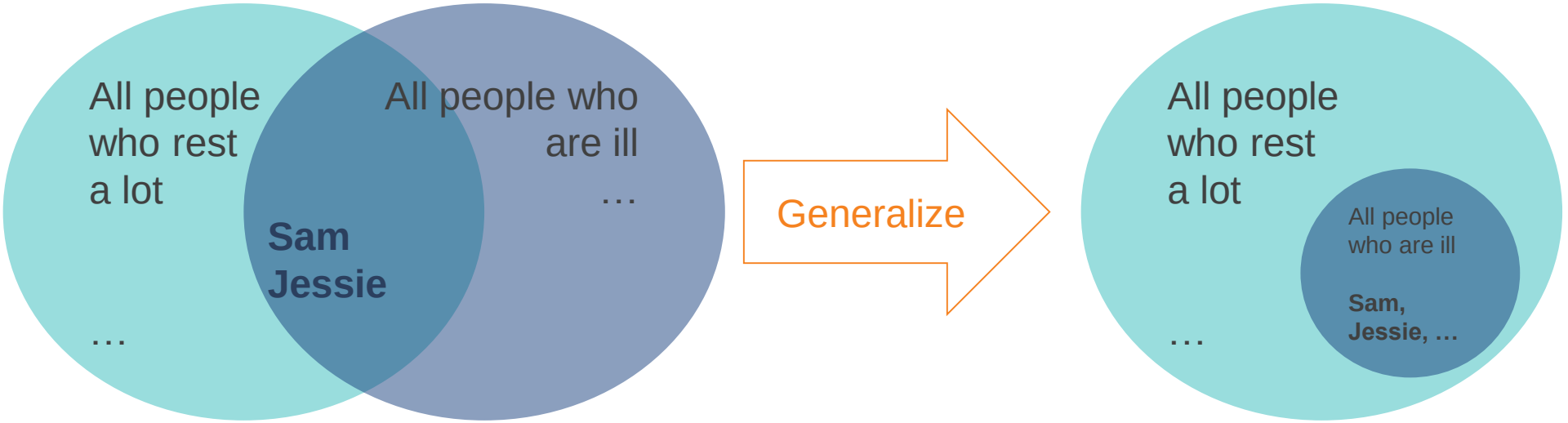
- **Knowledge/Rule** : **All people** who are **ill**, they rest a lot.
- **Individual 1** : **Sam** is **ill**, therefore he rest a lot.
- **Individual 2** : **Jessie** is **ill**, therefore she rest a lot.
- **Individual …**

☺ **Reasoning Rationality: Universal → Individual**

Common Forms of Reasoning

2. Inductive Reasoning

- **Individual 1** : When **Sam** is **ill**, he rests a lot.
- **Individual 2** : When **Jessie** is **ill**, she rests a lot.
- **Generalised Rule** : **All people** who are **ill**, they rest a lot.

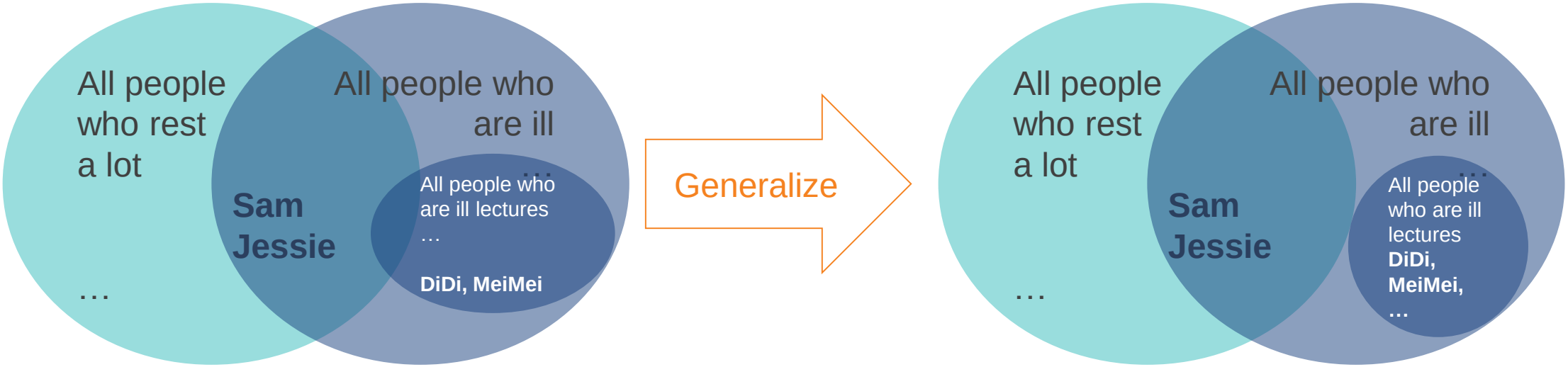


☺ **Reasoning Rationality: Individual → Universal (Machine Learning)**

Common Forms of Reasoning

2. Inductive Reasoning

- **Individual 1** : When **DiDi** is **ill** AND he is **lecturer**, he doesn't rest a lot.
- **Individual 2** : When **MeiMei** is **ill** AND she is **lecturer**, she doesn't rest a lot.
- **Generalised Rule** : **All people** who are **ill lecturers**, they don't rest a lot.

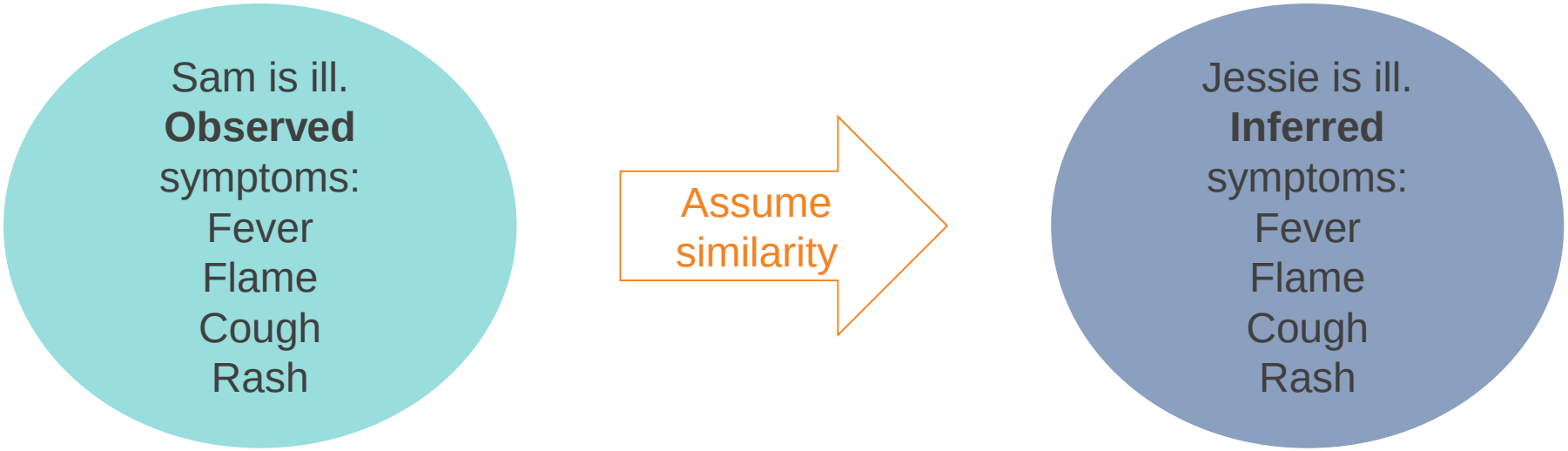


☺ **Reasoning Rationality: Individual → Universal (Machine Learning)**

Common Forms of Reasoning

3. Analogical Reasoning

- **Known case** : **Sam** is ill with his symptoms: fever, flame, cough, and rash.
- **Inferred case** : **Jessie** is ill too, therefore she **would** have **same** symptoms as **Sam**: fever, flame, cough, and rash.

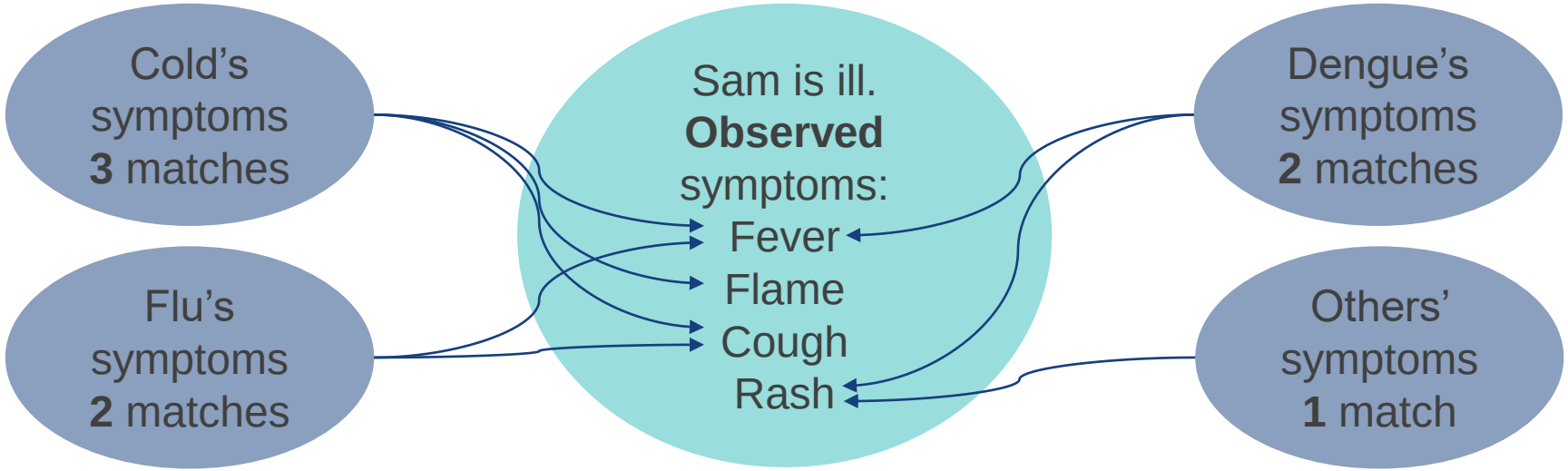


☺ **Reasoning Rationality: Known case → Inferred case**

Common Forms of Reasoning

4. Abductive Reasoning

- **Known observations** : **Sam** is ill with his symptoms: fever, flame, cough, and rash.
- **Inferred root cause** : **Cold? Flu? Dengue? Others?**



☺ **Reasoning Rationality: Observations → Causes likelihood**

Common Forms of Reasoning

Others Types: Fuzzy Reasoning

Long Hair Group ← Hair length ≥ 10 cm

Hair length < 10 cm → Short Hair Group

Long Hair Group ← Hair length is long

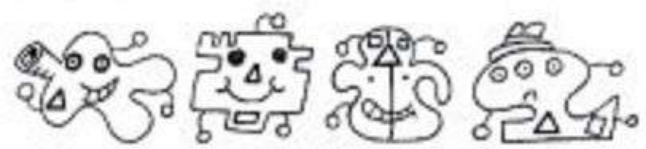
Hair length is short → Short Hair Group

What if the hair length is both long and short → Which Group?

Source https://www.google.com/search?q=nicolas+cage&rlz=1C1GCEU_enSG820SG820&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiOt7bhkqTjAhVcknAKHTSZBHgQ_AUIECgB&biw=1920&bih=896

Common Forms of Reasoning

Aliens



Not aliens

Which one is alien?

A B C D E

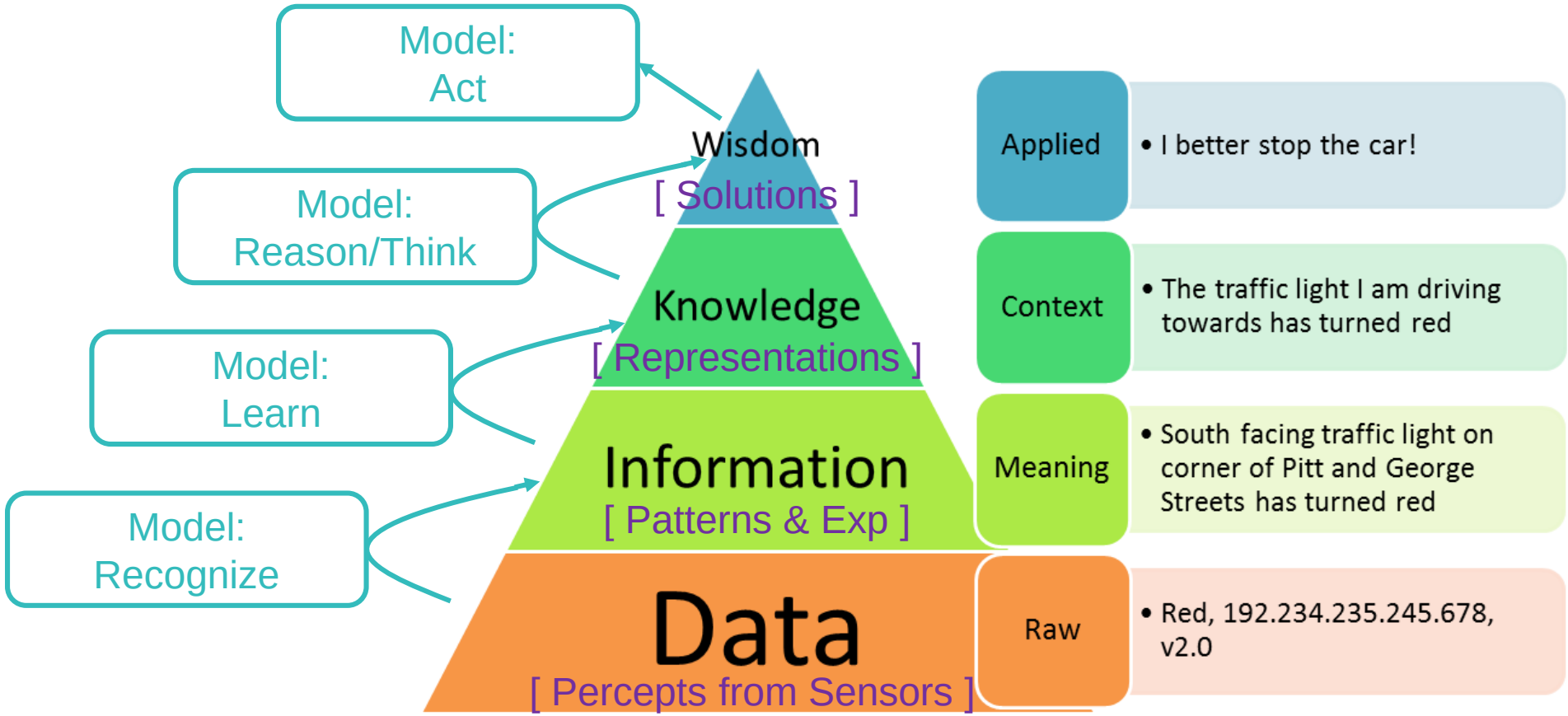
Revisit Cognition – One Definition:

Cognition is "the mental action or process of **acquiring knowledge and understanding** through **thought** (recognition, learning, computation, reasoning & thinking), **experience** (information & data), and the **senses** (perceptions & sensors)". It encompasses many aspects of **intellectual functions** and processes such as attention, the formation of knowledge, memory and working memory, judgment and evaluation, reasoning and "computation", problem solving and decision making, comprehension and production of language.

