JOHNS HOPKINS UNIVERSITY

A Hyperparameter Optimization Toolkit for Neural Machine Translation Research

Xuan Zhang, Kevin Duh, Paul McNamee

Motivation

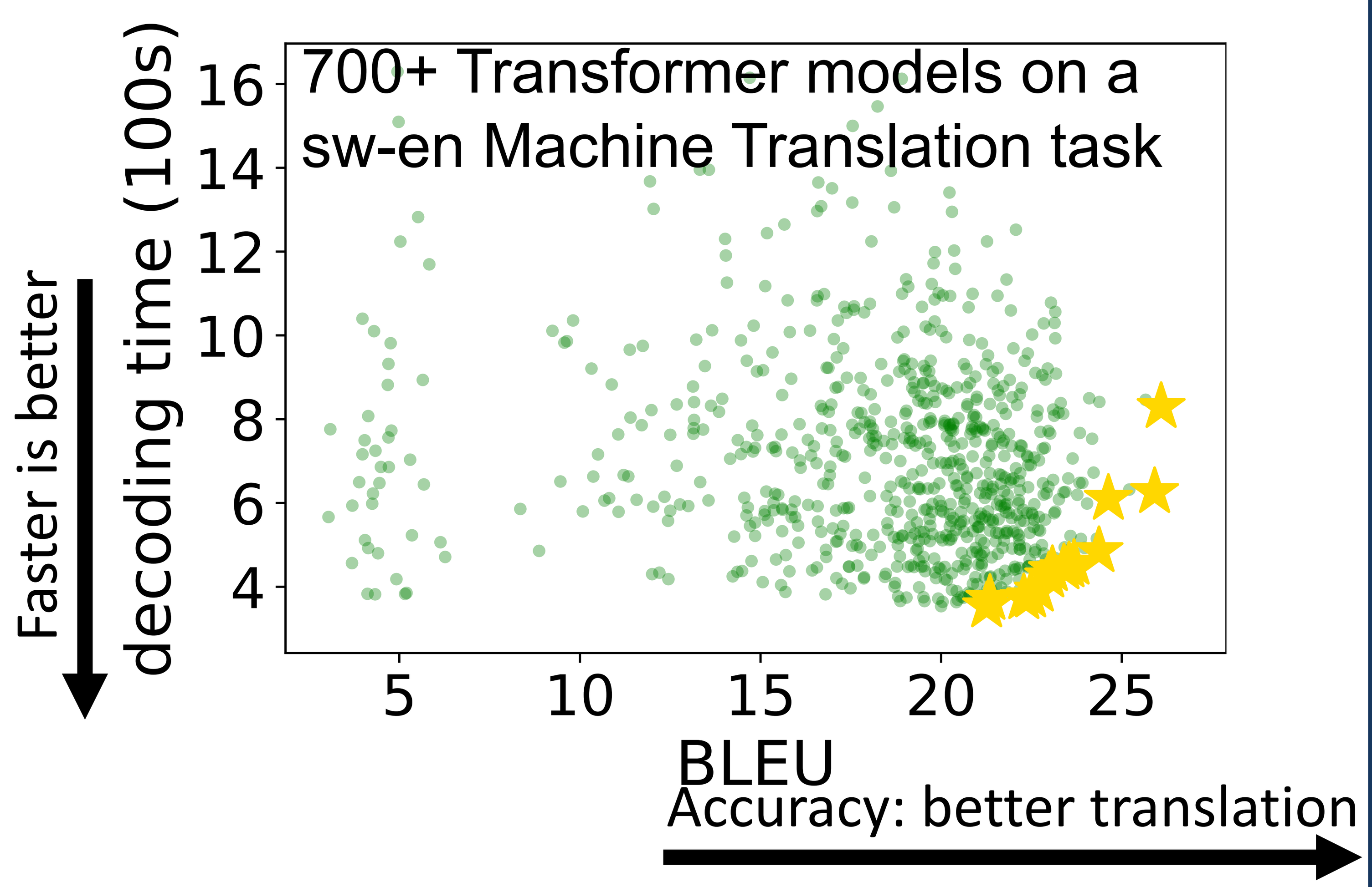
Hyperparameter optimization is important but often done haphazardly.

