

# Remote Sensing - Advanced Methods

## AI4E0 Hackathon

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# Agenda

- 1.Introduction
- 2.Meet the data
- 3.Machine learning
- 4.Deep learning
- 5.Open problems
- 6.Challenge

## What is artificial intelligence?

It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.

John McCarthy, 2007

# AI >> ML > DL

Artificial Intelligence  
*Mimicking human intelligence*

NLP

Speech

Vision

Expert systems

Robotics

Optimization

Machine Learning

*The use and development of computer systems that are able to learn*

Deep Learning

*ML based on artificial neural networks that uses multiple layers to extract high-level features*

Biology

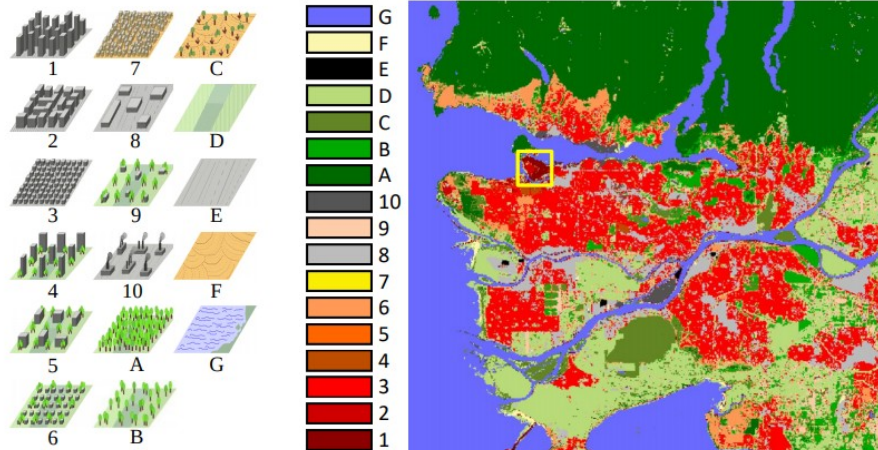