Cognitive processes **use existing knowledge** (computation, reasoning & thinking) and **generate new knowledge** (learning supported by pattern recognition using experience/information from data/perceptions/sensors).

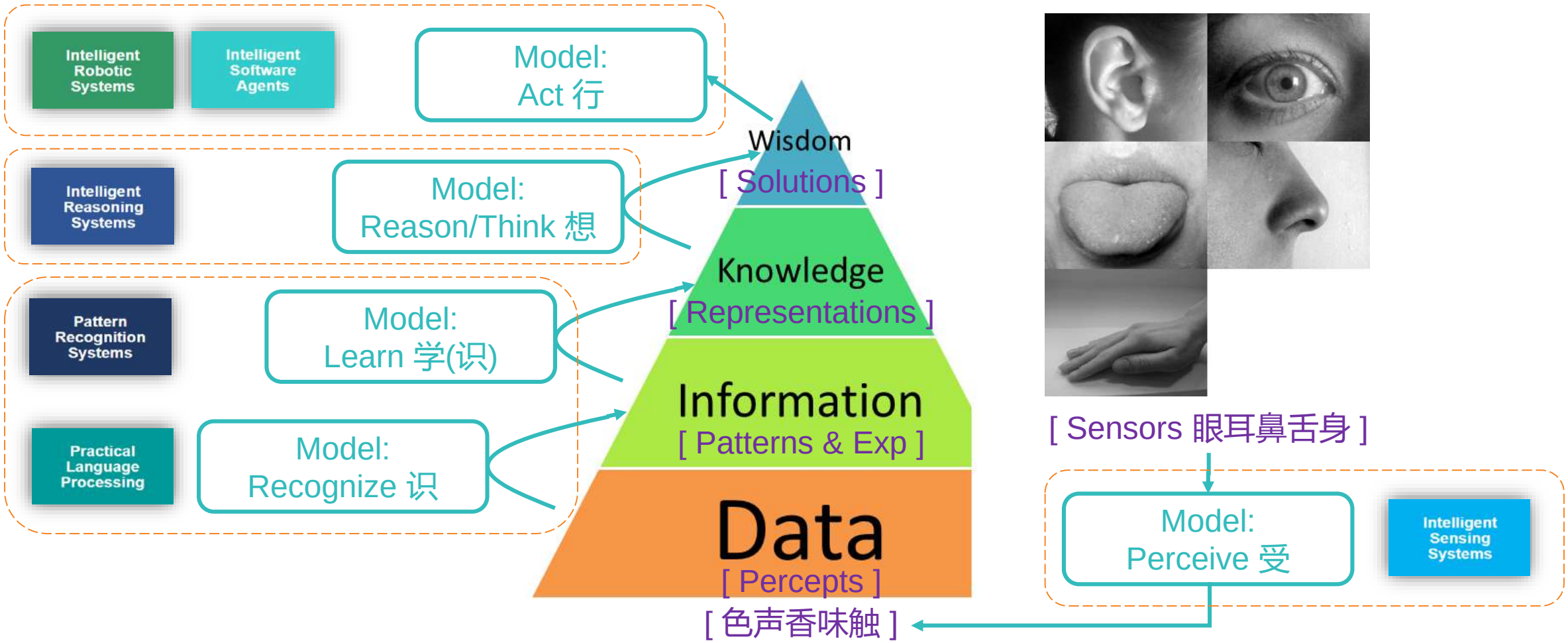
Cognitive Processes/Functions/Models

- Use **existing** knowledge through: Reasoning/Thinking
- Generate **new** knowledge through: Learning/Recognition



Cognitive Processes/Functions/Models

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



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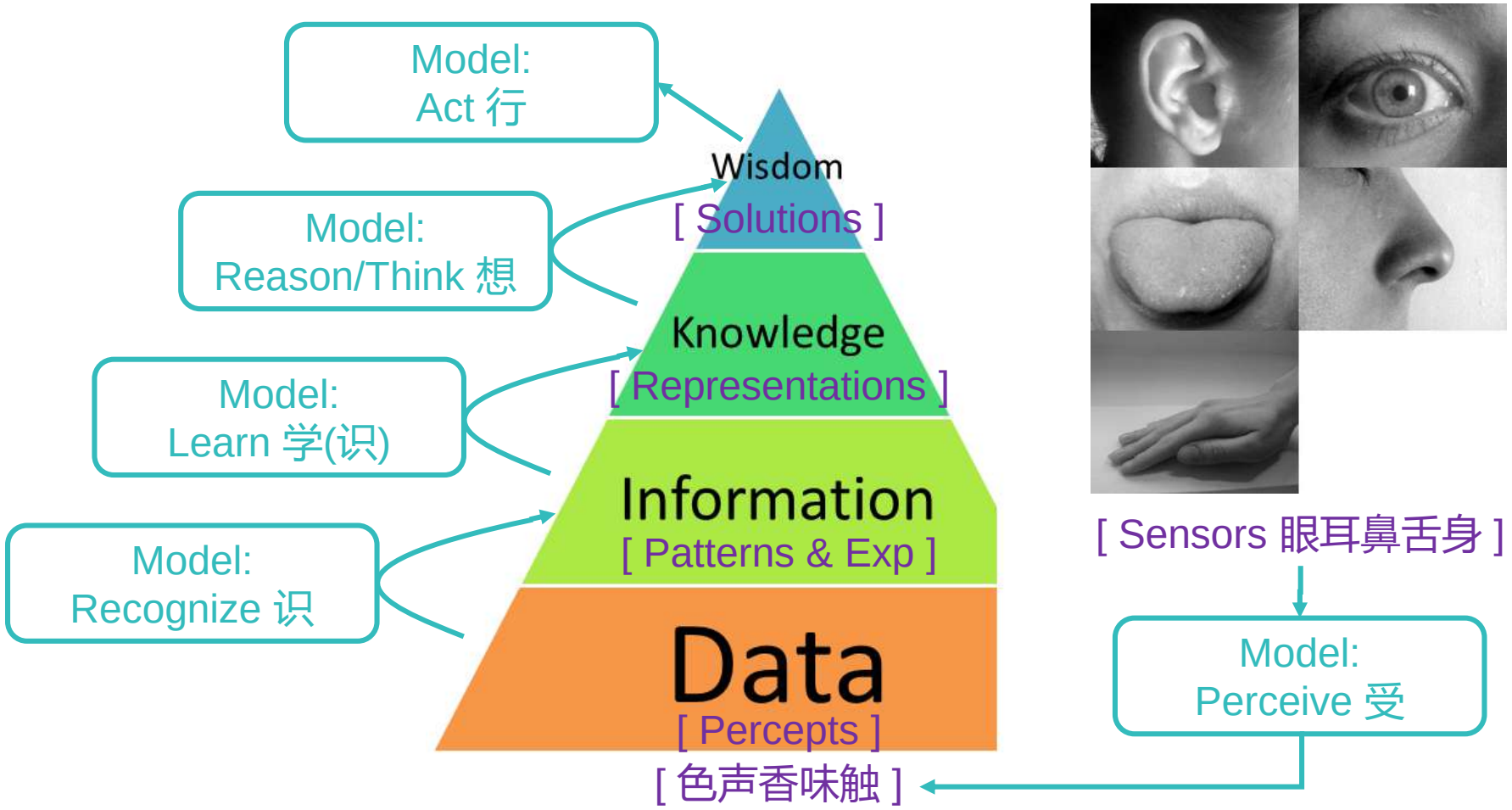
Artificial Intelligence
Intelligent Systems

https://www.iss.nus.edu.sg/stackable-certificate-programmes/Intelligent-systems

https://www.iss.nus.edu.sg/executive-education/discipline/detail/artificial-intelligence

What's a "model"?

What's a "model"?



What's a conceptual model?

A ***model*** is a piece of **organized & represented *knowledge*** (our understanding of the *world/domain*), which can **be (re)used** to **generate/predict** outcome results based on input observations. Technically, it's a ***function*** (white or black box), which **maps** input(s) to output(s)

What's a physical model?

A *model* could be considered just as a tangible text file stored in computer/server, e.g. model.txt

model.txt - Notepad

File Edit Format View Help

```
Output  : Salary
Input 1 : Year-of-Education
Input 2 : Year-of-Working

Formula : Output = a x Input 1 + b x Input 2 + c
           (Salary)    (Year-of-Education) (Year-of-Working)

Formula parameters/coefficients       : a = 520
Formula parameters/coefficients       : b = 798
Formula parameters/coefficients       : c = -5007
```

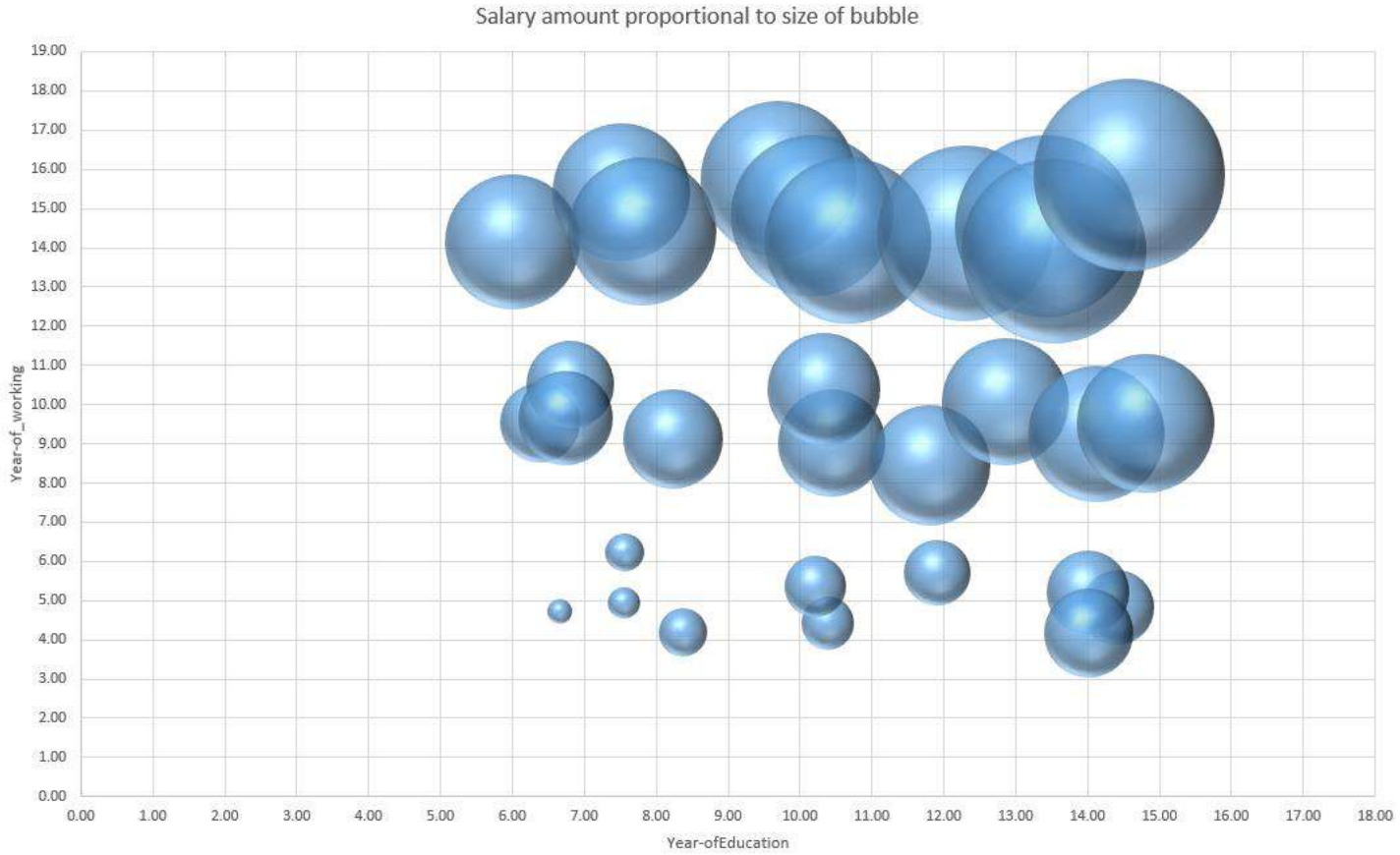
Salary.xlsx

Salary v02.xlsx - Excel

File Home Insert Page Layout Formulas Data Review View Team Enterprise Connect Tell me what you want to do... Sign in Share

