AutoML: Neural Architecture Search (NAS)

Search Spaces

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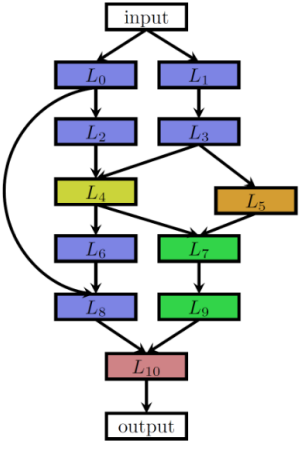
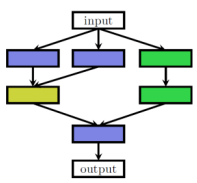
Basic Neural Architecture Search Spaces

Chain-structured space
(different colours:
different layer types)

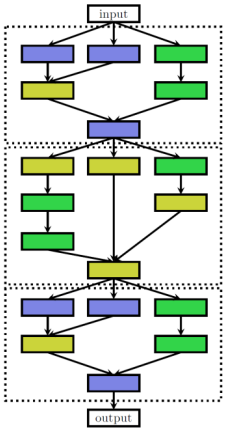


More complex space
with multiple branches
and skip connections

Cell Search Spaces [Zoph et al. 2018]



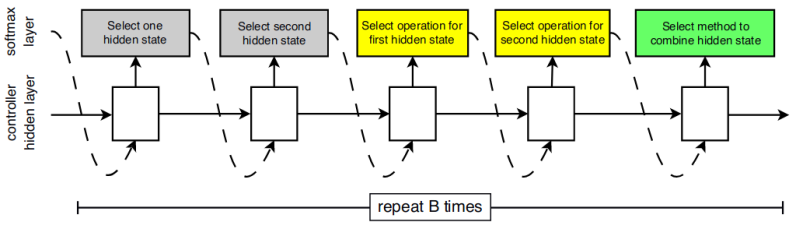
Two possible cells

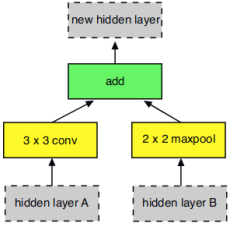


Architecture composed of stacking together individual cells

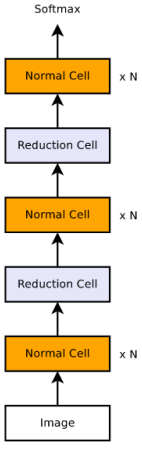
Details on Cell Search Spaces [Zoph et al. 2018]

- 2 types of cells: normal and reduction cells
- For each type of cell: B blocks, each with 5 choices
  - Choose two previous feature maps (from this cell)
  - For each of these, choose an operation (3×3 conv, max-pool, etc.)
  - Choose a merge operation to combine the two results (concat or add)

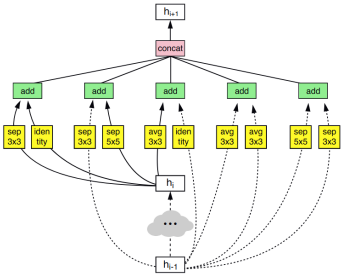




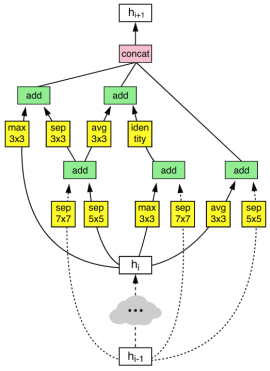
Example of an architecture sample with B=5



CIFAR10
Architecture



Normal Cell



Reduction Cell

Source: [Zoph et al. 2018]

Pros and Cons of Cell Search Space

What are some pros and cons of the cell search space compared to the basic one?

Please think about this for a few minutes before continuing.

Pros and Cons of Cell Search Space

Pros:

- Reduced search space size; speed-ups in terms of search time.
- Transferability to other datasets (e.g., cells found on CIFAR-10 transfer to ImageNet)
- Stacking repeating patterns is proven to be a useful design principle (ResNet, Inception, etc.)

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Cons:

- Still need to (manually) determine the *macro* architecture, i.e., the way in which cells are connected.
- Limiting if different cells work better in different parts of the network
  - E.g., different spatial resolutions may favour different convolutions

Hierarchical representation of search space [Liu et al. 2017]

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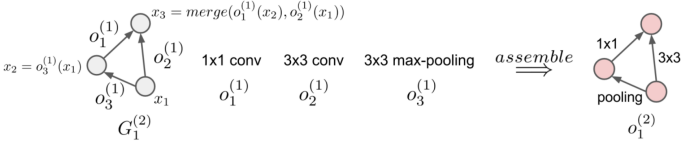

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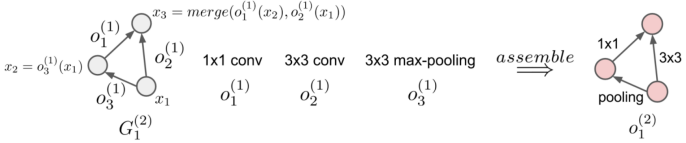
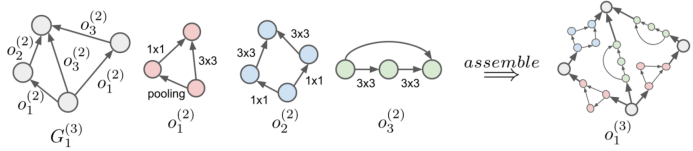


  - Level-3 motivs: combinations of level-2 motivs



Pros and Cons of Hierarchical Search Space

What are some pros and cons of a hierarchical search space compared to the cell search space?

Please think about this for a few minutes before continuing.

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Pros:

- Flexibility of constructing building blocks and reusing them many times
  - like a cell search space
- Flexibility of using different building blocks in different parts of the network
  - like a basic search space
- Ability to reuse building blocks at various levels of abstraction
  - again, this pattern has been used in manual design, e.g., in Inception nets

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Cons:

- Larger than cell search space
- Vastly more expressive than cell search space $\rightarrow$ potentially much harder to search

Questions to Answer for Yourself / Discuss with Friends

- Repetition:
  What are some pros and cons of the cell search space compared to the basic one?
- Repetition:
  Explain the way in which level-3 motivs in the hierarchical search space use level-2 motivs.
- Repetition:
  What are some pros and cons of the hierarchical search space compared to the other ones?