Psychology

# So2Sat LCZ42

17 LCZ classes

10 urban

7 natural



42 Cities

32 Train

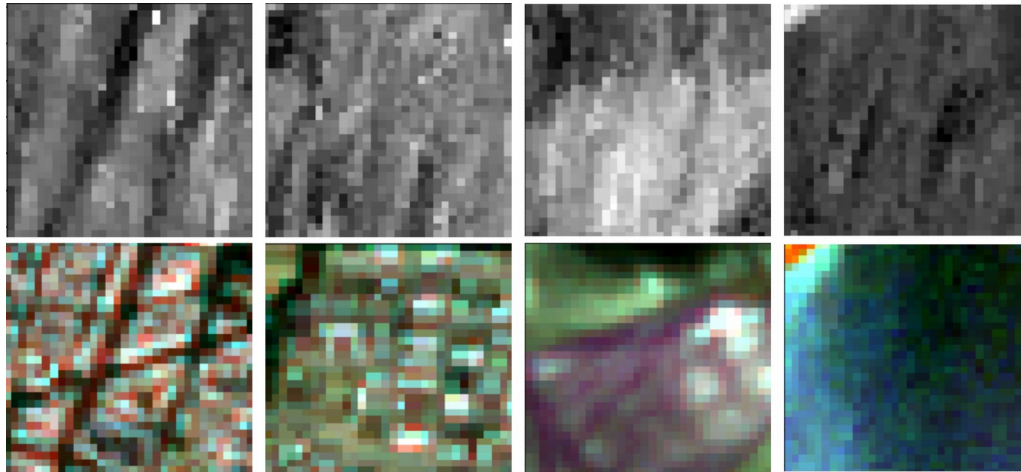
10 Test



Manually labeled by  
10 remote sensing experts

# So2Sat LCZ42 patches

32x32 pixels



2. Compact midrise

6. Open low-rise

14. Low plants

17. Water

Sentinel-1  
8 real-valued bands

Sentinel-2  
10 real-valued bands

17 one hot encoded classes

## 2.Meet the data

<https://github.com/acamero/rsam-lcz42-2021>

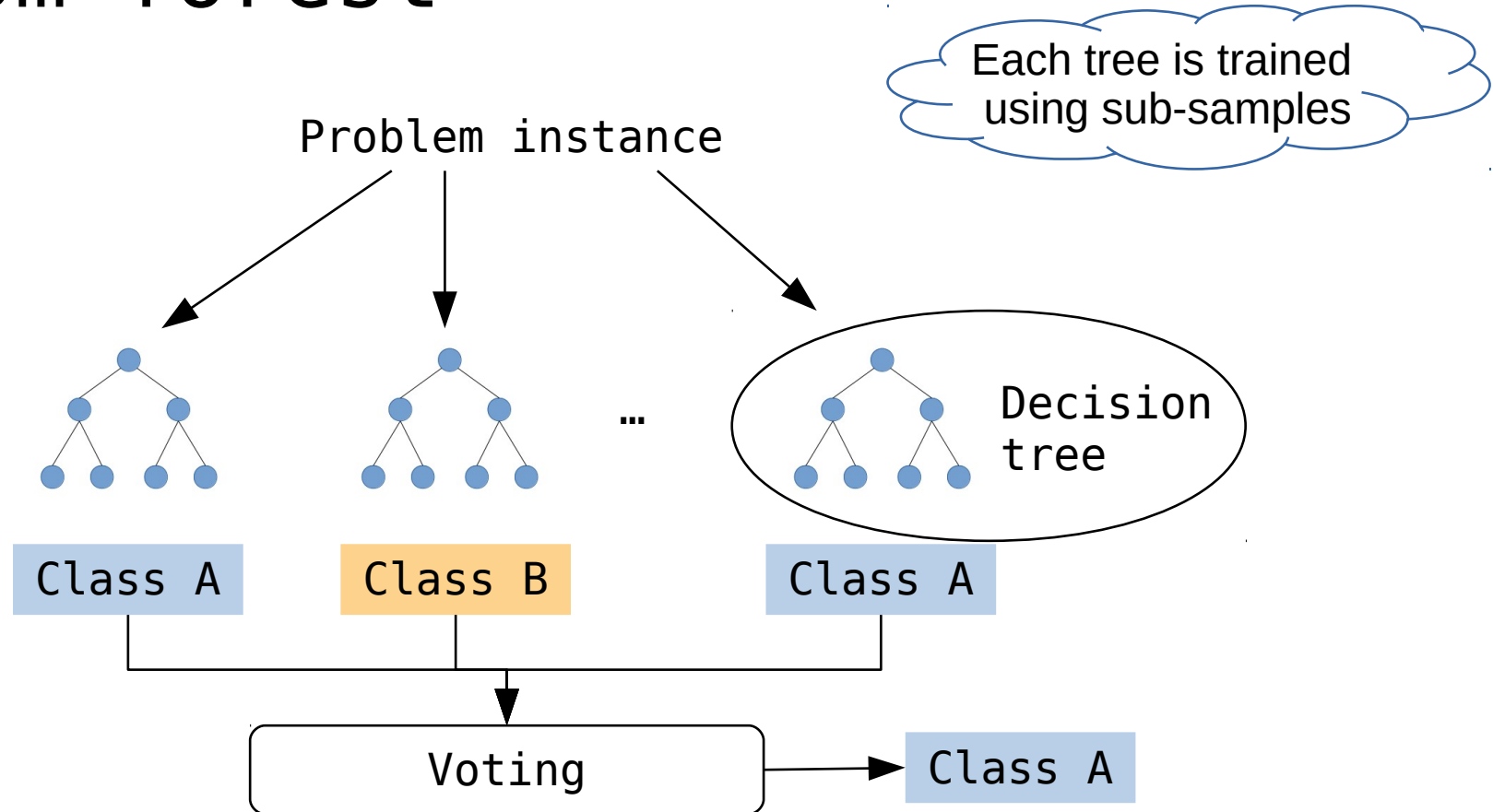
# Machine Learning

A computer program is said to learn from experience  $E$  with respect to some task  $T$  and some performance measure  $P$ , if its performance on  $T$ , as measured by  $P$ , improves with experience  $E$ .