AB85

sn	Year-of-Education	Year-of-Working	Salary
1	6.65	4.72	$1,817
2	7.55	4.94	$2,305
3	7.56	6.22	$2,832
4	8.37	4.19	$3,502
5	10.39	4.42	$3,890
6	10.22	5.35	$4,568
7	11.91	5.70	$4,884
8	14.41	4.82	$5,478
9	14.00	5.20	$6,181
10	14.01	4.18	$6,597
11	6.38	9.54	$5,860
12	6.81	10.52	$6,519
13	6.74	9.66	$7,018
14	8.23	9.12	$7,405
15	10.44	9.01	$7,945
16	10.33	10.40	$8,384
17	11.80	8.45	$8,954
18	12.85	10.06	$9,482
19	14.12	9.25	$10,102
20	14.81	9.52	$10,339
21	6.00	14.16	$10,067
22	7.51	15.43	$10,301
23	7.80	14.42	$11,056
24	9.69	15.76	$11,652
25	10.17	14.81	$12,078
26	10.66	14.17	$12,463
27	12.30	14.38	$13,144
28	13.42	14.55	$13,561
29	13.53	13.93	$13,851
30	14.57	15.86	$14,344



data regression

Ready 100%

Salary v02.xlsx - Excel

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AZ92

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.984375561
R Square	0.968995246
Adjusted R Square	0.966698597
Standard Error	667.5580743
Observations	30

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	376041022.2	188020511.1	421.9170953	4.30806E-21
Residual	27	12032112.13	445633.7825		
Total	29	388073134.3			

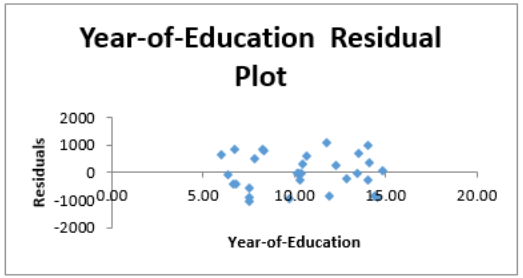
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-5007.776515	551.1804093	-9.085548816	1.06587E-09	-6138.705299	-3876.847731	-6138.705299	-3876.847731
Year-of-Education	520.7382643	42.89431991	12.14002846	1.90221E-12	432.7263898	608.7501389	432.7263898	608.7501389
Year-of-Working	798.286873	30.15824157	26.46994093	7.53819E-21	736.4072726	860.1664733	736.4072726	860.1664733

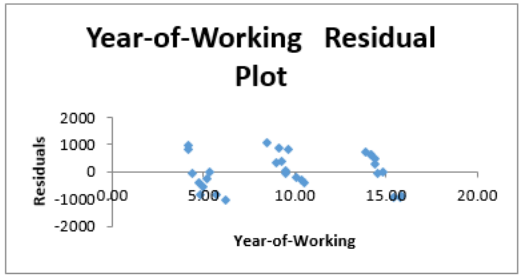
RESIDUAL OUTPUT

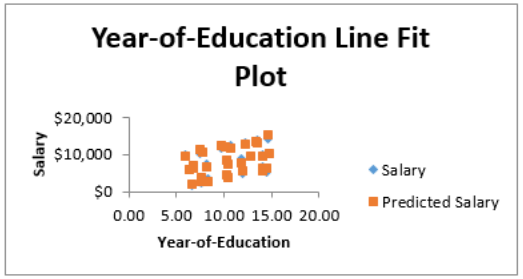
Observation	*Predicted Salary*	*Residuals*	*Standard Residuals*
1	2227.378049	-410.3780489	-0.63710672
2	2865.1592	-560.1591999	-0.869640059
3	3897.843043	-1065.843043	-1.654707816
4	2696.024781	805.9752188	1.251266313
5	3934.190757	-44.19075715	-0.06860559
6	4582.710338	-14.71033805	-0.022837613
7	5745.008025	-861.0080251	-1.336704047
8	6348.358938	-870.3589379	-1.351221221
9	6439.491245	-258.4912447	-0.401304382
10	5626.422479	970.5775209	1.506809301
11	5932.578944	-72.57894434	-0.112677891
12	6933.034306	-414.0343056	-0.642783012
13	6208.28567	809.7143298	1.257071236
14	6555.942708	849.057292	1.318150686
15	7624.171392	320.8286079	0.498082348

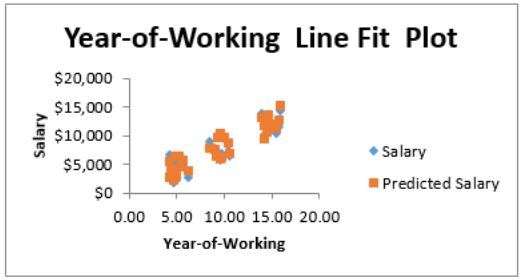
PROBABILITY OUTPUT

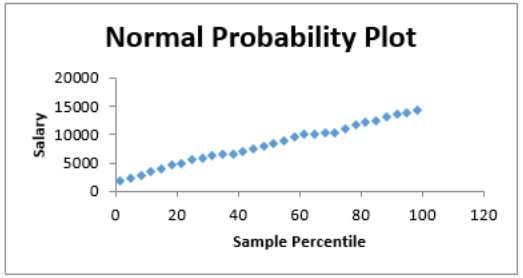
Percentile	*Salary*
1.666666667	1817
5	2305
8.333333333	2832
11.66666667	3502
15	3890
18.33333333	4568
21.66666667	4884
25	5478
28.33333333	5860
31.66666667	6181
35	6519
38.33333333	6597
41.66666667	7018
45	7405
48.33333333	7945









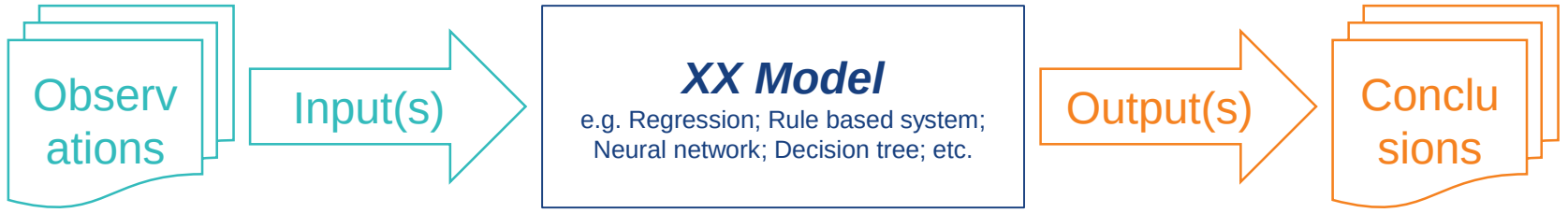


data regression

Ready

What are differences between models?

Different *(machine learning) model* *(applied mathematical algorithm, which is capable of minimizing an objective function's value)*, e.g. Regression; Neural network; Decision tree, etc., **extracts**, **organizes** and **represents *knowledge*** in **different** ways: **different** (mathematical) forms.



Machine Intelligence/Cognition
Artificial Intelligence/Cognition

Machine/Artificial Intelligence

- Goals
- Roots
- Sub Fields

MACHINE/ARTIFICIAL INTELLIGENCE

Goals

"Artificial Intelligence (AI) is the part of computer science concerned with designing intelligent computer systems, that is, systems that exhibit characteristics we associate with intelligence in human behaviour – understanding language, learning, reasoning, solving problems, and so on."

(Barr & Feigenbaum, 1981)

- **Scientific Goal:** To determine which **ideas/frameworks** about knowledge representation, learning, reasoning, (ir)rationality, and so on, explain various sorts of real/augmented intelligence.

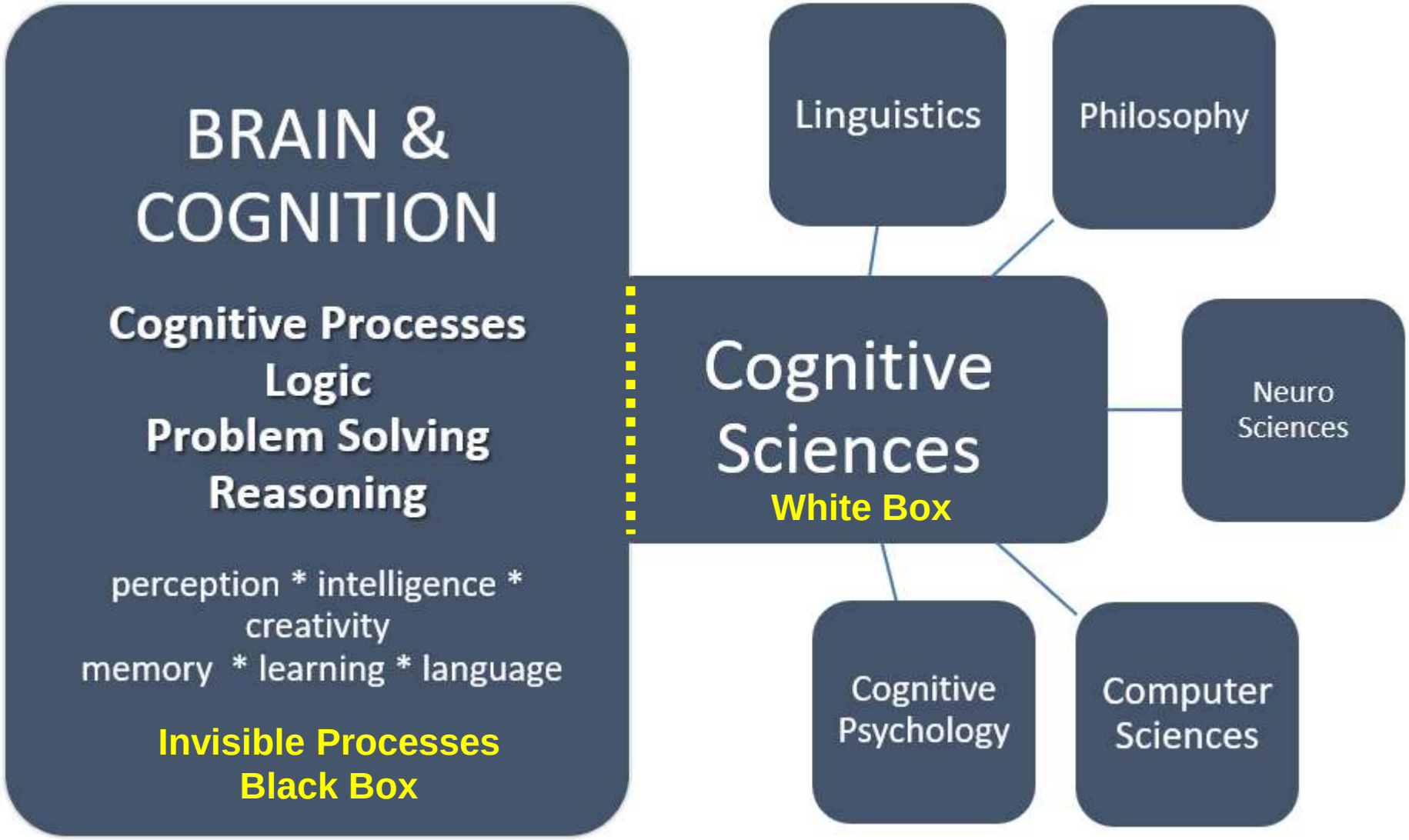
- **Engineering Goal:** To solve valuable real world problems using **AI techniques (tools, codes and libraries)** such as knowledge representation, learning, rule systems, search, model/function approximation, and so on.

MACHINE/ARTIFICIAL INTELLIGENCE

Roots

Rooted from older disciplines, particularly:

- **Philosophy**, e.g. Syllogism, Deductive Reasoning
- **Logic/Mathematics**, e.g. First-order logic, Knowledge Graph
- **Computation**, e.g. Calculation, Turing Machine
- **Psychology/Cognitive Science**, e.g. Mind Operations, Language, Knowledge Representation, Learning
- **Biology/Neuroscience**, e.g. Neural Network, Function Approximation
- **Evolution**, e.g. Natural Selection, Genetic Programming



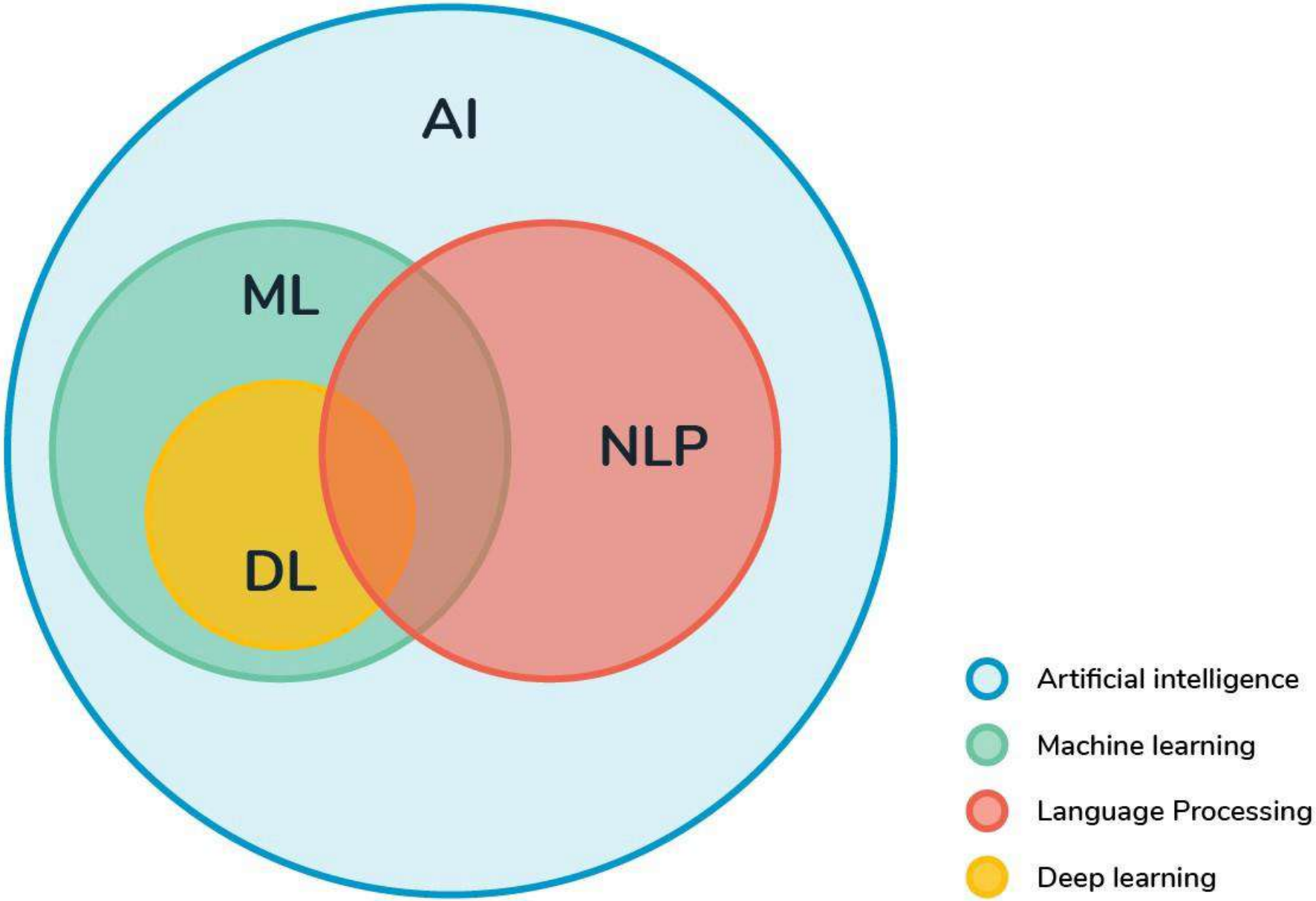
Source https://medium.com/womeninai/human-cognition-and-artificial-intelligence-a-plea-for-science-21a2388f6e7e

