TECH DAYS 2021

Evolving Neural Networks

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TITANSOFT

Agenda

1. Evolving Neural Networks
2. A bit of History
3. Machine Learning (ML)
4. AutoML
5. AutoML: Neural Architecture Search (NAS)
6. Evolving Neural Architecture Search (NAS)
7. Recap
8. Tips for data practitioners in industry

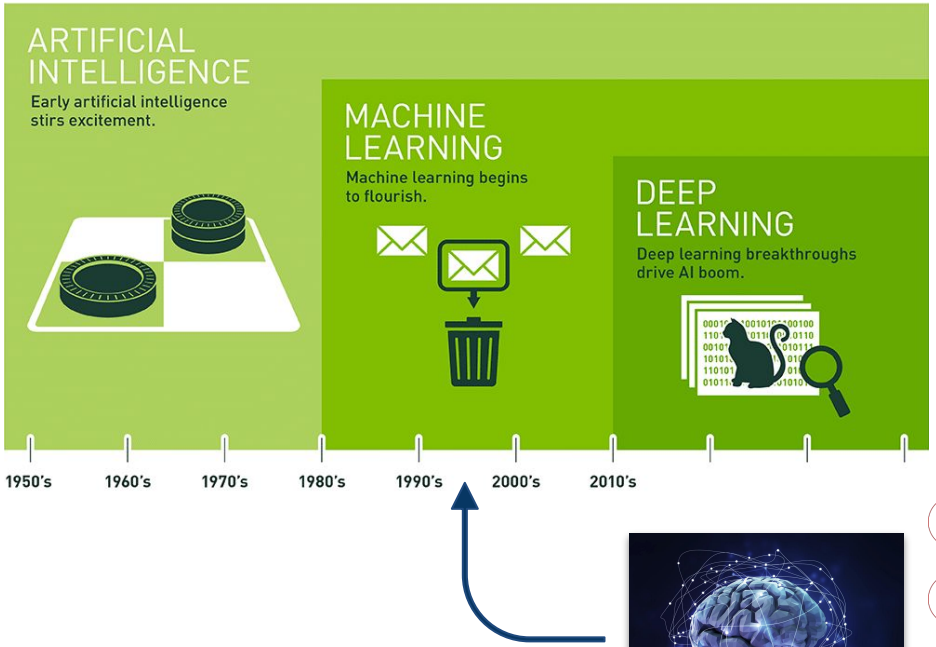
1. Evolving Neural Networks

Evolving Neural Networks

- Artificial Intelligence?
- Machine Learning?
- Dystopian society?

2. A bit of History

A bit of History



1. **A.I.**

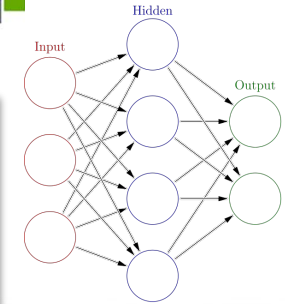
Engineering of making Intelligent Machines and Programs