- Insufficient exploration may lead to poor results, killing a promising research idea
- Inequitable allocation of compute for hyperparameter optimization may lead to exaggerated differences among models

We need tools to standardize the process and make things easy for researchers.

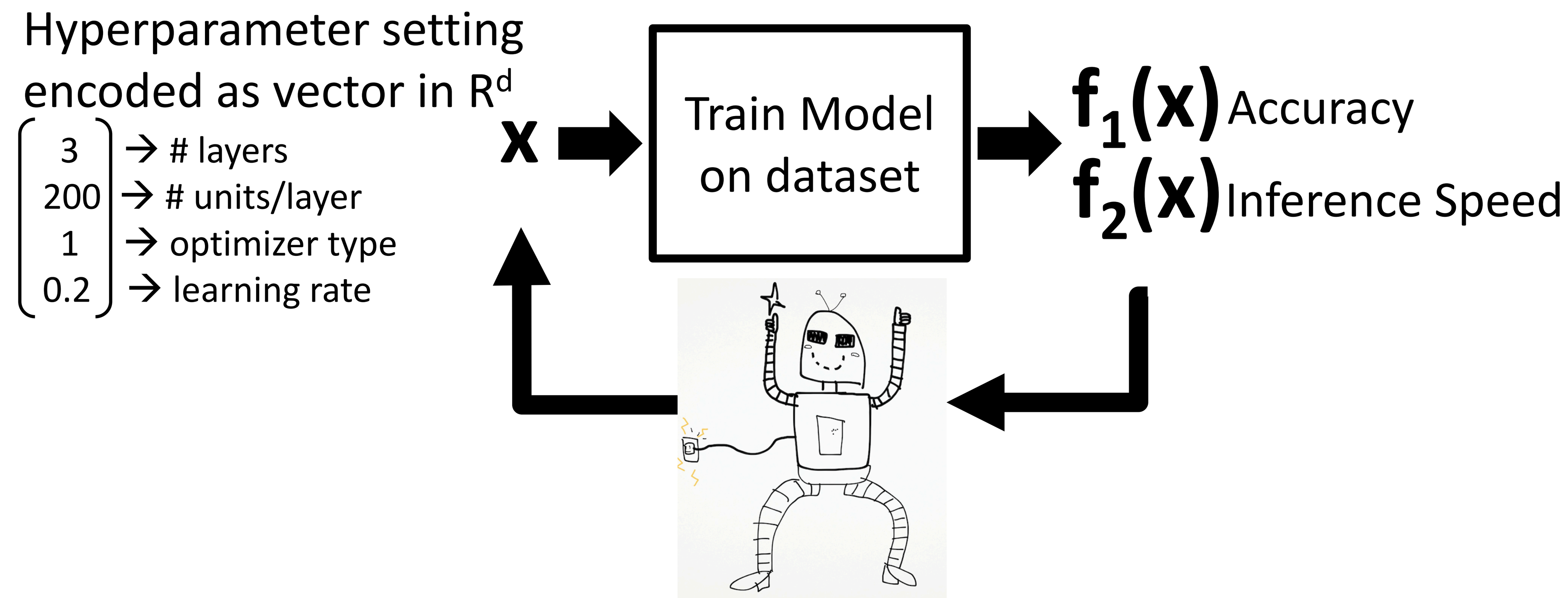
Contribution: a toolkit for optimizing Neural Machine Translation transformer models (in Sockeye3 framework) on a distributed grid
https://github.com/kevinduh/sockeye-recipes3

Example: High variance in model accuracy & speed due to different hyperparameters. The tool finds good models automatically.