MACHINE/ARTIFICIAL INTELLIGENCE

Sub Fields

Major AI Sub-fields, with a variety of techniques:

- **Neural Networks**, e.g. brain modelling, time series prediction, classification
- **Evolutionary Computation**, e.g. genetic algorithms, genetic programming
- **Vision**, e.g. object recognition, image understanding
- **Robotics**, e.g. dynamic control, autonomous exploration
- **Expert Systems**, e.g. decision support systems, teaching systems
- **Speech Processing**, e.g. speech recognition and production
- **Natural Language Processing**, e.g. machine translation
- **Planning**, e.g. search, scheduling, game playing
- **Machine Learning**, e.g. decision tree learning, version space learning



Source https://medium.com/@neha49712/artificial-intelligence-and-its-sub-fields-a5a63d8263e8

Demystify

Machine Reasoning
Machine Learning
Machine Perception
Machine Action

Model:
Reason/Think 想

Model:
Learn 学(识)

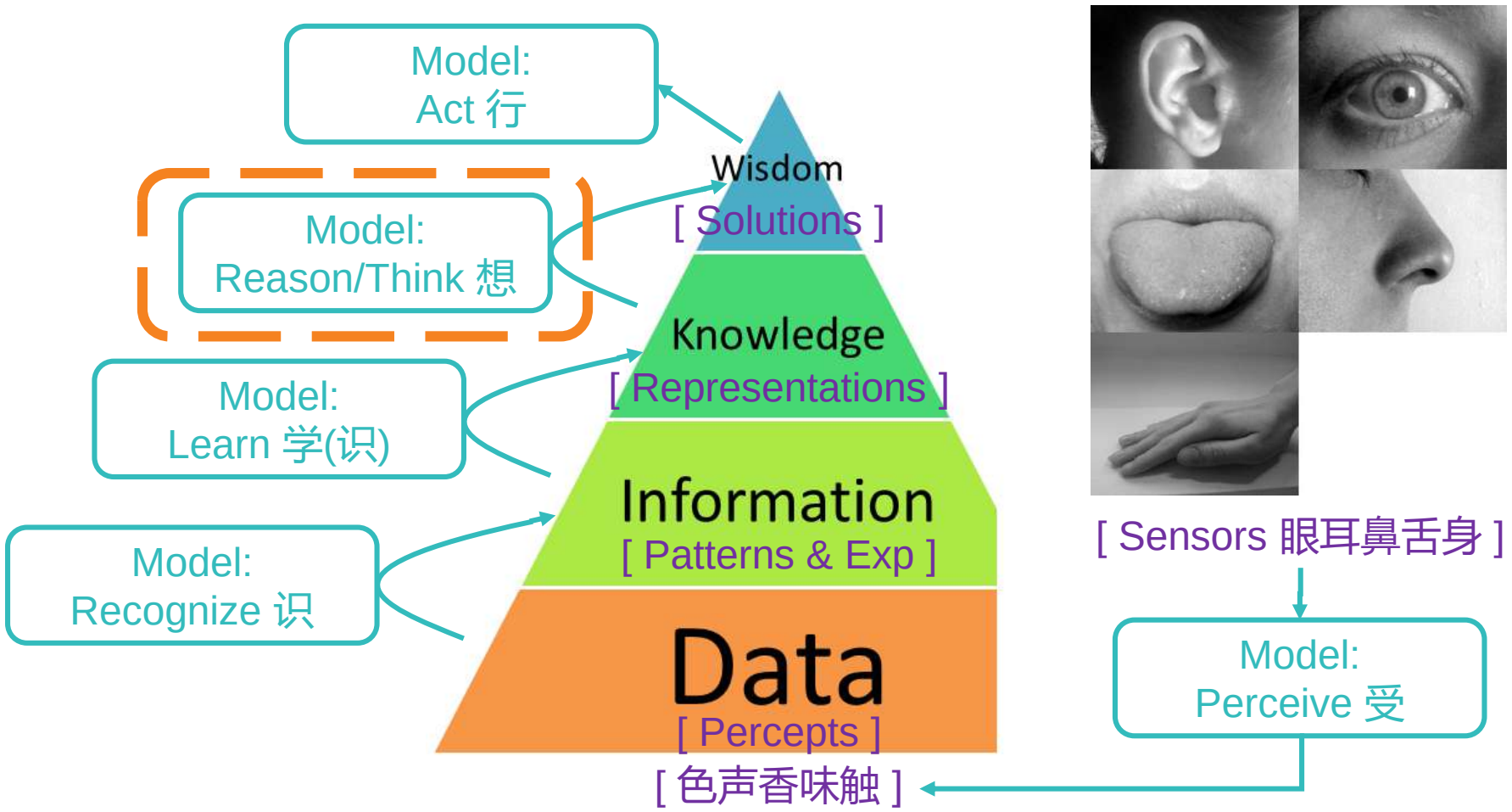
Model:
Perceive 受

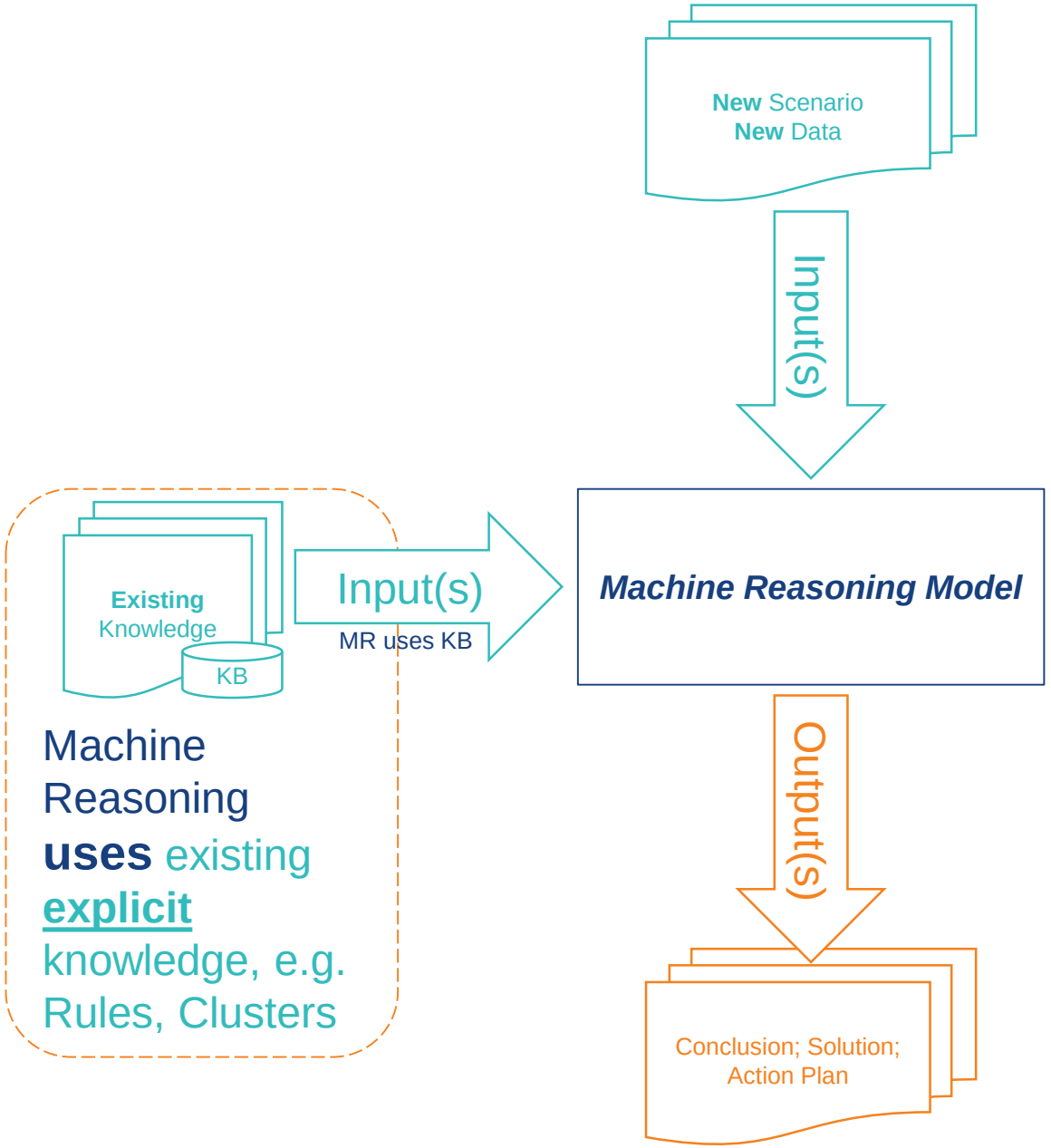
Model:
Act 行

A “model” view of “reasoning/thinking”

Model:
Reason/Think 想

What's a (reasoning/thinking) "model"?





EXAMPLE OF MACHINE REASONING (LOGICAL INFERENCE)

Deductive Reasoning

- **Knowledge/Rule** : **All ill people** need rest a lot.
- **Individual 1** : **Sam** is **ill**, therefore he need rest a lot.
- **Individual 2** : **Jessie** is **ill**, therefore she need rest a lot.
- **Individual …**

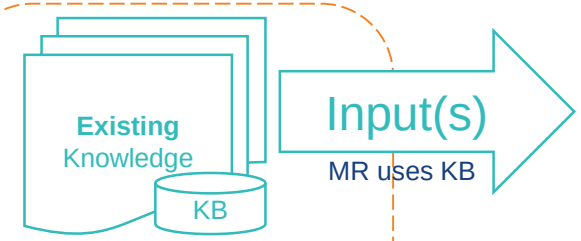
☺ **Reasoning Rationality: Universal → Individual**

Sam is ill.

New but similar
Scenario
New Data

Input(s)

All ill people need rest a lot.



Input(s)
MR uses KB

Machine Reasoning Model

Logic-based Inference and **Knowledge Base (KB)** are separated.

Machine Reasoning **uses** existing **explicit** knowledge, e.g. Rules, Clusters

Output(s)

Conclusion; Solution; Action Plan
With
Logical Explanations

Therefore Sam need rest a lot.

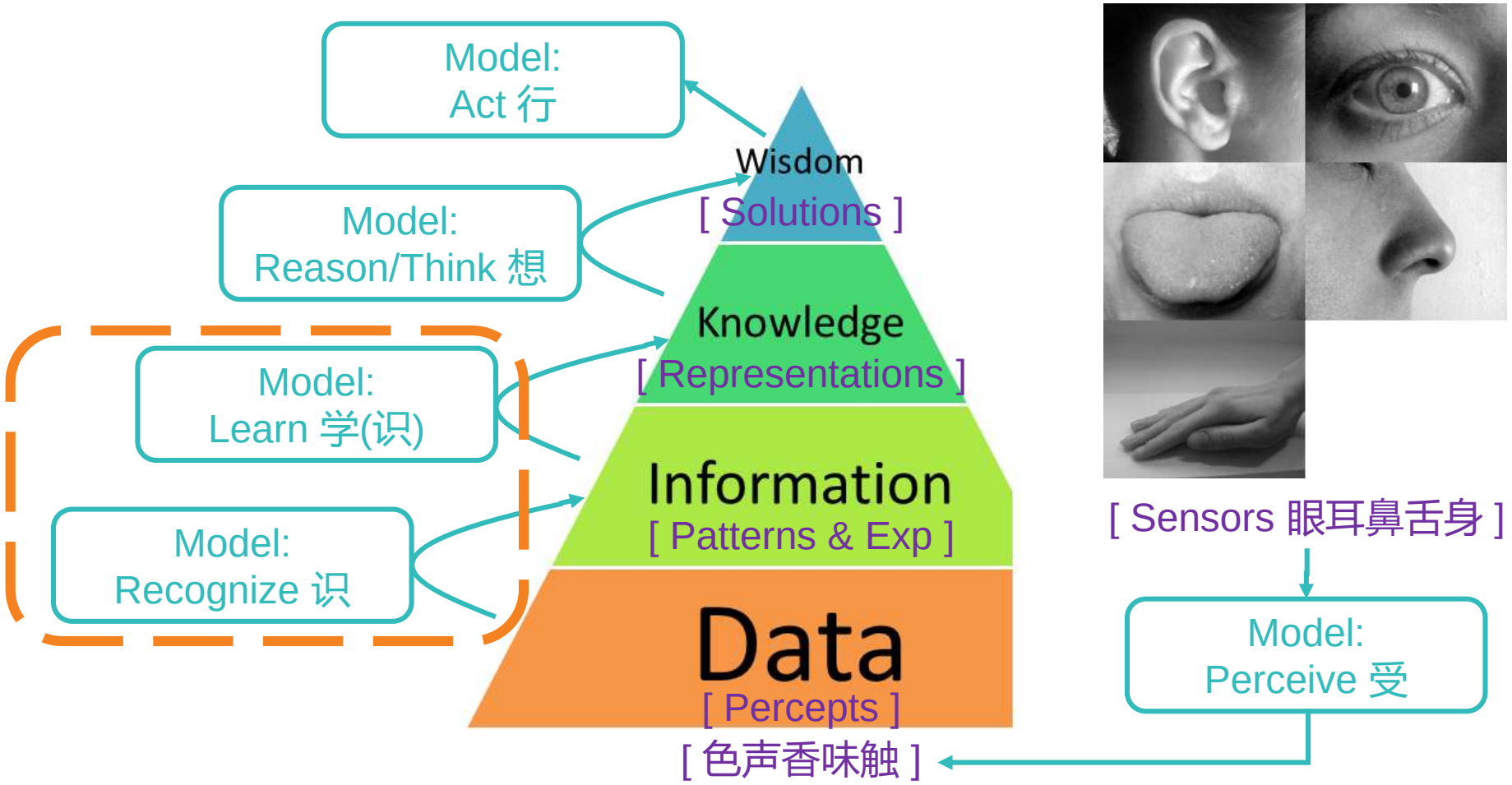
A “model” view of “learning/recognition”