2. **M.L.**

Ability to learn without being explicitly programmed

3. **D.L.**

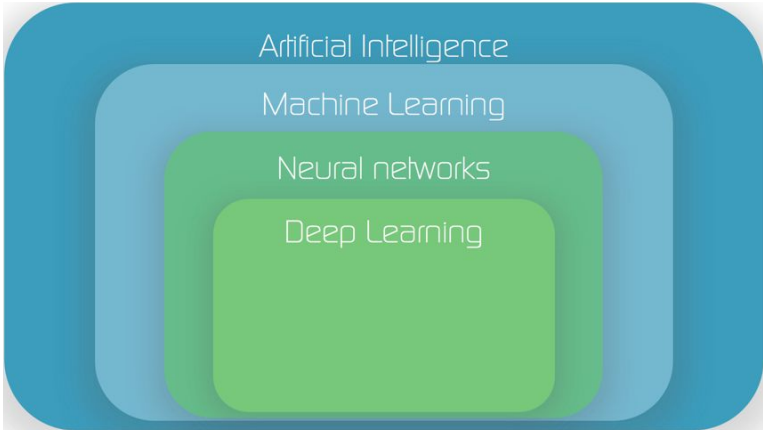
Learning based on Deep Neural Networks



3. Machine Learning (ML)

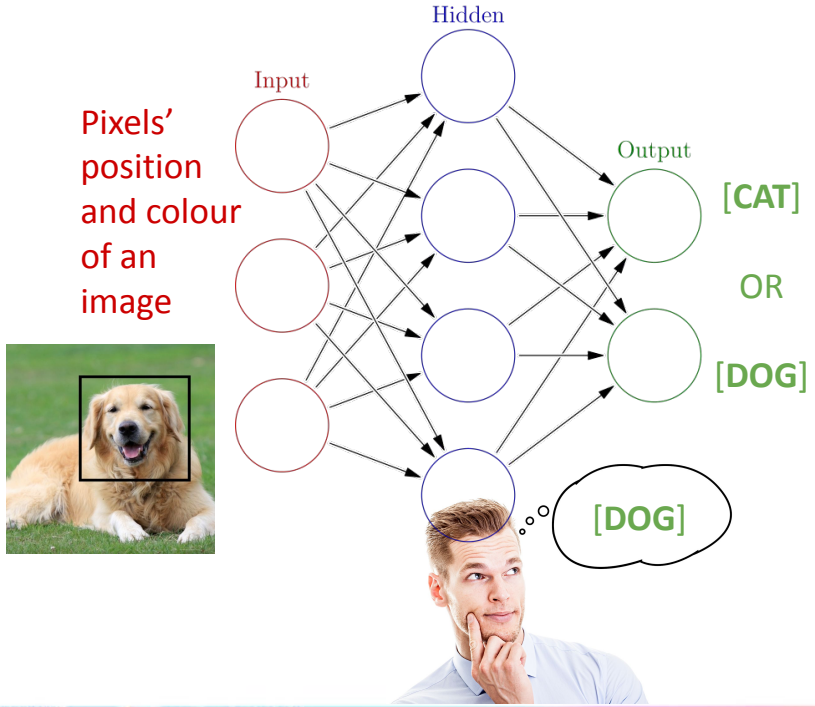
Machine Learning (ML): Neural Networks

- *"A neural network is a series of algorithms that aims to recognize underlying relationships in a set of data through a process that mimics the way the human brain operates"*



Machine Learning (ML): Neural Networks

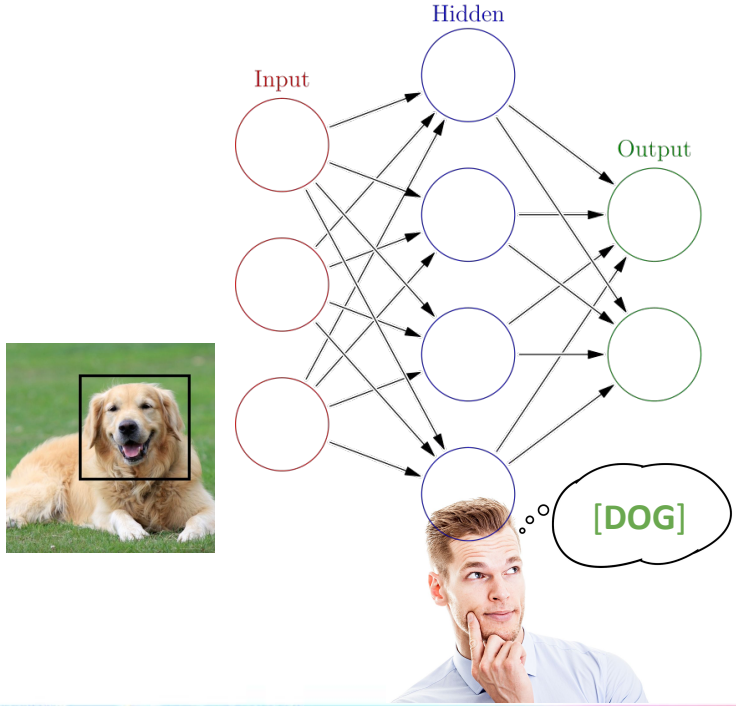
- *"A neural network is a series of algorithms that aims to recognize underlying relationships in a set of data through a process that mimics the way the human brain operates"*
- Ability to learn without being explicitly programmed
- Providing millions of data samples



How will ML and NN evolve?