Problem Formulation

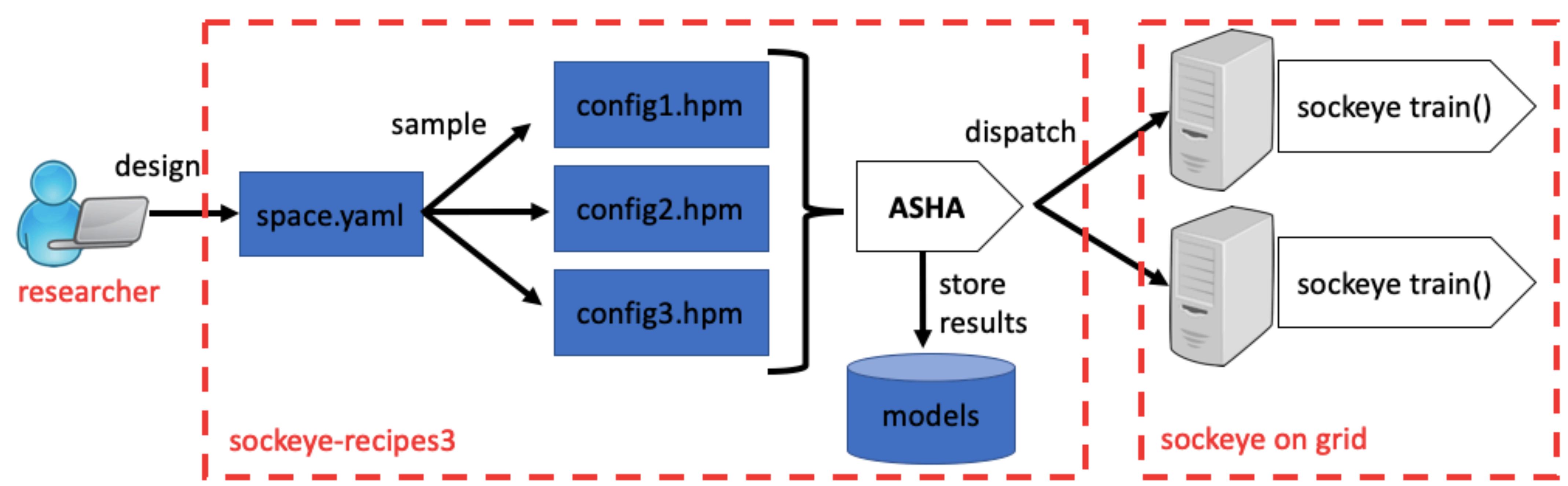
Hyperparameter Optimization (HPO):
Given a fixed budget of "function evaluations", find as many Pareto-optimal hyperparameter settings (x) as possible



Definition: Assume we want to find x that maximizes $f_1(x)$ and $f_2(x)$. A point p is **pareto-optimal** iff there does not exist a q such that $f_k(q) >= f_k(p)$ for all k and $f_k(q) > f_k(p)$ for at least one k

Software Design

1. User defines hyperparameter space
2. Sample a subset of configurations. These are candidates for training on the compute grid.
3. Run hyperparameter optimization, which intelligently decides whether or when to train each config given budget