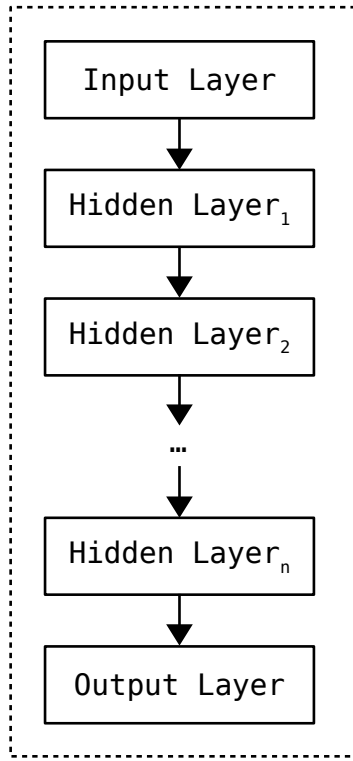
*Tom M. Mitchell, 1997*



## Random forest



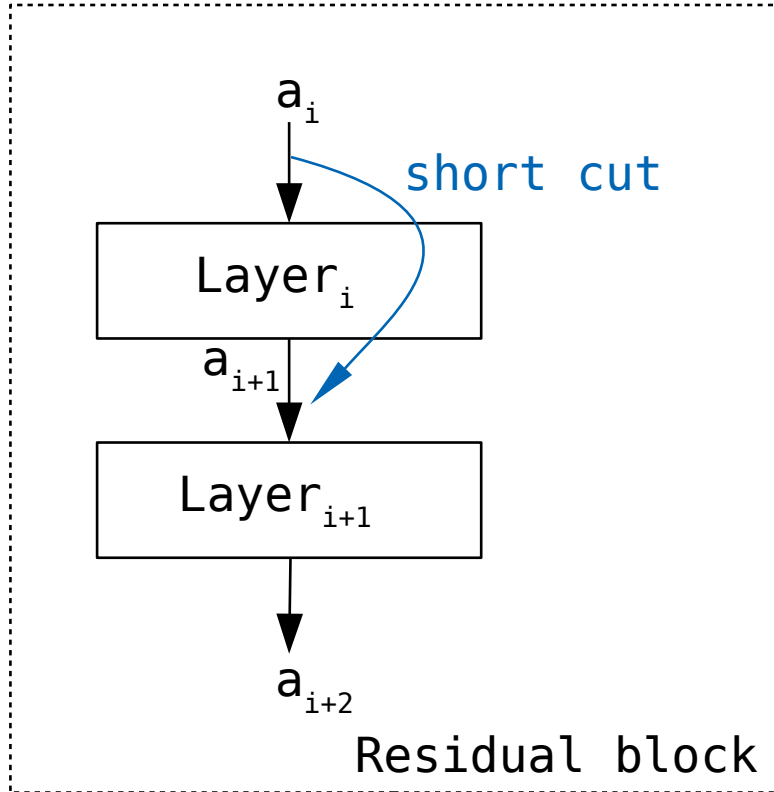
# Deep neural networks



Deep-learning methods are representation-learning methods with multiple levels of representation, obtained by composing simple but non-linear modules that each transform the representation at one level (starting with the raw input) into a representation at a higher, slightly more abstract level. With the composition of enough such transformations, very complex functions can be learned.