What is the future of ML and NN?
How can they evolve?

*"The biggest lesson that can be read from 70 years of AI research is that **general methods that leverage computation** are ultimately the most effective, and by a large margin" - Rich Sutton*



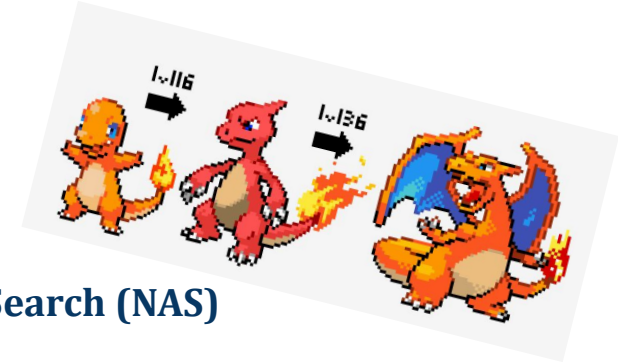
4. AutoML

AutoML vs ML

- **Automated ML** is the process of automating the tasks of applying machine learning to real-world problems.
- AutoML allows non-experts to make use of machine learning models and techniques.
- Advantages: simpler and faster solutions, models that often outperform hand-designed models.

Evolving {insert fancy term}

- **AI** 
  - **ML (and Neural Networks)**
    - **AutoML: Neural Architecture Search (NAS)**
      - **AutoML evolution/future?**



5. AutoML: Neural Architecture Search (NAS)

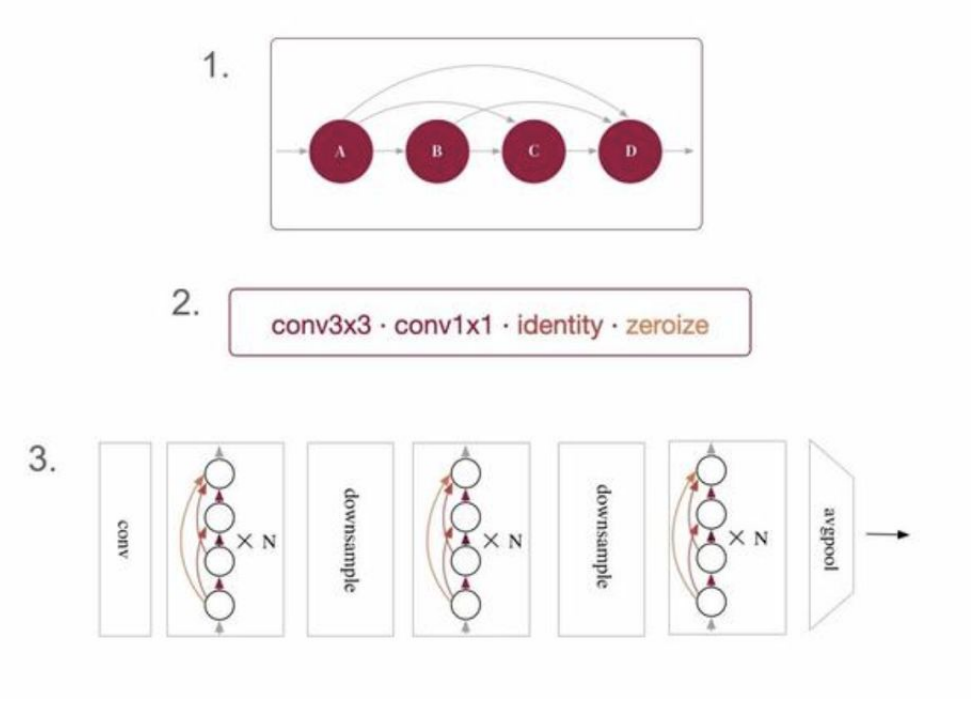
AutoML: Neural Architecture Search (NAS)