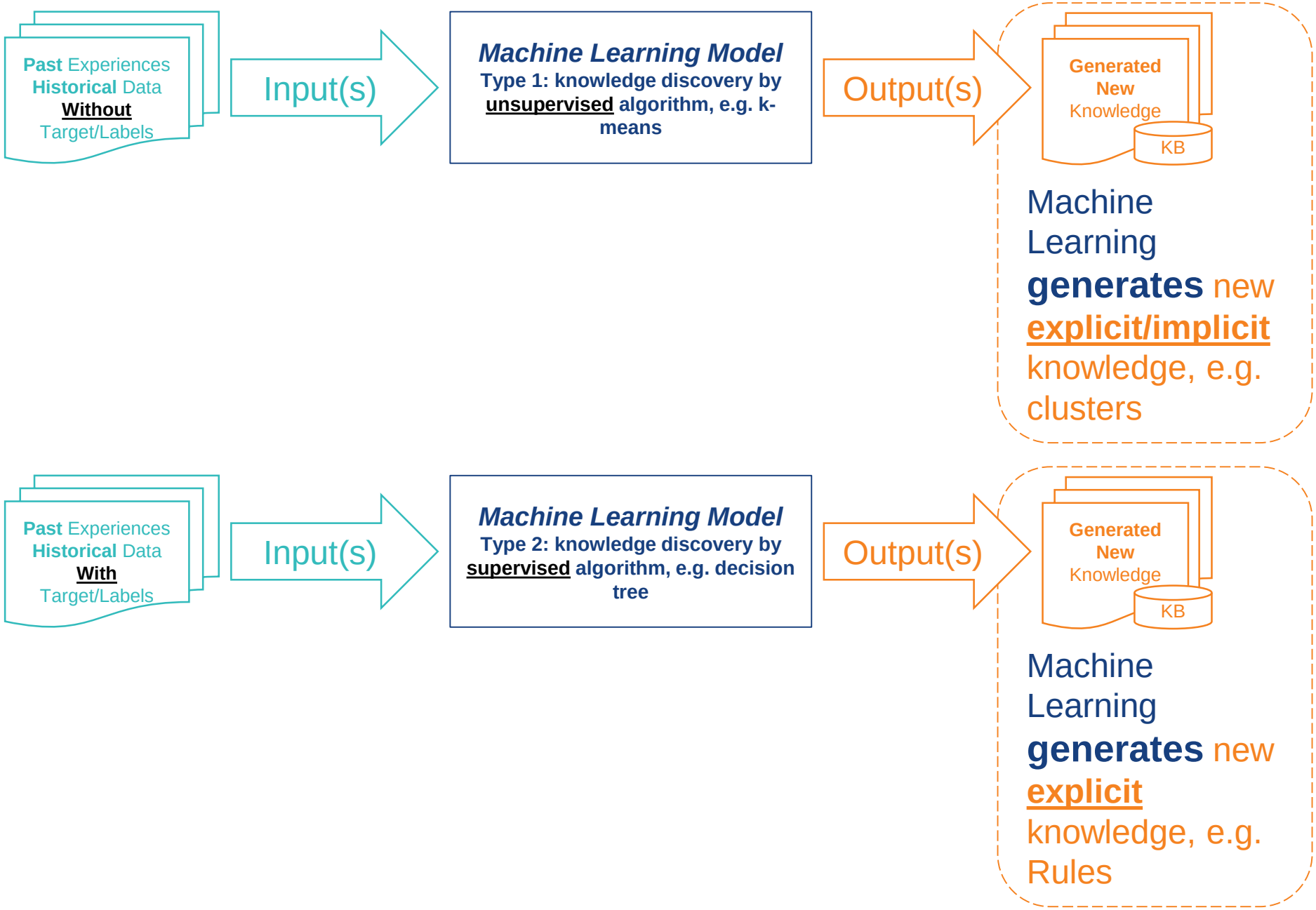
Model:
Recognize 识

Model:
Learn 学(识)

- knowledge-discovery-based (white box) machine learning model
- function-approximation-based (black box) machine learning model

What's a (knowledge-discovery-based machine learning) "model"?





Past Experiences
Historical Data
Without
Target/Labels

Input(s)

Machine Learning Model
Type 1: knowledge discovery by unsupervised algorithm, e.g. k-means

Output(s)

Generated New Knowledge

KB

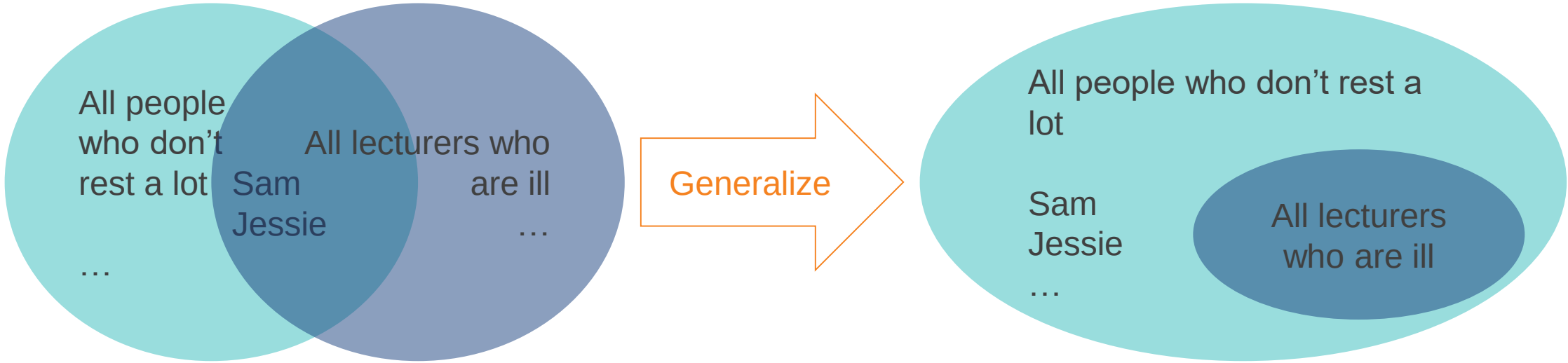
Machine Learning **generates** new **explicit/implicit** knowledge, e.g. clusters

EXAMPLE OF MACHINE LEARNING

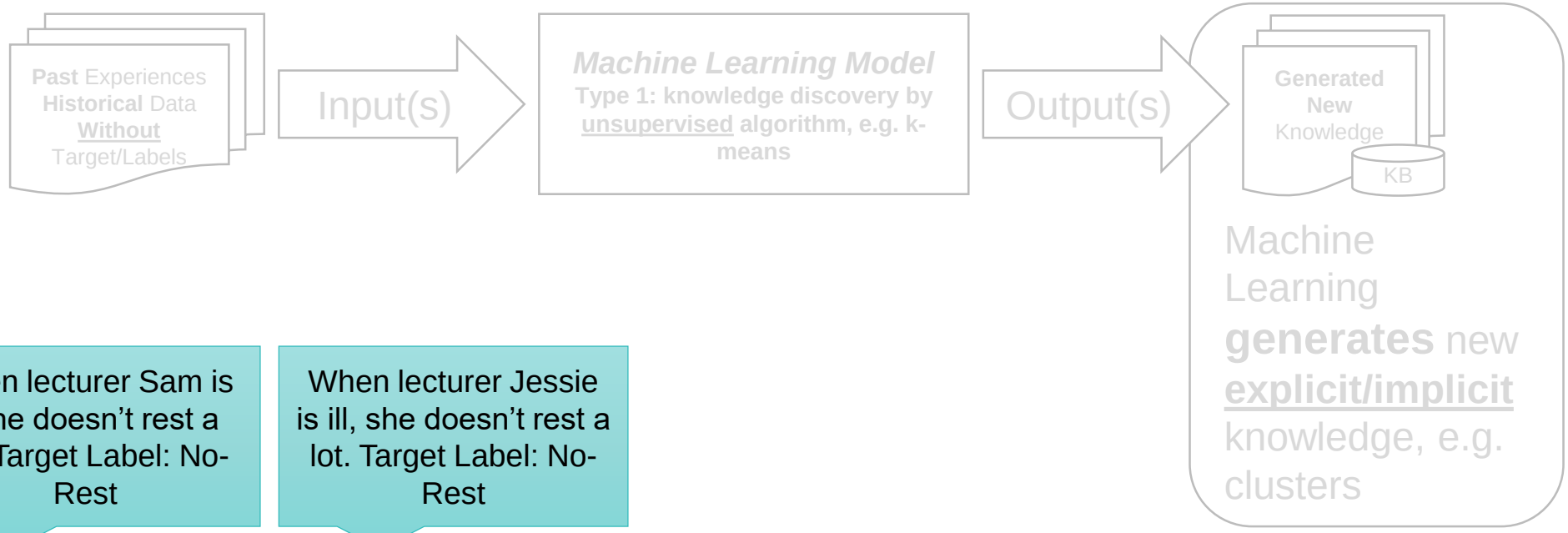
Inductive Reasoning

- **Individual 1** : When **lecturer Sam** is **ill**, he doesn't rest a lot.
- **Individual 2** : When **lecturer Jessie** is **ill**, she doesn't rest a lot.
- **Generalised Rule** : **All lecturers** who are **ill**, they don't rest a lot.

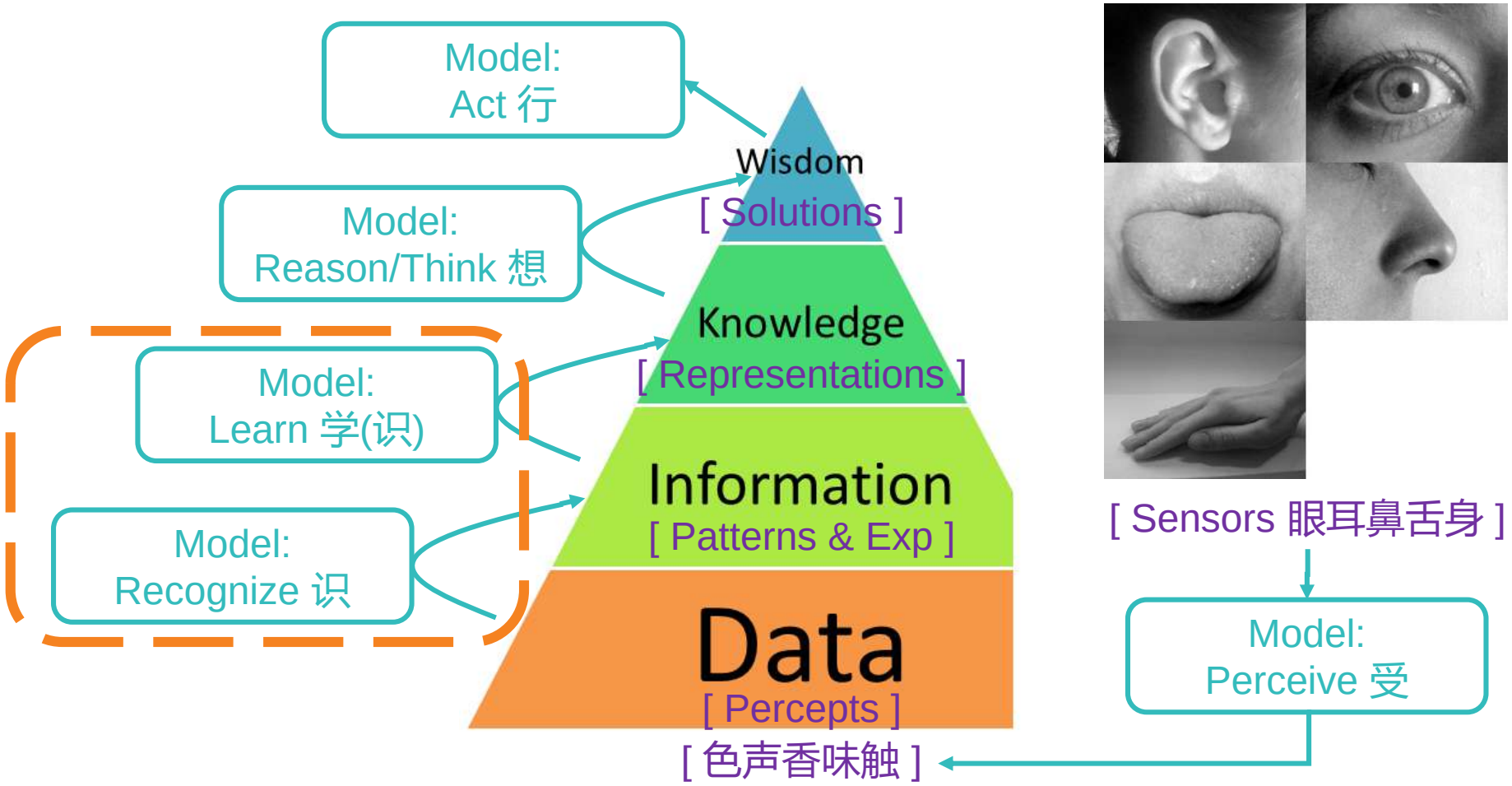
Targets: No-Rest



☺ **Reasoning Rationality: Individual → Universal (Machine Learning)**



What's a (function-approximation-based machine-learning) "model"?



Past Experiences
Historical Data
With
Target/Labels

Input(s)

Machine Learning Model
Type 2: knowledge discovery by supervised algorithm, e.g. decision tree

Output(s)

Generated
New
Knowledge

KB

KB/Rules/Conditions:
has round forward eyes
has whisker
has triangular ear
has thin tail
is hairy
...