*Yann LeCun, Yoshua Bengio and Geoffrey Hinton, 2015*

# Residual block

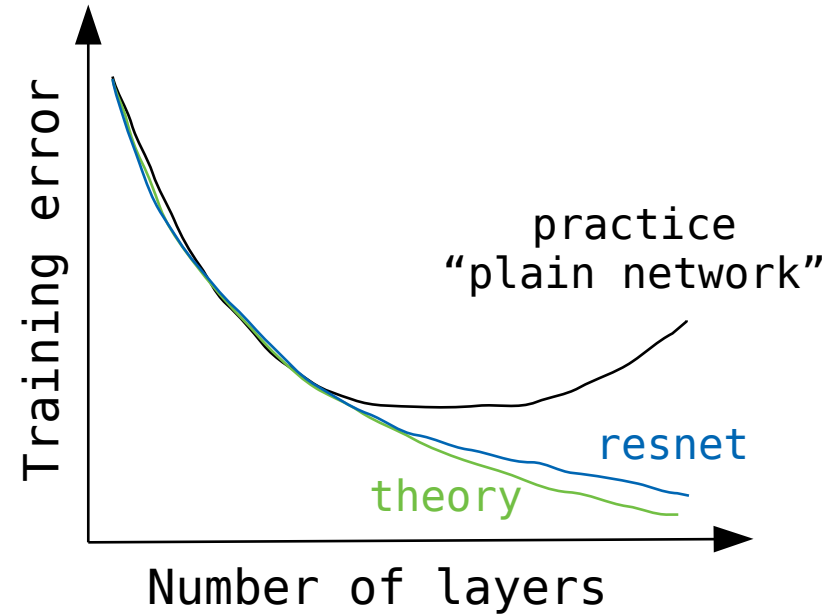
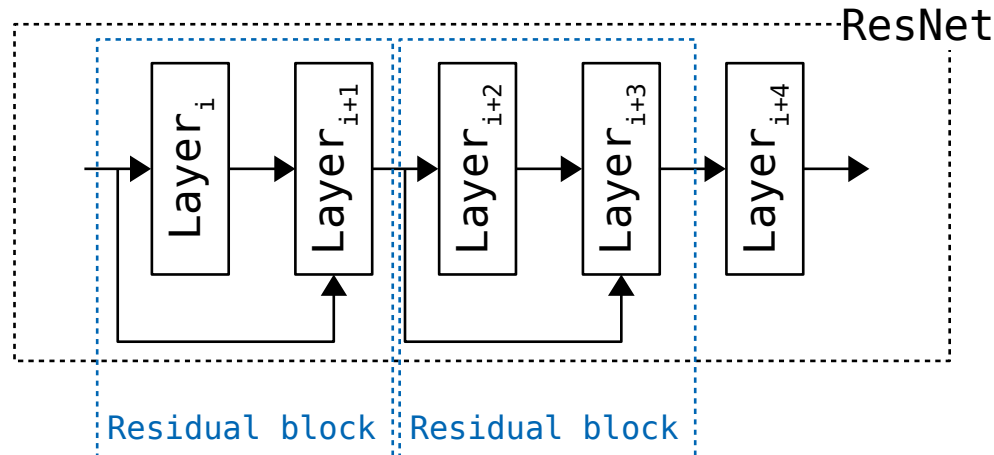
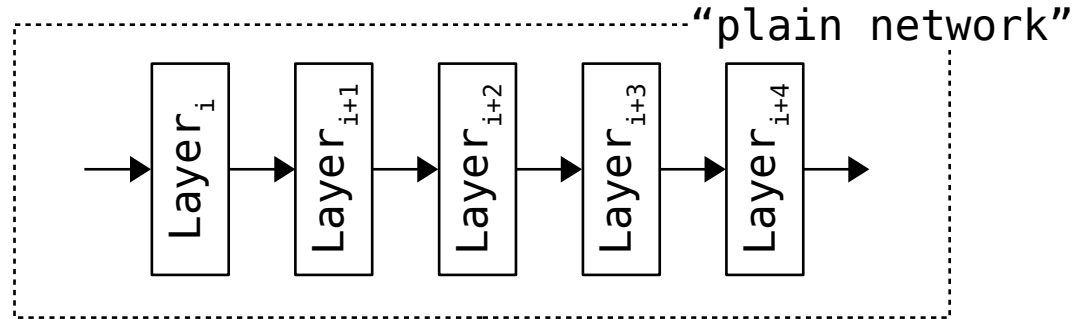


