

# Advanced Topics in Artificial Intelligence & Machine Learning

## Learning Frameworks: Meta-Learning, Few-Shot Learning, Multi-Tasking, and Multi-Modality

Aleksandr Petiushko

ML Research

February 12th, 2024



# Content

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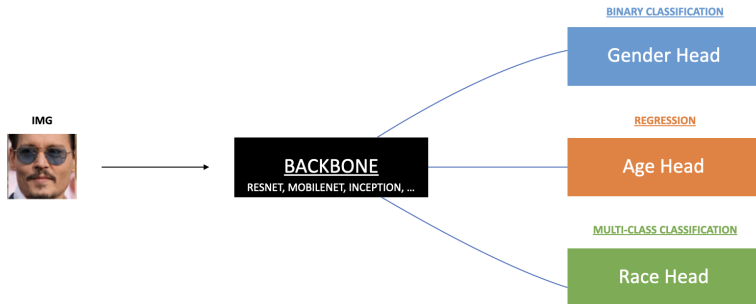
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- But sometimes:
  - ▶ Need to adapt quickly to the new task and small data
  - ▶ Need to solve multiple tasks in parallel by a single model
  - ▶ Need to work with completely different modalities
- Direction to tackle these problems: **Representation Learning**

# Multi-tasking

- How to solve different tasks by a single model, when we have enough training data?
- It can be done simultaneously: we train the same feature extractor (“*backbone*”) providing the common **representation** for all tasks with multiple heads on tops solving these tasks; multiple objectives (losses) are optimized in parallel
- Sometimes different tasks can help each other (in data-greedy regime)
- Read material: [link](#)



# Few-shot Learning and Meta-learning framework

- How to solve different tasks by a single model, when we don't have enough training data?
- Few-shot learning problem setting:
  - ▶ A lot of training data but classes are not the same as during inference
  - ▶ **N-way-K-shot classification** during the inference: we have a *support* set with  $N$  classes with  $K$  examples of each, and a *query* set of examples of unknown classes (which we need to infer)
- The framework for it is called **Meta-learning** (for any task description): e.g., in case of few-shot learning we just need to sample multiple times different support sets with different classes
- Read material: [link](#)

Training task 1

Support set



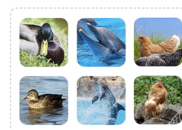
Training task 2 . . .

Support set



Test task 1 . . .

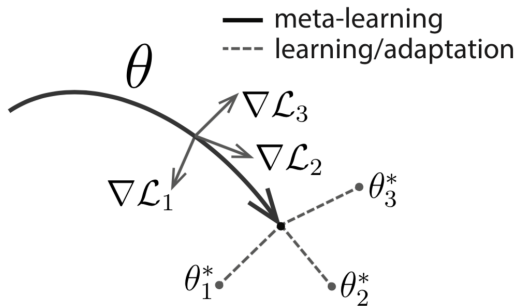
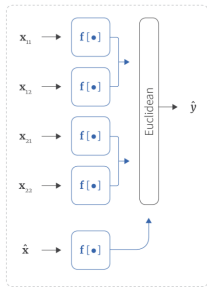
Support set



# Meta-learning

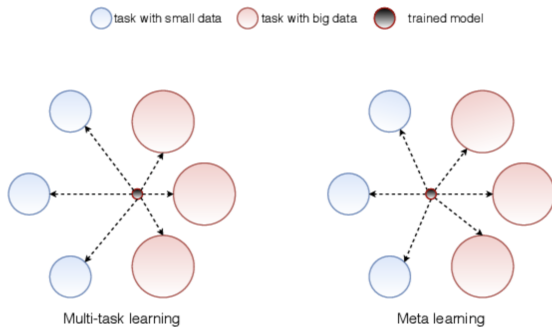
- The main approaches to tackle the meta-learning problem:
  - ▶ Metric Learning (e.g., by the Prototypical Networks): find the representation template for support set classes and calculate the 1-NN based on the Euclidean distance between query set representation
  - ▶ Gradient-based (e.g., by MAML): find the best NN weight initialization by averaging the gradients of losses (objectives) of multiple tasks
- Read material: [link](#)

b) Prototypical network



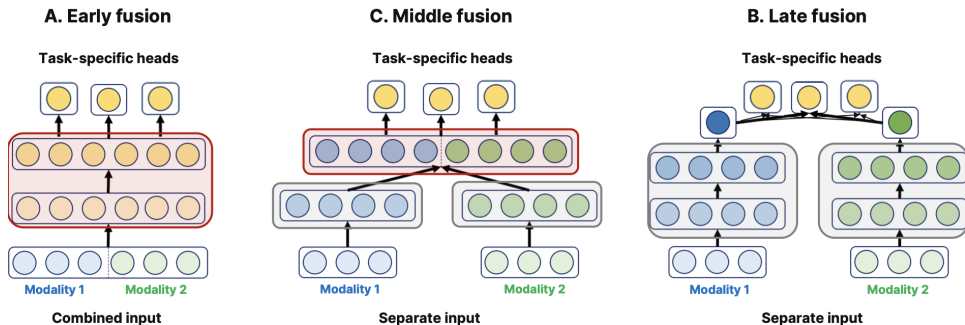
# Meta-learning vs Multi-tasking

- If multi-task learning is done sequentially, then we come to meta-learning
- If multi-task learning is done simultaneously, then we come to multi-tasking
- Read material: [link](#)



# Multi-modality

- It seems that incorporating different modalities (like human does: vision, hearing, flair, etc.) can improve the performance of an ML modal
- Two main modalities to combine now: text and images
- Techniques differ in the way where we fuse the modality: early or late fusion (remember: representation learning!)
- Read material: [link](#)





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- 1 Read all the mentioned links
- 2 Meta-Learning is one of the hardest setting in DL
- 3 We can solve multiple tasks in parallel (multi-tasking) or sequentially (meta-learning)
- 4 We can fuse multiple modalities in one Neural Net
- 5 A lot of approaches are based on the Representation Learning!

# Thank you!