IF True: cat; ELSE: not cat

Machine Learning **generates** new **explicit** knowledge, e.g. Rules

Past Experiences
Historical Data
With
Target/Labels

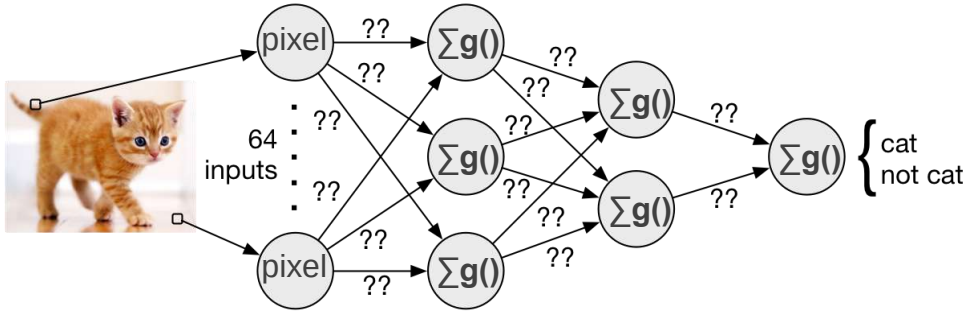
Input(s)

Machine Learning Model
Type 3: function approximation (input-output mapping) by supervised algorithm, e.g. neural network; deep learning

Output(s)

Generated
New
Knowledge

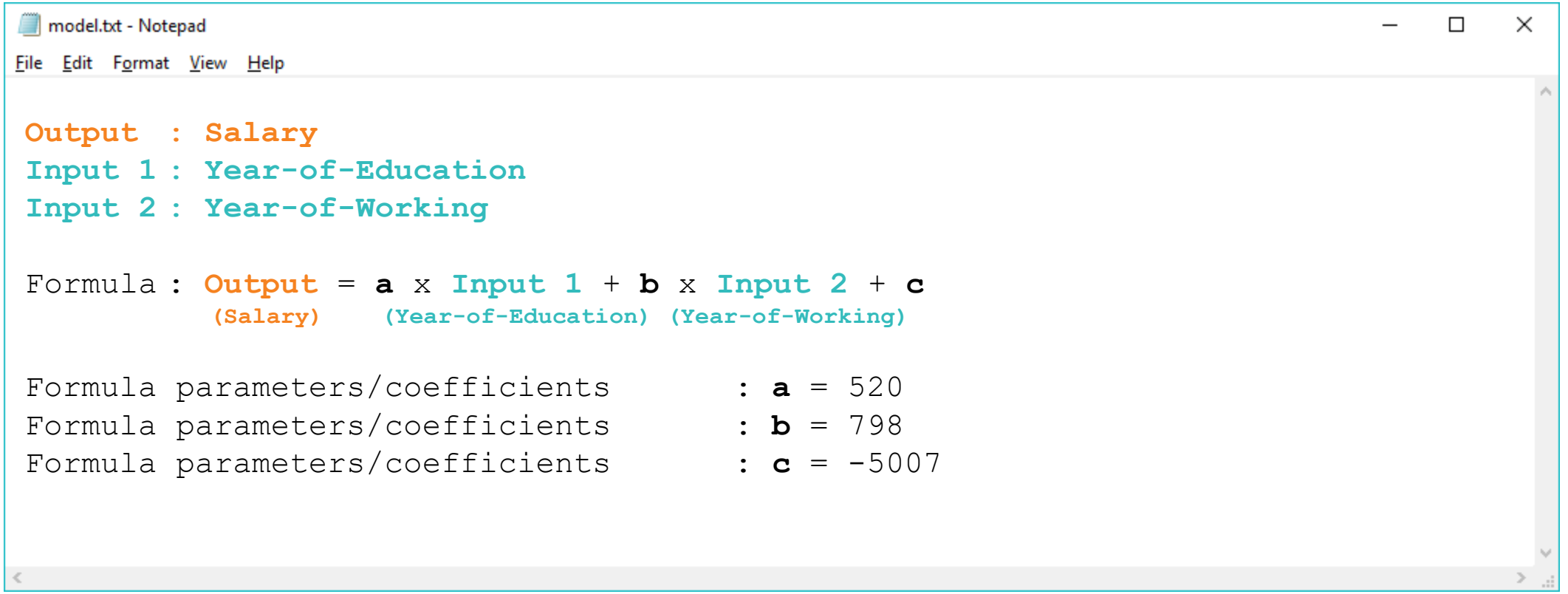
~~KB~~
F()



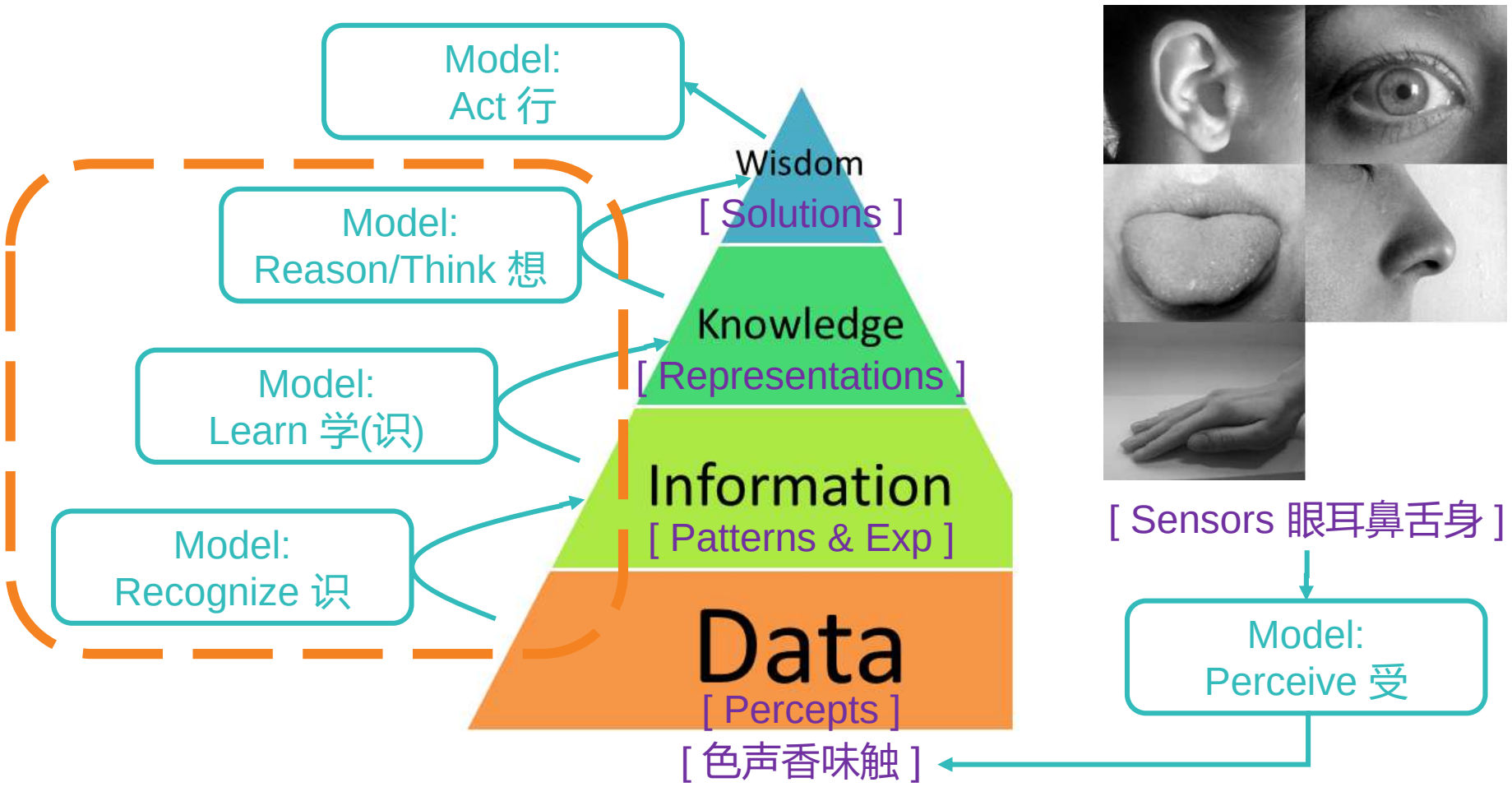
Machine Learning **generates** new **implicit** knowledge, e.g. functions F()

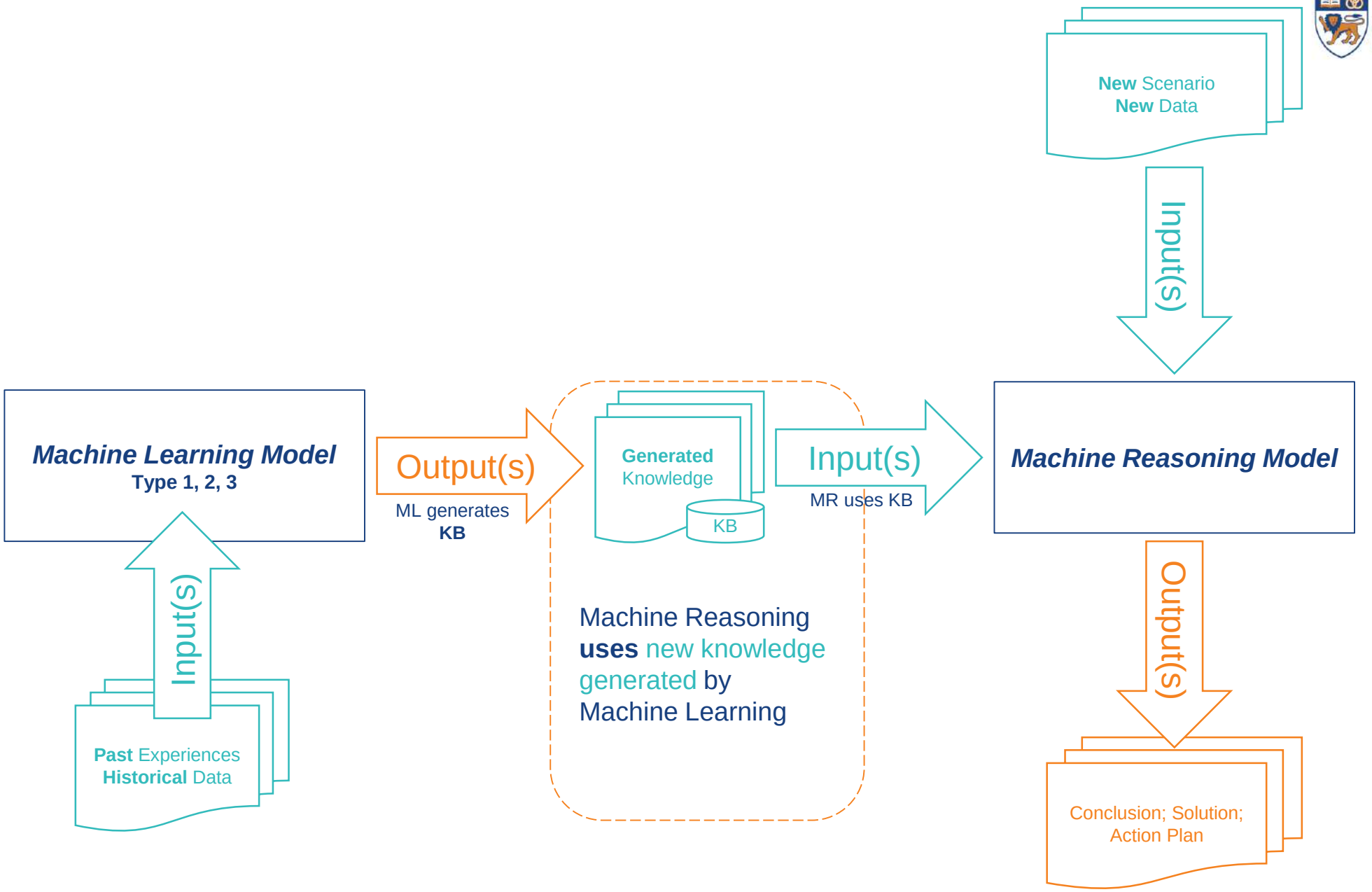
Is this model a white box or black box?

