Automated Machine Learning

Making ML models accessible to users with little expertise

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Outline

- Learning Goals
- Introduction
- Automated Machine Learning (AutoML)
- Summary

Learning Goals

- Get an overview of the expanding field of AutoML

- Get familiar with AutoKeras (tutorial)

Jin, H., Song, Q. and Hu, X., 2019, July. Auto-keras: An efficient neural architecture search system. In *Proceedings of the 25th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining* (pp. 1946-1956).

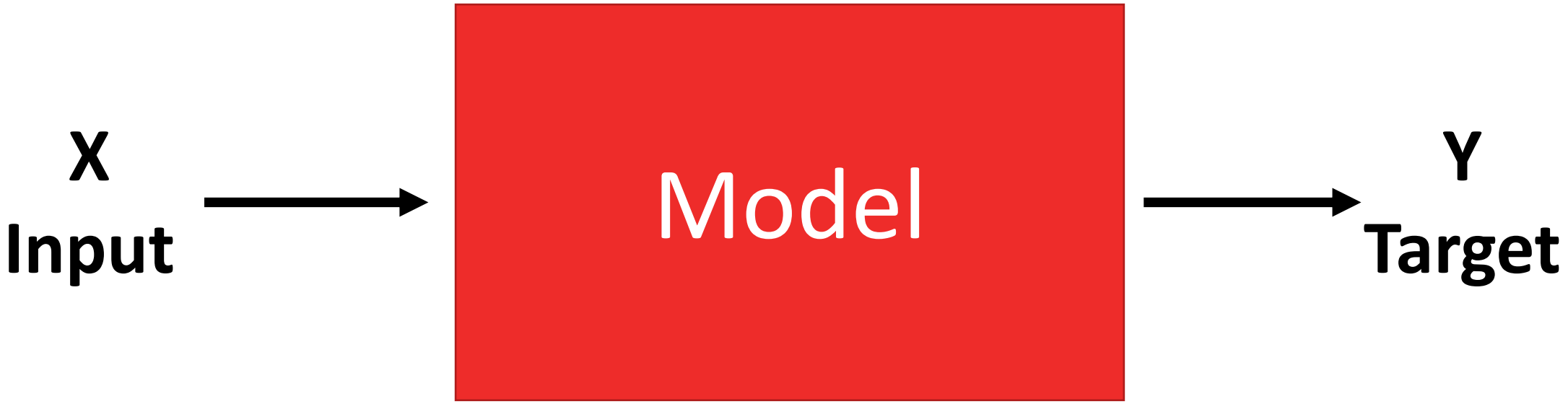
What is Machine Learning?

- **Algorithms to parse data, learn from it, and make determinations or predictions about something in the world**
- Build models by training with data
- Three aspects:
  - **Data** -> engineer or learn features? how to set the experiment?
  - **Model**-> which model is best? Many times arbitrary
  - **Cost function minimization** -> set model parameters

AutoML

- The goal of AutoML is to enable people with limited machine learning background knowledge to use machine learning models easily
  - Automatic model selection
  - Automatic hyperparameter tuning
  - Neural architecture search (NAS)

ML Model



- AutoML finds the best model for you
- Eliminates the need of ML expertise to develop and deploy ML models

