Optinum

Fault Location Detection and Classification

MathWorks
Authorized Reseller

OPAL-RT TECHNOLOGIES

About the Presenters

- Name: Nur’ain Areff
- Role: Consultant – Software Engineering
- Education: BSc (Eng) Electrical Engineering & Biomedical Engineering
- Interests: Computer Vision, Software Engineering. Hardware

- Name: Enzo du Plessis
- Role: Consultant – Software Engineering
- Education: BSc (Eng) Mechanical Engineering
- Interests: AI, Control Systems, Automotive Engineering

Optinum | MathWorks Authorized Reseller | OPAL-RT TECHNOLOGIES

Optinum is a high-tech consulting and engineering firm with 30+ engineers and developers, specialising in **Artificial Intelligence**, **Model Operations**, and **Engineered Systems**.

- Trusted MathWorks partner since 1992
- Original developers of MathWorks' Industrial Communication Toolbox
- Successfully delivered more than 250 projects locally and internationally
- 30+ years in business delivering technical solutions
- Deep experience navigating complexity, and we are good at "blue sky"

MTN AUTONOSKY AERIAL TECHNOLOGY SOLUTIONS sasol reaching new frontiers HENSOLDT Detect and Protect. lodox critical imaging technology CSIR AngloAmerican NEDBANK

3

Our Competencies

Artificial Intelligence

- Computer vision for hazardous environments
- Generative AI for marketing
- Behavioural modelling in finance and telecoms
- Camouflage testing

Model Operations

- Real-time credit decisioning engine
- Continuous calculation engine for process analytics
- Process hazard identification
- Embedded software for a medical imaging device

Engineered Systems

- Digital mine simulator for manager training
- Autonomous vehicles for deformable terrains
- AUTOSAR algorithm implementation

Agenda

- Problem Statement
- Real-World Example
- Injecting faults into a IEEE 123 Node Test Feeder model
- Classification Algorithm
- Interpreting and displaying data from AI model
- Q&A

Problem Statement

- Can data-driven techniques be used to generate a classification algorithm for fault location detection on a power system, using only a limited number of voltage and current measurements?

Real World Example

- **One undetected fault caused one of the deadliest wildfires in California history**

Lives lost	Damage Cost	Cause
85	$16.65B	Single warn hook

- A worn hook arcing against the tower produces a distinct high-impedance ground-fault waveform. A trained classifier flags this
- Correctly identifying it as a single line-to-ground fault, not a transient or load event, tells protection systems to act rather than ride through it

IEEE 123 Node Test Feeder

- Distribution test system to evaluate:
  - Power flow algorithms,
  - Unbalanced three-phase systems
  - Smart grid operations