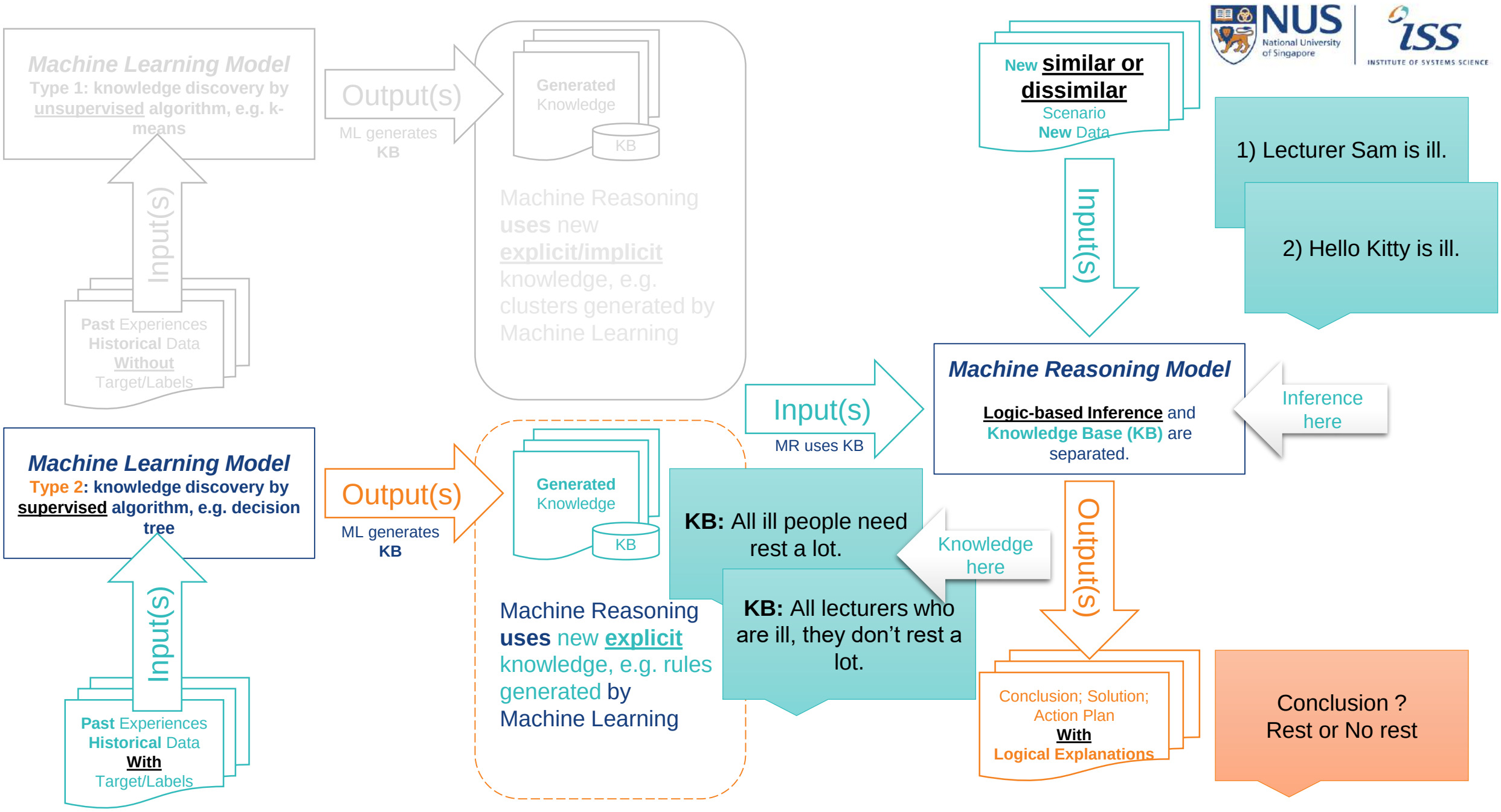
- knowledge-discovery-based (white box)
- function-approximation-based (black box)

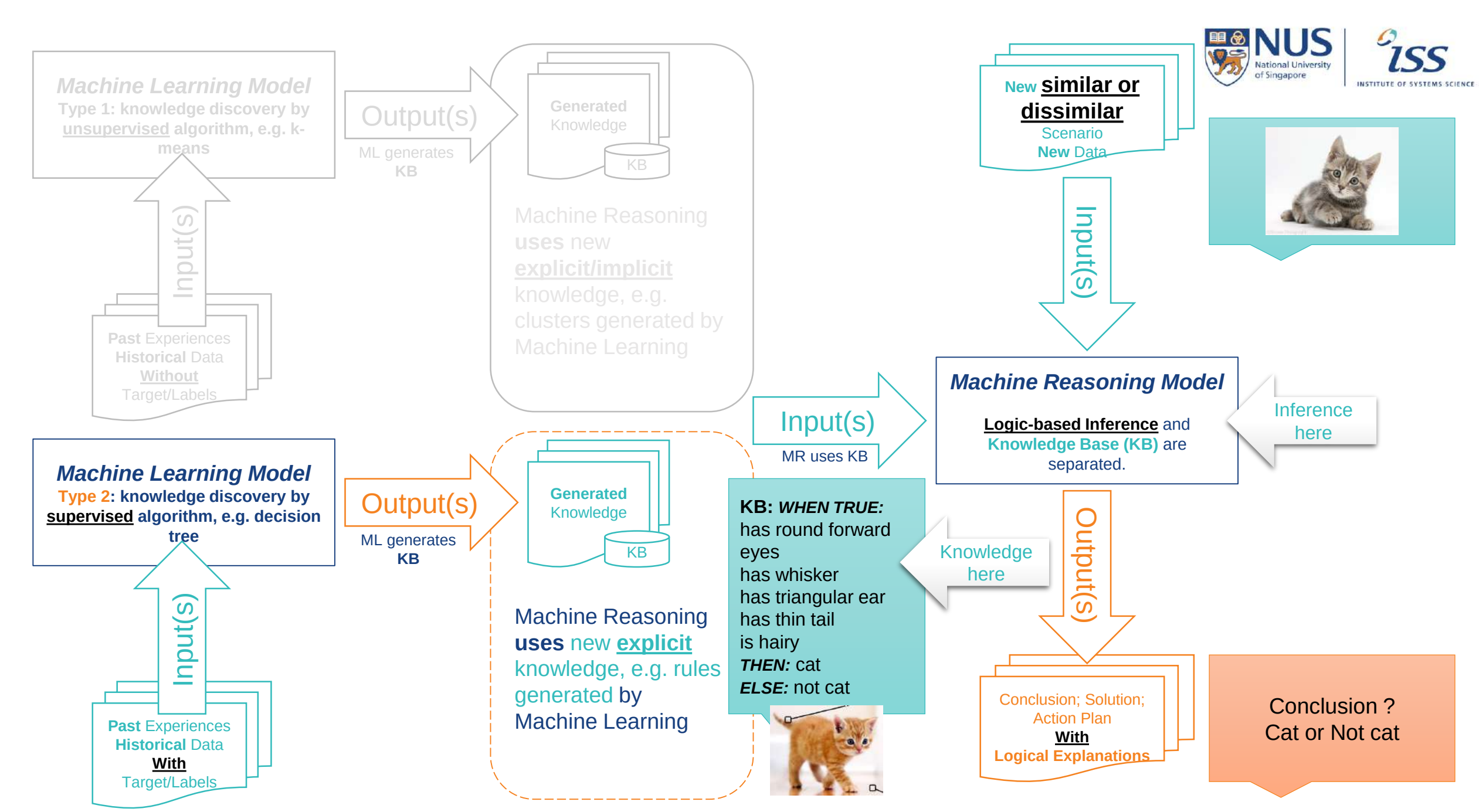


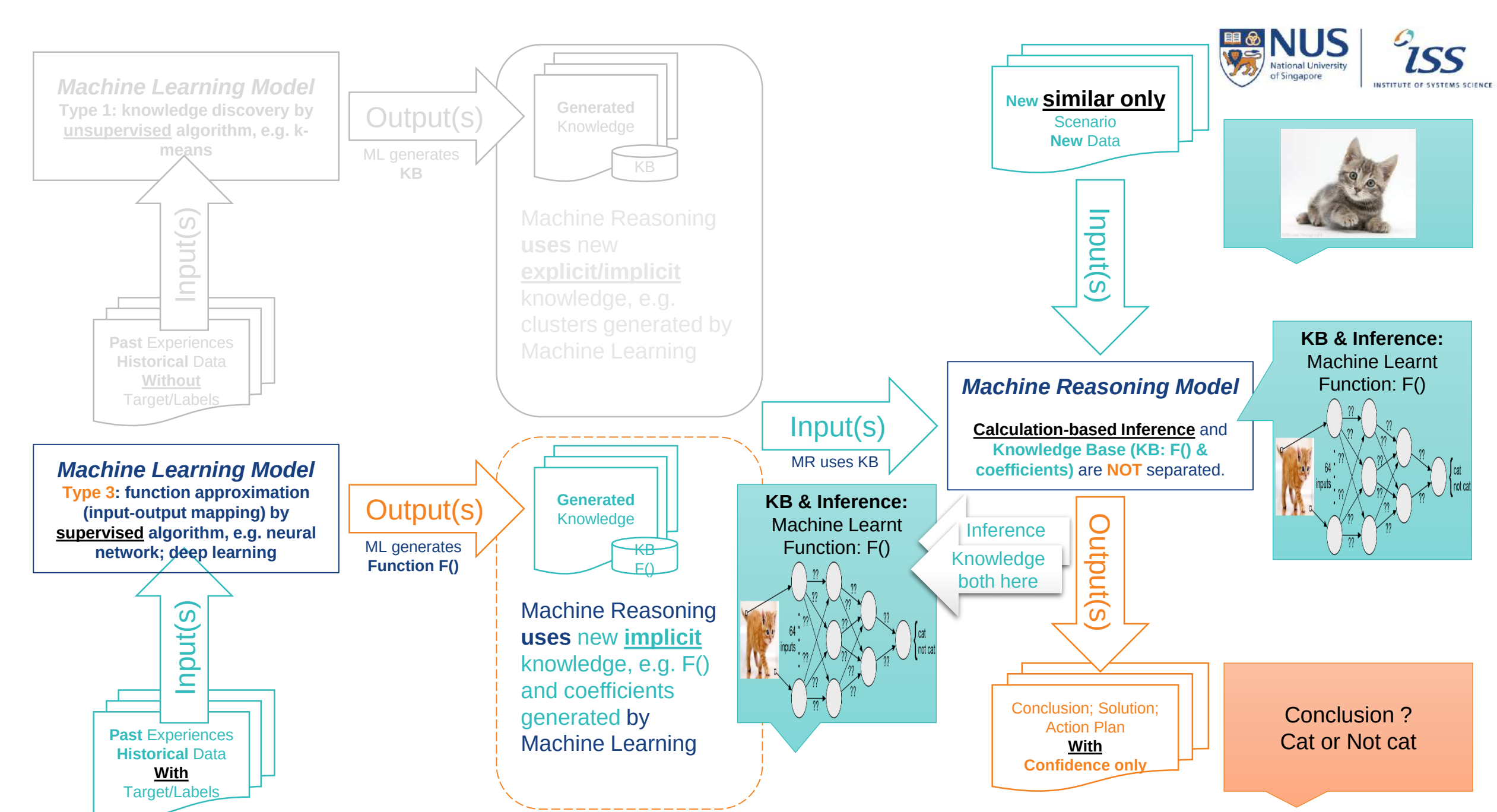
What's a (learning + reasoning) "model"?







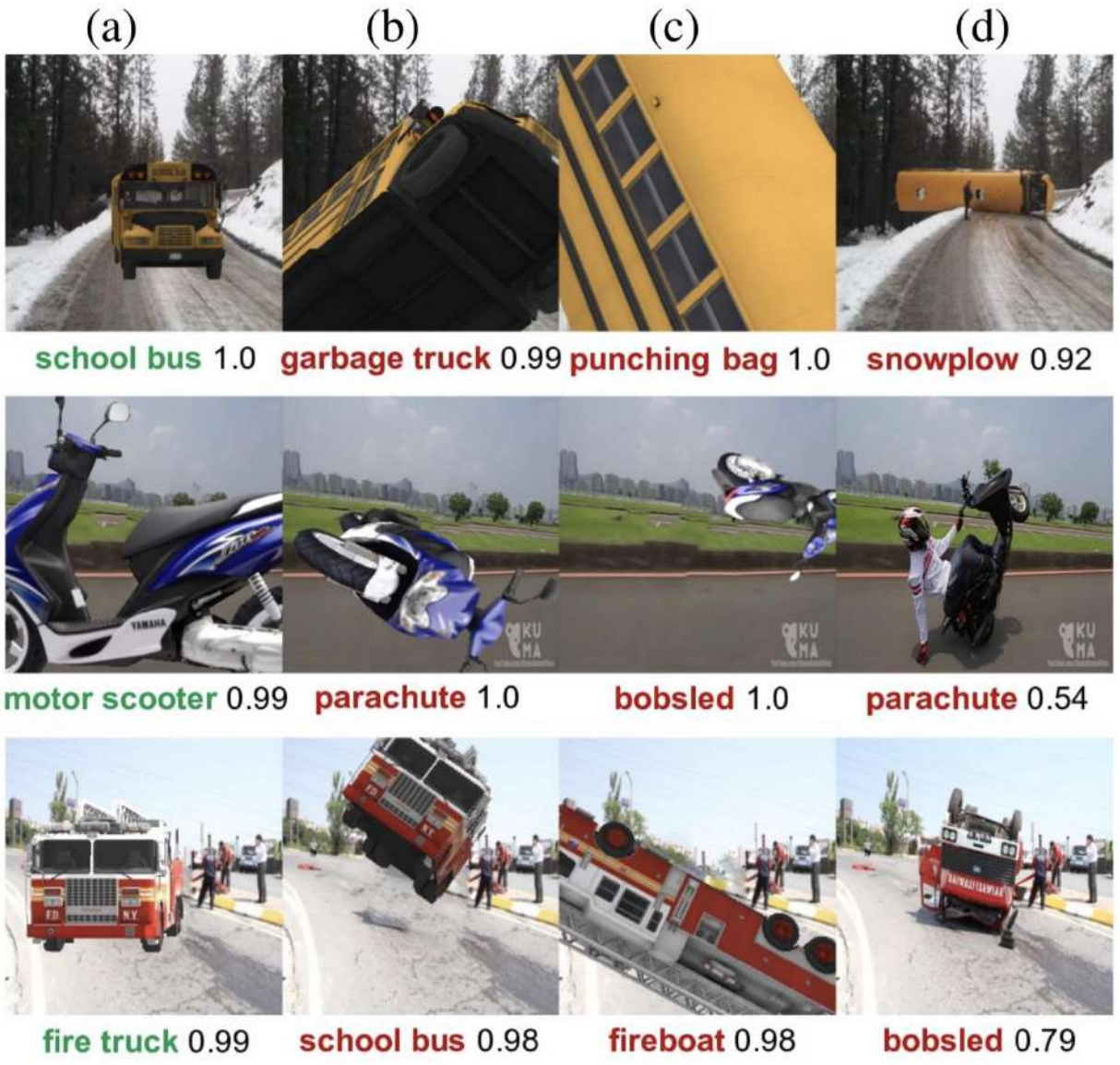




The Deepest Problem with Deep Learning (Type 3 ML model)

Gary Marcus

https://medium.com/@GaryMarcus/the-deepest-problem-with-deep-learning-91c5991f5695



What does a Strong AI look like?

An AI who can answer **the Ultimate Question of Life, the Universe, and Everything!**

What's the answer to the ultimate question of life, the universe and everything?

question

AI Model

Artificial General Intelligence (AGI)

answer

?

Source https://en.wikipedia.org/wiki/The_Hitchhiker%27s_Guide_to_the_Galaxy

A Strong AI may fail in exam?!