$$a_{i+1} = g(W_i \cdot a_i + b_i)$$

$$a_{i+2} = g(W_{i+1} \cdot a_{i+1} + b_{i+1}) \quad \text{"Plain network"}$$

$$a_{i+2} = g(W_{i+1} \cdot a_{i+1} + b_{i+1} + a_i) \quad \text{"Short cut"}$$

# Residual network: ResNet



# Remote sensing data is...

Multimodal

Geo-located

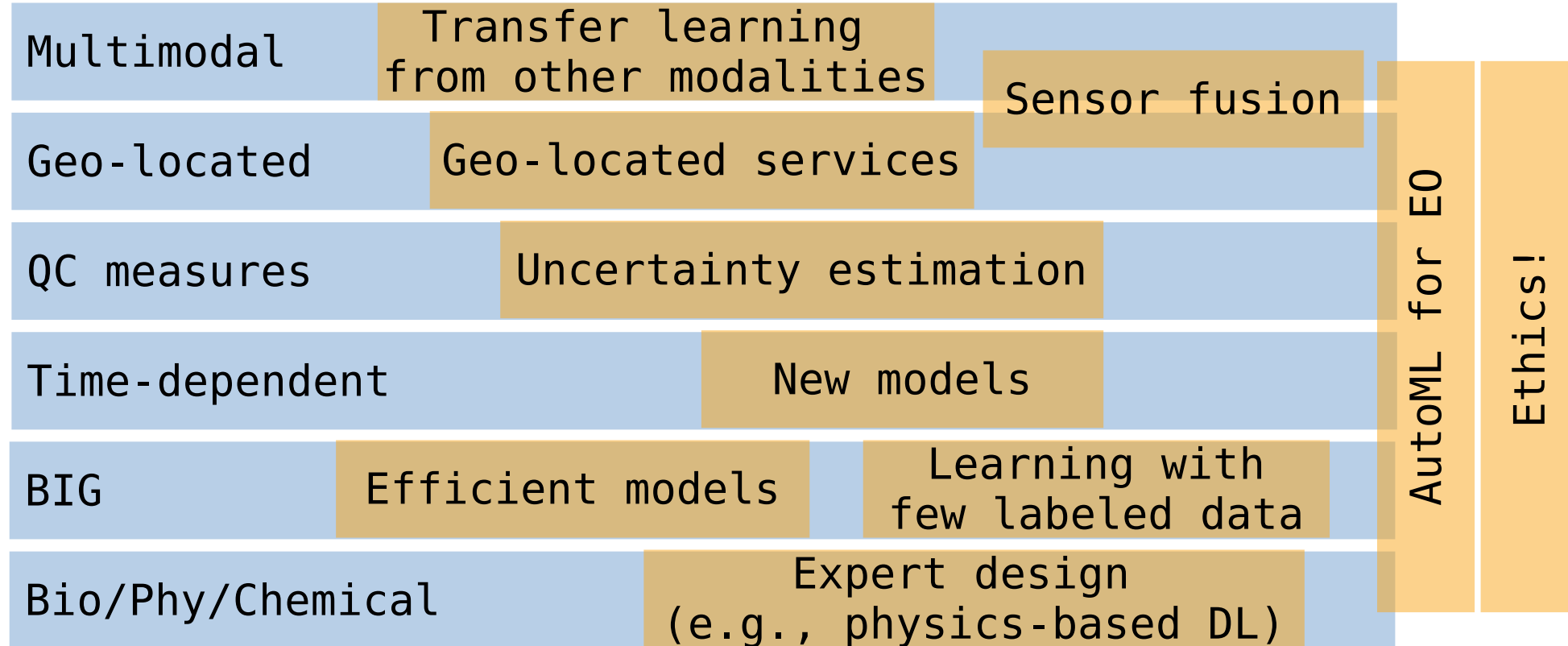
QC measures

Time-dependent

BIG

Bio/Phy/Chemical

# Thus, requires...



# Few labels

# References

1. He, K., Zhang, X., Ren, S. and Sun, J., 2016. Deep residual learning for image recognition. In Proceedings of the IEEE conference on computer vision and pattern recognition (CVPR) (pp. 770-778).
2. LeCun, Y., Bengio, Y. and Hinton, G., 2015. Deep learning. nature, 521(7553), pp.436-444.
3. McCarthy, J., 2007. What is artificial intelligence?
4. Mohri, M., Rostamizadeh, A. and Talwalkar, A., 2018. Foundations of machine learning. MIT press.
5. Zhu, X.X., Hu, J., Qiu, C., Shi, Y., Kang, J., Mou, L., Bagheri, H., Haberle, M., Hua, Y., Huang, R. and Hughes, L., 2020. So2Sat LCZ42: a benchmark data set for the classification of global local climate zones [Software and Data Sets]. IEEE Geoscience and Remote Sensing Magazine, 8(3), pp.76-89.
6. Zhu, X.X., Tuia, D., Mou, L., Xia, G.S., Zhang, L., Xu, F. and Fraundorfer, F., 2017. Deep learning in remote sensing: A comprehensive review and list of resources. IEEE Geoscience and Remote Sensing Magazine, 5(4), pp.8-36.