Specific Implementation: ASHA

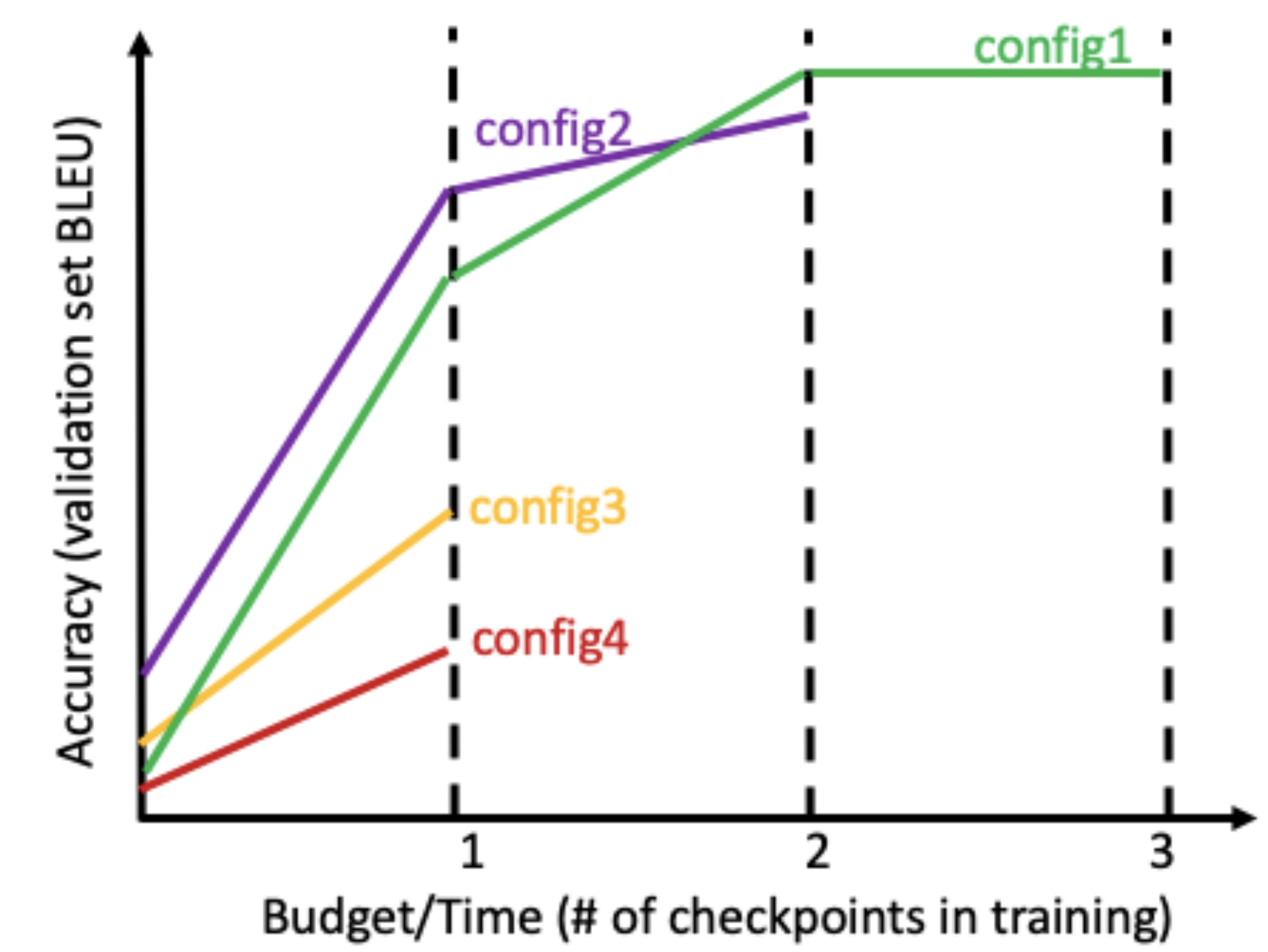
Many hyperparameter optimization methods:

- Bayesian Optimization
- Evolutionary Algorithms
- Population-based Training
- Bandit Learning

See our EACL23 tutorial:

We implement a bandit method called ASHA (Asynchronous Successive Halving Algo):

- Trains multiple config in parallel
- After few checkpoints, pre-emptively stop training for models that under-perform
- Assume: learning curves are comparable
- Resources are spent on promising config



References

[1] Zhang & Duh. Reproducible and Efficient Benchmarks for HPO of Neural Machine Translation Systems, TACL 2020
[2] Li et al., A System for Massively Parallel Hyperparameter Tuning, Proc of Machine Learning and Systems, 2020
[3] Hieber et al., Sockeye 3: Fast Neural Machine Translation with PyTorch, arXiv, 2022.
[4] Duh & Zhang. AutoML for NLP. Tutorial at EACL2023.