Example of bad exam answer: black box crystal ball

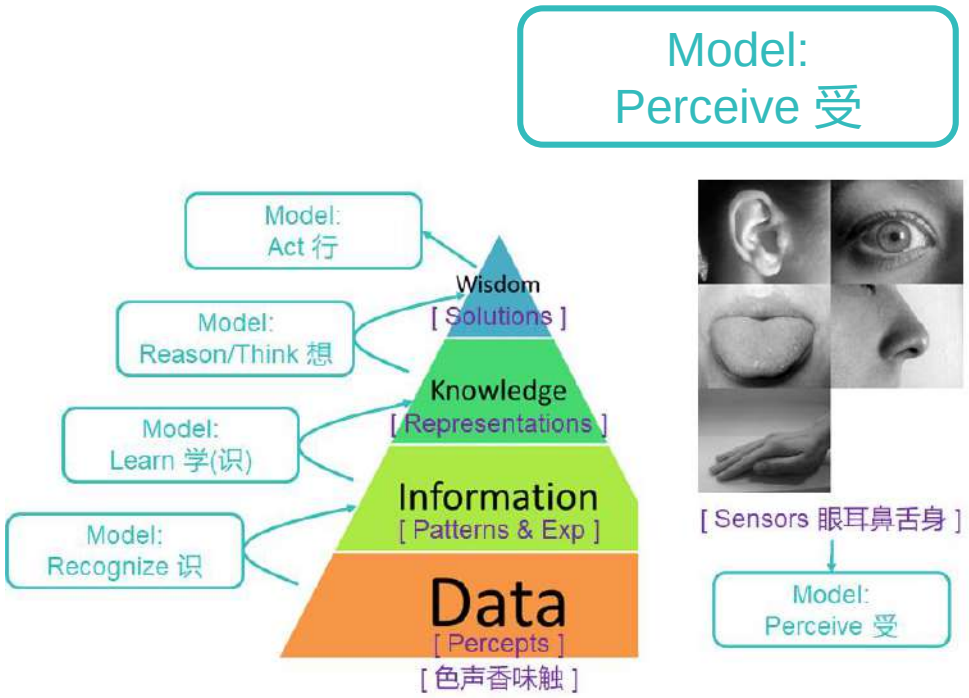
Any Exam Questions

This blue bounding box called model

Solution Answers: Use xxx “AI ML model”

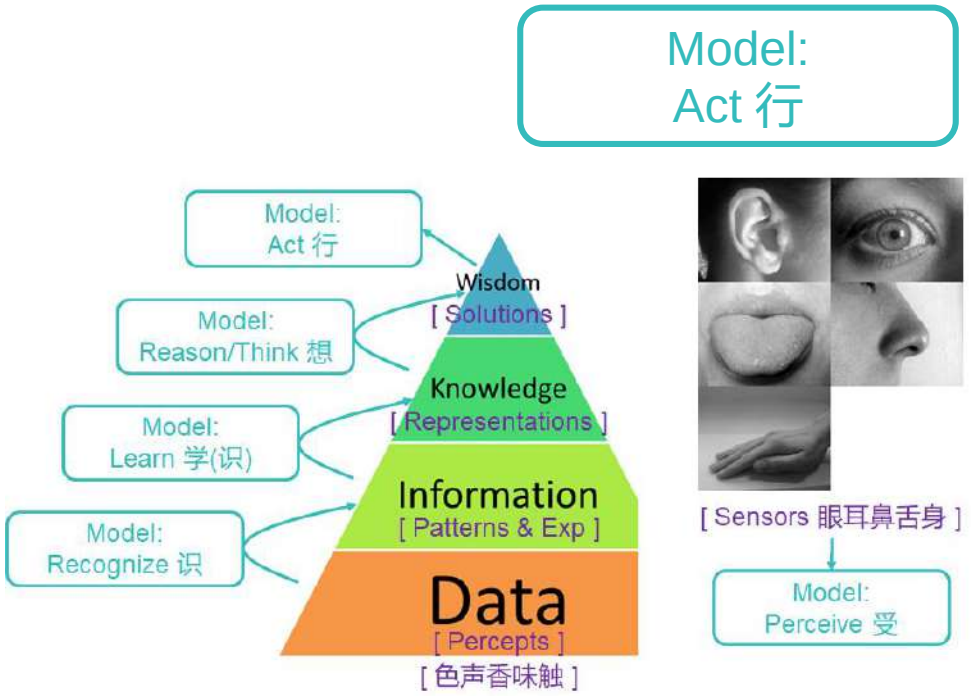
A “model” view of “perceiving”

[skipped – use your analogical reasoning]



A “model” view of “acting”

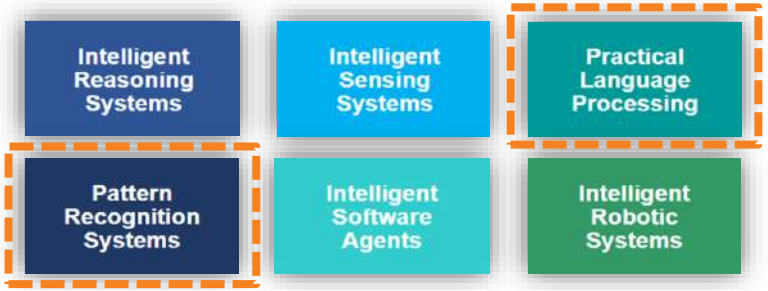
[skipped – use your analogical reasoning]



From Human Learning
To Machine Learning

Model:
Recognize 识

Model:
Learn 学(识)



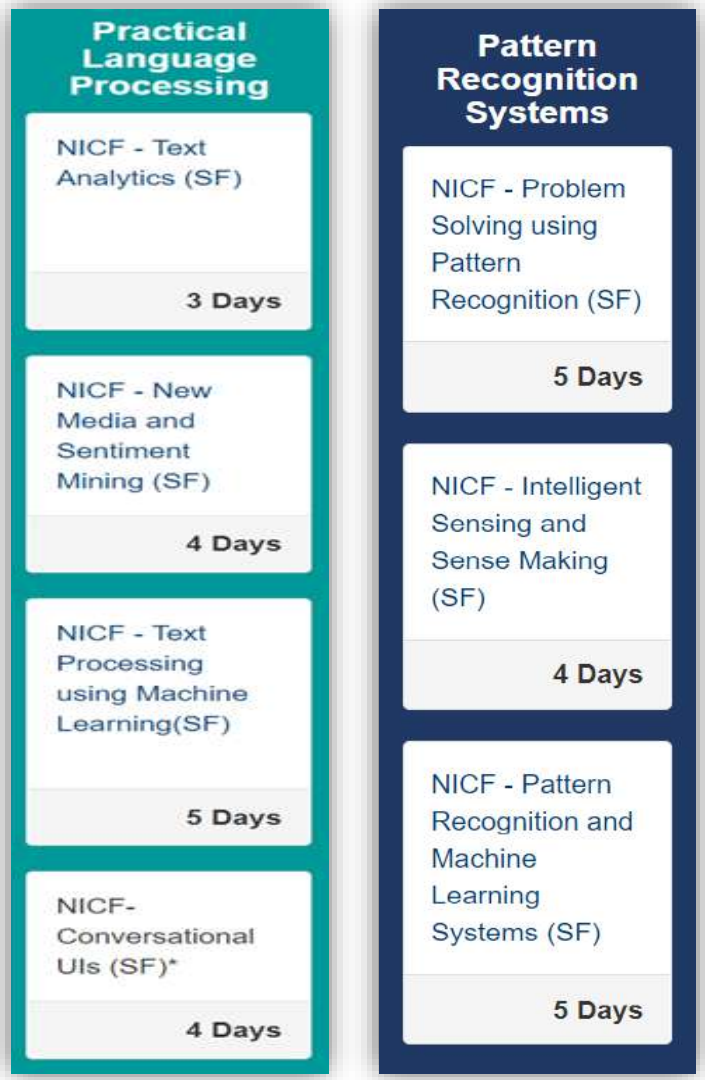
Human Learning → Machine Learning

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)



Source https://www.iss.nus.edu.sg/stackable-certificate-programmes/Intelligent-systems

From Human Reasoning
To Machine Reasoning

Model:
Reason/Think 想

Human Reasoning → Machine Reasoning

Intelligent Reasoning Systems

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

Source https://www.iss.nus.edu.sg/stackable-certificate-programmes/Intelligent-systems

From Human Perception
To Machine Perception

Model:
Perceive 受

Human Perception → Machine Perception

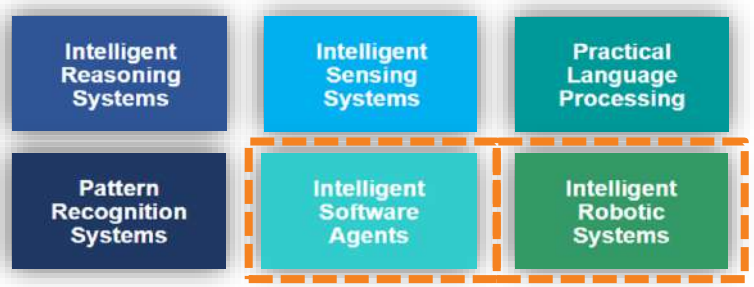
Intelligent Sensing Systems

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

Source https://www.iss.nus.edu.sg/stackable-certificate-programmes/Intelligent-systems

From Human Action
To Machine Action

Model:
Act 行



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

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

Source https://www.iss.nus.edu.sg/stackable-certificate-programmes/Intelligent-systems

Stack Up to a Master of Technology in Intelligent Systems

Participants who wish to continue their learning journey towards the **Master of Technology in Intelligent Systems** degree will have to complete **2 mandatory certificates in the fundamental areas**, **any 2 of 4 certificates in the specialist areas** as well as a **capstone project in Artificial Intelligence**.

Capstone Project in Intelligent Systems (6 – 12 months)

Participants will gain in-depth experience and also demonstrate ability by applying Artificial Intelligence techniques to build systems that make intelligent decision based on diverse data and sensory inputs. degree.

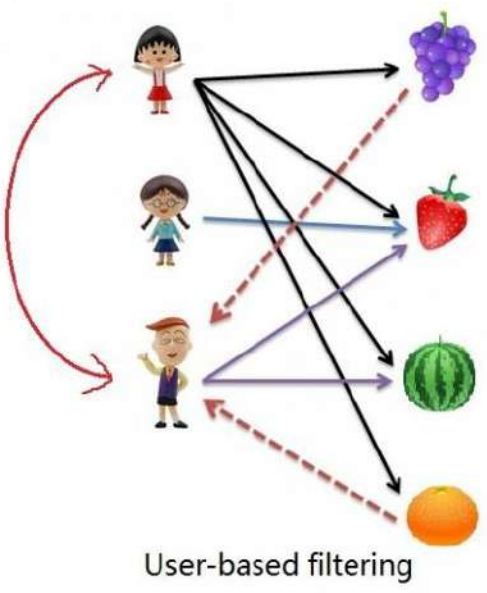
4 Certificates Courses

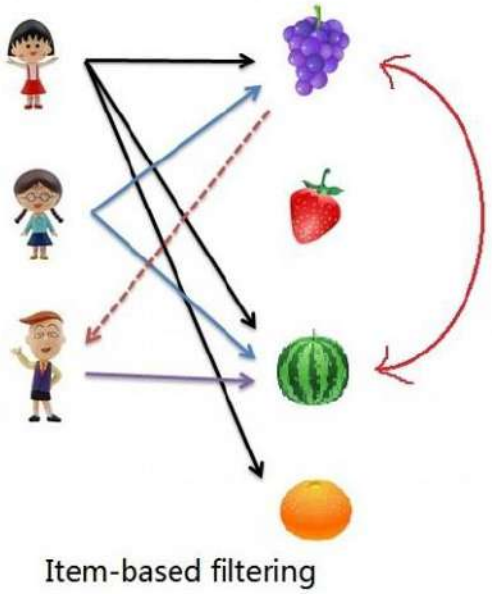
+

Capstone Project

=

NUS Master Degree


User-based filtering


Item-based filtering

Source https://medium.com/@cfpinela/recommender-systems-user-based-and-item-based-collaborative-filtering-5d5f375a127f

Analytics Project Management and Delivery	Core Analytics Techniques	Customer Analytics	Big Data Processing	Practical Language Processing	Advanced Predictive Modelling Techniques
NICF - Data Analytics Process and Best Practice (SF) – 3 Days	NICF - Statistics Bootcamp (SF) – 5 Days	NICF - Customer Analytics (SF) – 3 Days	NICF - Feature Engineering & Analytics using IOT Data (SF) – 3 Days	NICF - Text Analytics (SF) – 3 Days	NICF - Service Analytics (SF) – 3 Days
NICF - Data Storytelling (SF) – 3 Days	NICF - Data Analytics Process and Best Practice (SF) – 3 Days	NICF - Advanced Customer Analytics (SF) – 3 Days	Graph & Web Mining* – 3 Days	NICF - New Media and Sentiment Mining (SF) – 4 Days	Complex Predictive Modeling & Forecasting* – 5 Days
NICF - Data Governance & Protection (SF) – 3 Days	NICF - Predictive Analytics – Insights of Trends and Irregularities (SF) – 5 Days	NICF - Campaign Analytics (SF) – 3 Days	NICF - Big Data Engineering for Analytics (SF) – 5 Days	NICF- Text Processing using Machine Learning (SF) – 5 Days	NICF - Health Analytics (SF) – 3 Days
NICF - Managing Business Analytics Projects (SF) – 3 Days	NICF - Text Analytics (SF) – 3 Days			NICF- Conversational UIs (SF)* – 4 Days	
	NICF - Recommender Systems (SF) – 3 Days				

Data Science
Business Analytics

https://www.iss.nus.edu.sg/stackable-certificate-programmes/business-analytics

https://www.iss.nus.edu.sg/executive-education/discipline/detail/data-science

Data Science: **(analytics, data visualization, forecasting, predictive modelling, data mining, machine learning, business insights dashboarding…)**

The application of Artificial Intelligence techniques, e.g. data mining & knowledge discovery, **for business**

Artificial Intelligence: (philosophy, cognitive science, psychology, mathematics, economics, computer science, software engineering, mechanical engineering…)

The approximation and augmentation to Human Intelligence

Caveat of term "model"

Because of some model's black-box nature, the word "model" is also commonly used by a pundit (can be read as: lecturer) **as a "filler word" when things cannot be explained clearly or intuitively…**

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End of Lecture Notes