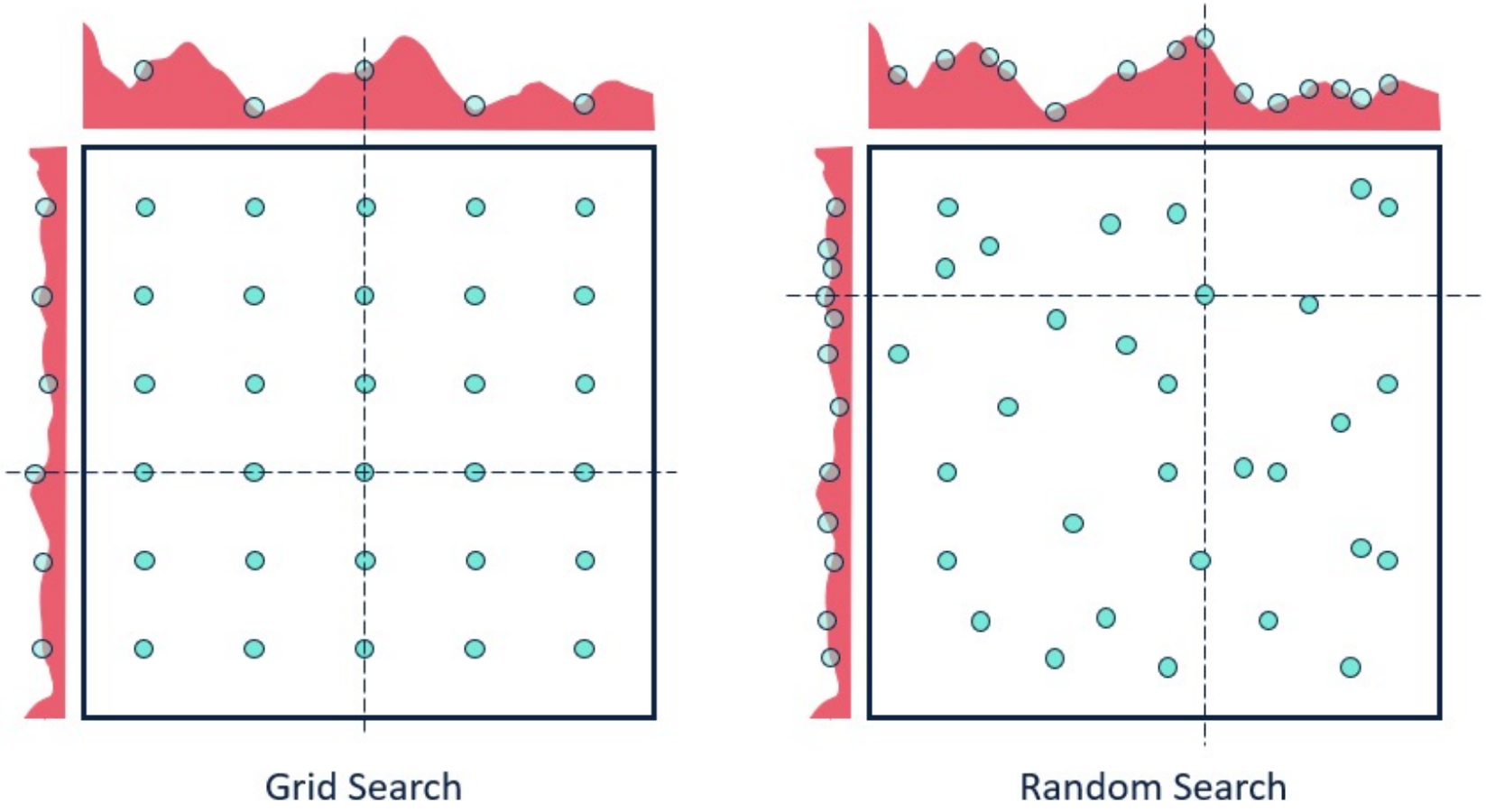
Grid-search – Tuning Hyper-Parameters

- Example: Polynomial fitting with regularization
- Hyper-parameters: Polynomial degree (θ), regularization (λ)
- $\theta = \{\theta_1, \theta_2, \dots, \theta_M\}$
- $\lambda = \{\lambda_1, \lambda_2, \dots, \lambda_K\}$
- Necessity to train $M \times K$ models
- Computationally expensive for models that have many hyper-parameters
- Does not consider the different importance's of the hyper-parameters

Random-search – Tuning Hyper-Parameters

- $\theta = [\theta_{min}, \theta_{max}]$
- $\lambda = [\lambda_{min}, \lambda_{max}]$
- The number of models to be trained, N, is pre-set. The hyper-parameters are randomly chosen within the intervals
- Also computationally expensive
- Good for exploring the hyper-parameter space

Grid-search and Random-search



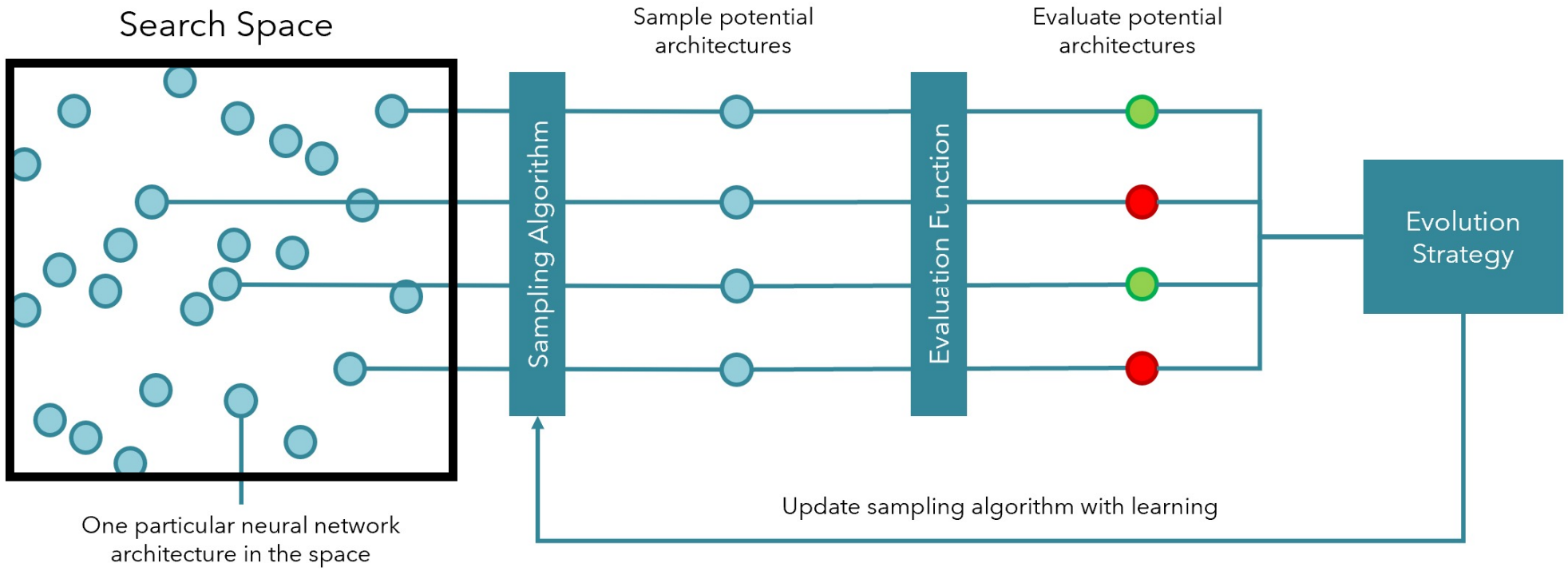
Neural Architecture Search (NAS)