- **NAS** is a technique for automating the design of neural networks.
  - Designing architectures by hand is hard!
  - NAS lets us get good architecture design automatically
  - However, NAS algorithms can be extremely expensive to run

NAS spaces

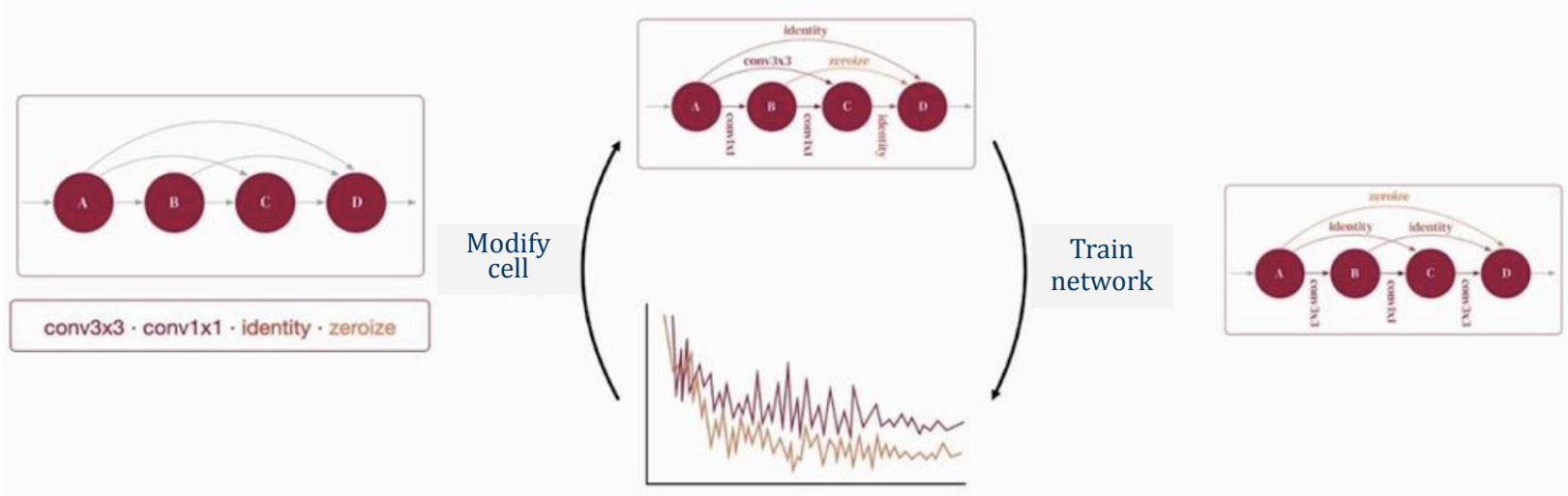
NAS spaces are composed of:

1. A cell structure
2. A list of possible operations
3. A network skeleton



NAS requires extensive training

1. Define cell space
2. Generate architectures and train them
3. Output the best found

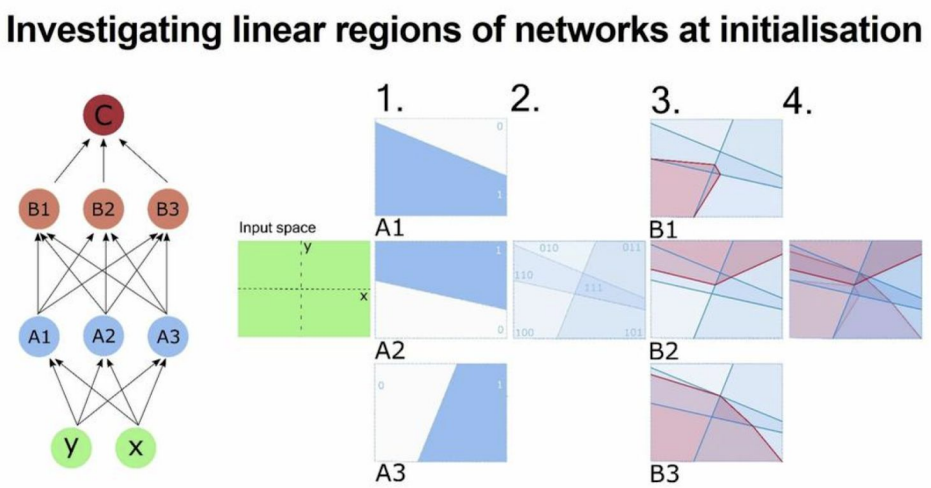


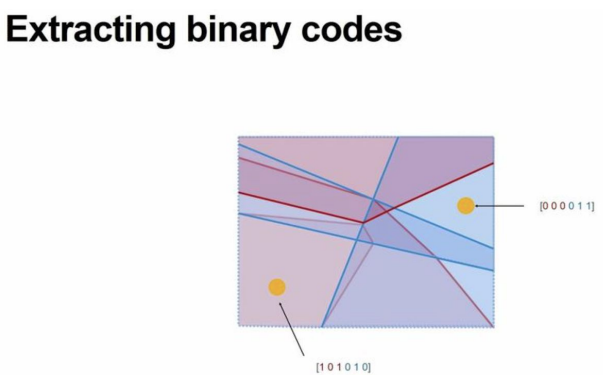
This is very expensive

6. Evolving Neural Architecture Search (NAS)

Evolving NAS

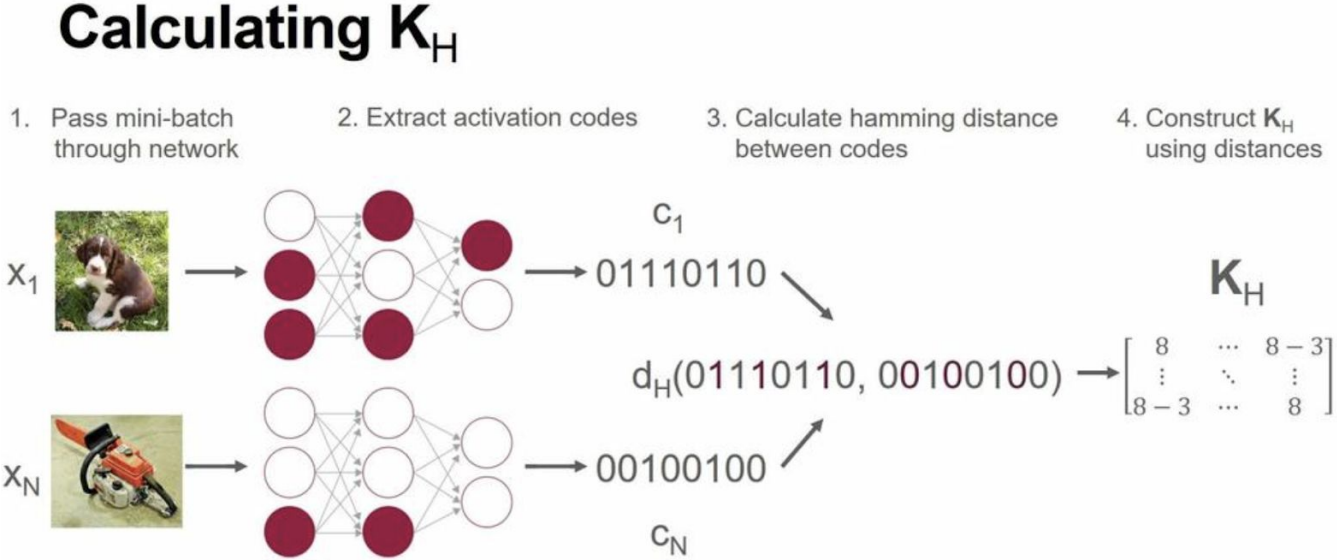
Neural Architecture Search without Training, Mellor et Al. (ICML 2021)





Evolving NAS

Neural Architecture Search without Training, Mellor et Al. (ICML 2021)

