Project Portfolio Summary

Nico OR

1 splisp

A copy-free lisp compiler and associated Stack VM

- **Learning outcomes**
  - Implemented a lexer, parser, and semantic analyzer to provide a language back end.
  - Implemented a Stack based Virtual Machine from the Oxford specification and extended it with heap instructions to support closures.
  - Implemented a code generator which lowers the abstract syntax tree into the Stack's ISA
- **Impact**
  - Demonstrates C++ aptitude, working with advanced features such as concepts, smart pointers, and a working understanding of move semantics.
  - Demonstrates ability to plan ahead when coding and utilize tests to ensure integration of subsystems in the project.
- **Technologies**
  - C++
  - gtest

2 Neural Networks, Haskell, and You

On the surprising ergonomics of functional programming for machine learning

- **Learning outcomes**
  - Implemented a multilayer perceptron from scratch and reviewed the math behind training.
  - Applied functional programming patterns to linear algebra-heavy code.
  - Connected gradient-based optimization theory to a working implementation.
- **Impact**
  - Demonstrated a working neural network with a clear, educational write-up.
- **Technologies**

  - Haskell
  - HMatrix
  - matplotlib

3 the t-distribution and its consequences

Some of the mathematical leg work behind a fundamental statistical tool

- **Learning outcomes**
  - Traced the derivation and intuition behind the t-distribution and hypothesis testing.
  - Connected variance, sampling, and degrees of freedom to practical inference.
  - Strengthened technical exposition of probability concepts.
- **Impact**
  - Produced an accessible explanation for students learning statistical inference.
- **Technologies**
  - Mathematical writing

4 FSAEStats

Scalable Analytics for the FSAE student competition

- **Learning outcomes**
  - Evaluated ORM tradeoffs and moved toward a columnar, record-batch approach.
  - Integrated DuckDB with Apache Arrow for efficient query and transport.
  - Streamlined PDF-to-CSV extraction workflows for downstream analytics.
- **Impact**
  - Delivered a lightweight API for querying FSAE results without heavy joins.
  - Enabled faster analysis by packaging results as Arrow record batches.
- **Technologies**
  - Rust
  - DuckDB
  - Apache Arrow
  - Camelot (PDF table extraction)