Project Portfolio Summary

Nico OR

1 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

2 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

3 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)

4 Great Value Three Body Problem

Using Too Many Moving Parts to Solve Too Many Moving Parts

- **Learning outcomes**
  - Built a physics simulation with ECS patterns and 2D rigid-body tooling.
  - Implemented gRPC-based control and state inspection for an interactive sim.
  - Explored IPC tradeoffs and client-server separation for compute-heavy work.
- **Impact**
  - Produced a controllable three-body simulation with external configuration and state queries.
- **Technologies**
  - Rust
  - Bevy ECS
  - Rapier 2D
  - Tokio + Tonic (gRPC)
  - Protobuf
  - Python client

5 NoTeC

The Working Man's Automotive Data Collection Solution

- **Learning outcomes**
  - Designed a layered embedded architecture to isolate hardware dependencies.
  - Applied RTOS threading and synchronization for sensor acquisition.
  - Built modular interfaces to ease sensor and platform swaps.
- **Impact**
  - Delivered a robust FSAE data acquisition system with a scalable telemetry pipeline.
  - Enabled storage evolution from USB to Raspberry Pi and database-backed access.
- **Technologies**
  - STM32F4 and STM32H7
  - C++
  - ST HAL
  - CMSIS-RTOS v2
  - Raspberry Pi
  - MongoDB

6 Sauron

An only slightly hellish hackathon

- **Learning outcomes**
  - Built an observability pipeline across microservice-like components.
  - Integrated distributed tracing into Python services.
  - Practiced rapid infrastructure setup under hackathon constraints.
- **Impact**
  - Delivered a working demo for end-to-end data lifecycle visibility.
- **Technologies**
  - Confluent Kafka
  - Terraform
  - Kubernetes
  - OpenTelemetry
  - Jaeger
  - Python

7 Sicarii

Custom SSG, done probably the wrong way

- **Learning outcomes**
  - Built a static site generator pipeline from scratch.
  - Orchestrated markdown to HTML conversion with custom syntax highlighting.
  - Managed templating and asset discovery with filesystem traversal.
- **Impact**
  - Shipped a custom SSG to publish and organize personal technical writing.
- **Technologies**
  - Rust
  - Askama templates
  - Pandoc
  - Syntect
  - Kuchikiki