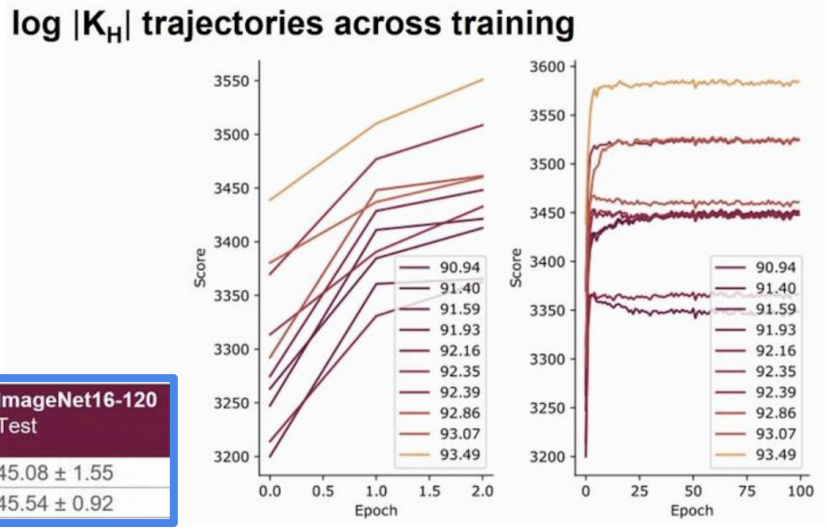


Evolving NAS

Neural Architecture Search without Training, Mellor et Al. (ICML 2021)

Algorithm:

1. Randomly sample N architectures from search space
2. Score using $\log|K_H|$, pick top scorer
3. Takes seconds, no training required!



Method	Search (s)	CIFAR-10 Test	CIFAR-100 Test	ImageNet16-120 Test
NASWOT(N=1000)	248.23	93.10 ± 0.31	69.10 ± 1.61	45.08 ± 1.55
REA	12000	93.22 ± 0.16	70.11 ± 0.61	45.54 ± 0.92

Evolving {insert fancy term}

AutoML vs ML: my two cents

- **Automated ML** is the process of automating the tasks of applying machine learning to real-world problems. ✅

- AutoML allows non-experts to make use of machine learning models and techniques. ❌

Who will do the data **pre-processing**, **feature engineering**, **extraction** and **selection**?

- Advantages: simpler and faster solutions, models that often outperform hand-designed models. ❌

- In practice, it requires a great effort to implement.
- Need vast resources (**time** and **computational power**)
- Does not guarantee better performance than hand-designed models.

AutoML vs ML: my two cents

81%

AUDIENCE SCORE

50,000+ Ratings

91%

AUDIENCE SCORE

250,000+ Ratings

7. Recap

Recap

1. Introduced AI, ML and Neural Networks
2. Compared AutoML to classic ML
3. Took a realistic approach to AutoML: Neural Architecture Search (NAS)
4. Evolving NAS: Neural Architecture Search without Training (paper)
5. Challenged the ideal vision of AutoML

If AutoML is not the only way to evolve ML, what can I do?

8. Tips for data practitioners in industry

Tips for data practitioners in industry

Tip 1: Datasets merging, labels with pseudo labels

- No practitioner would train their model on only one dataset - the more, the better.
- The pre-trained model might be a viable solution; yet it also raises concerns on system load and the latency of the model interference pass.
- Explicit dataset merging is the best solution an industry practitioner would want to adopt.

Tips for data practitioners in industry

Tip 2: Do dataset adjustment

- Data Supplement
  - Random selection at the beginning
  - Active selection with the current model to label
  - Least money, do the best
- Data Cleaning
  - Actively select data for review, re-label data
- Actively Select Method
  - Importance (by losses)
  - Uncertainty (by entropy)
  - Similarity (by distance)

  - **There are no fixed datasets in industry!**

References

- Evolving Deep Neural Networks (article)
- Automated Machine Learning (wiki)
- The Bitter Lesson (article)
- Neural Architecture Search without Training (ICML 2021, paper)
- Do we need AutoML… or AutoDM (Automated Data Management)? (article)
- The data centric research is currently lacking (ICML 2021, presentation)

Evolving Neural Networks

Thanks for listening