Alexei Finski - Statement of Research Interests

Generic data structures and algorithms with concurrency augmentation

https://github.com/alfin3/data-structures-algorithms-c

A set of generic data structures and graph algorithms were implemented from first principles in straight C, providing i) potential space and speed advantages relative to the use of C++ abstractions in settings with limited memory resources, and ii) measurements of performance bottlenecks for concurrency-based augmentation (work in progress).

Provisioning of distributed infrastructure for learning as an optimization problem

https://github.com/alfin3/infrastructure-as-opt

Two common considerations in the design of distributed approaches to learning are: i) which parts of a computation to distribute and reduce/synchronize, and ii) how to minimize communication latencies. These considerations pose an optimization problem in the “infrastructure vs. model architecture” search space.

To effectively traverse this search space, it is necessary to i) iterate across infrastructures and model architectures, and ii) measure the “fit” between an infrastructure and a model architecture. Towards this goal, I developed a one-step provisioning of an on-premises capable k8s infrastructure to streamline infrastructure iteration, and a set of proof-of-concept modules for constructing objective functions based on latency tracing.

Search for potential causes of rare events in sequence data

https://github.com/alfin3/seq-cause-search

Identifying causes of rare events remains a challenge across disciplines such as software safety and bioengineering. Causal information can often be contained in sequences of discrete tokens (e.g. thread states, nucleotides), associated with a discrete or continuous value indicating an occurrence or property of a rare event.

The presented search algorithm enables the identification of potential causal relationships underlying rare events in sequence data by enriching sequences associated with rare events in a concise logical representation. The algorithm i) is scalable in the number of considered sequence positions and ii) provides an interpretable search space.

Higher-order representation of function composition in neural networks

https://github.com/alfin3/functional-tf-nn

The commonly used libraries for implementing, training, and evaluating learning algorithms often improve usability at the expense of composability and research flexibility. However, a trade-off is not required to achieve a higher relational abstraction level.

The provided higher-order representation of function composition in neural networks, implemented within the constraints of a commonly used library (TensorFlow), demonstrates a segmentation of model construction with closure, and enables code simplicity and research flexibility. Generalizing this approach could potentially provide extensibility comparable to a language such as LISP.

Generative locality search

https://drive.google.com/file/d/18ll4NB2ERiwWfVUrcO2EZ9eQCqxSLVWn/view

The generative locality approach defines the locality of search solutions at each step of a local search with i) a generative model and ii) a generation randomization process that are used to reach outside an interpolant of previous search solutions in an automated manner.

The approach was applied to address a theoretically grounded limitation of studies conducted by researchers at the University of Washington, Microsoft Research, and Moderna.