- **Search space**: The NAS search space defines a set of operations (e.g. convolution, fully-connected, pooling) and how operations can be connected to form valid network architectures.

- **Search algorithm**: A NAS search algorithm samples a population of network architecture candidates. It receives the child model performance metrics as rewards and optimizes to generate high-performance architecture candidates.

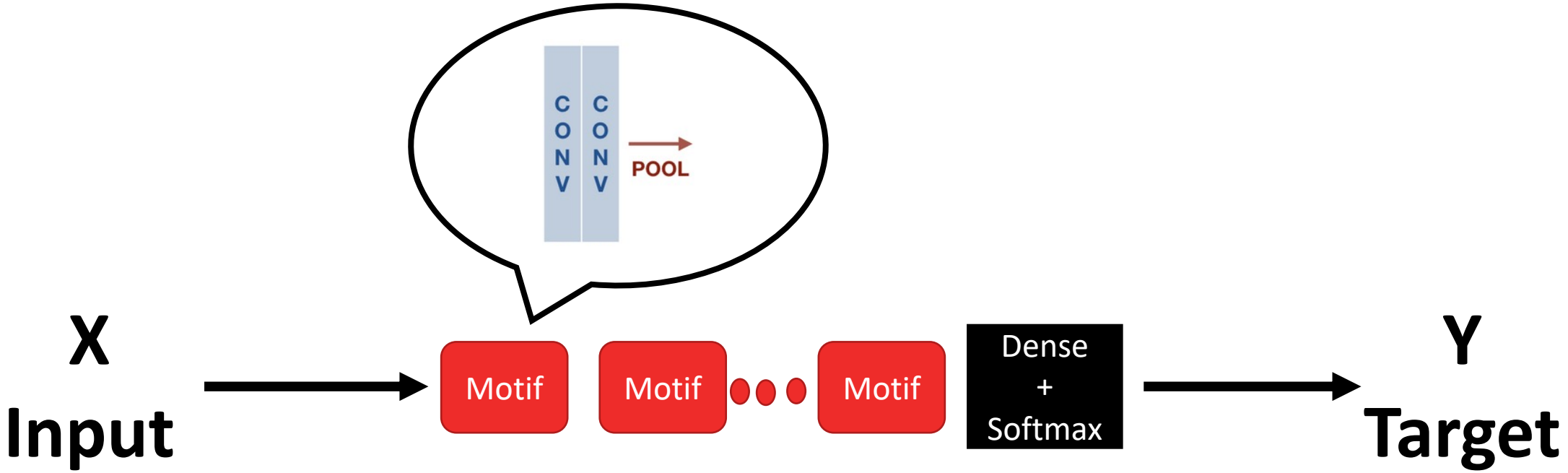
- **Evaluation strategy**: We need to measure, estimate, or predict the performance of a large number of proposed child models in order to obtain feedback for the search algorithm to learn.
  - Many methods have been proposed to save time or computation resources.

NAS



https://towardsdatascience.com/if-youre-hyped-about-gpt-3-writing-code-you-haven-t-heard-of-nas-19c8c30fcc8a

NAS – Using Motifs (i.e., design patterns)



Discussion and Summary

- AutoML seeks to make ML accessible to non-experts
- It can be very expensive computationally
  - Data centres can consume more energies than small cities
- AutoML can use heuristics to reduce the computation burden of the search of the optimal model (weights reuse, etc.)
- Some AutoML services available:
  - Google - https://cloud.google.com/automl
  - Azure - https://azure.microsoft.com/en-ca/services/machine-learning/automatedml/
- Interesting idea but still at early stages

Thank you!