Programmatically build network

Three-phase Buses

- 70 Buses
- 7 fault sequences per bus
- Heavy motors in industrial factories

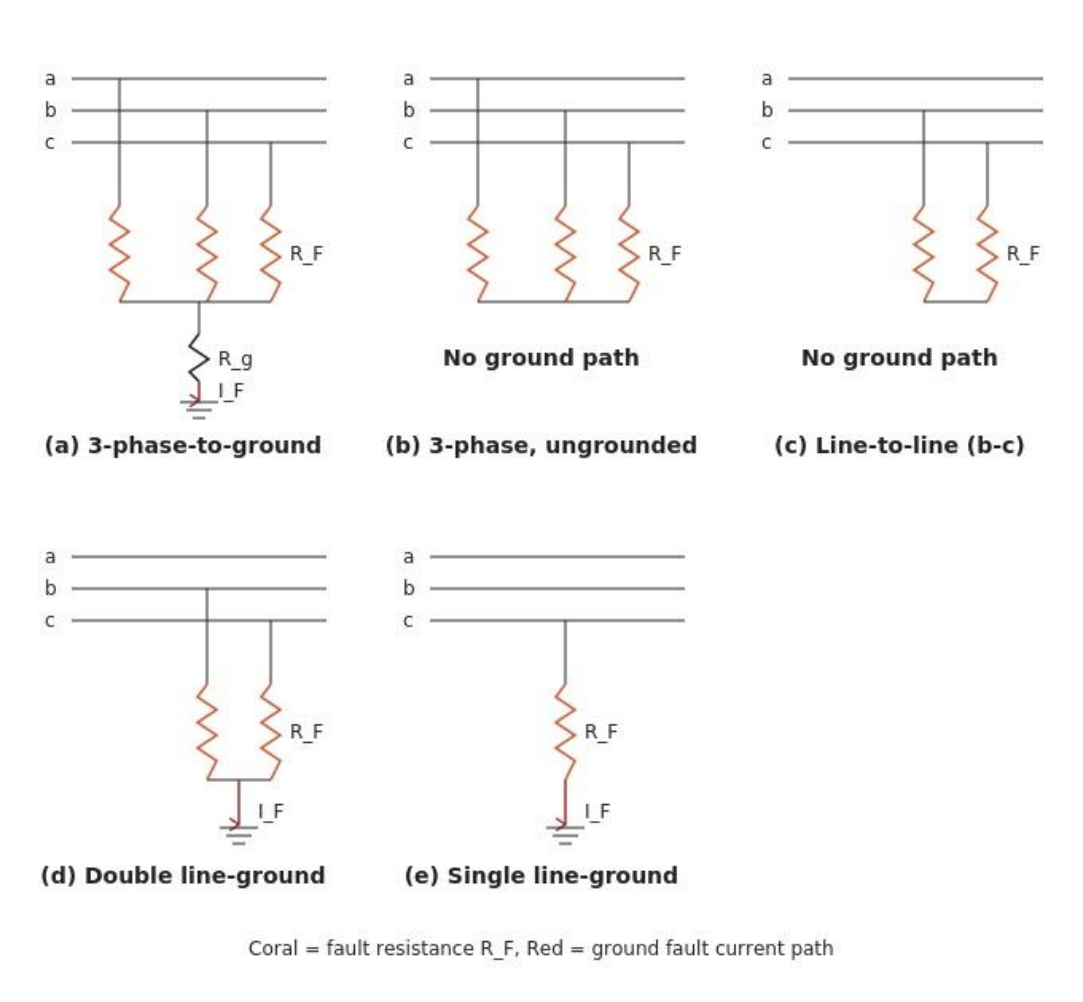
Two-phase Buses

- 3 buses
- 3 fault sequences per bus
- Stoves and appliances in North America

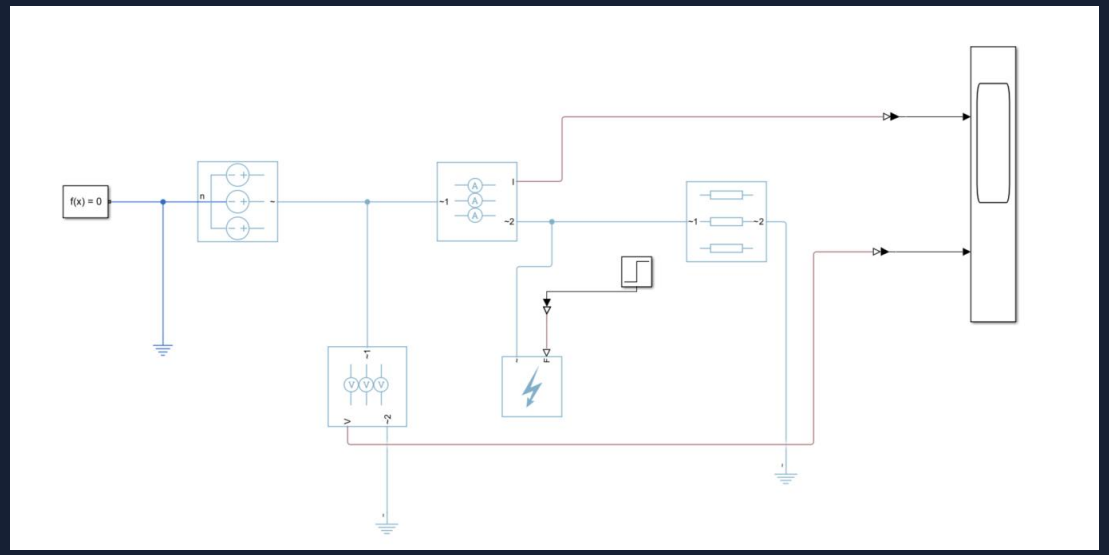
Single-phase Buses

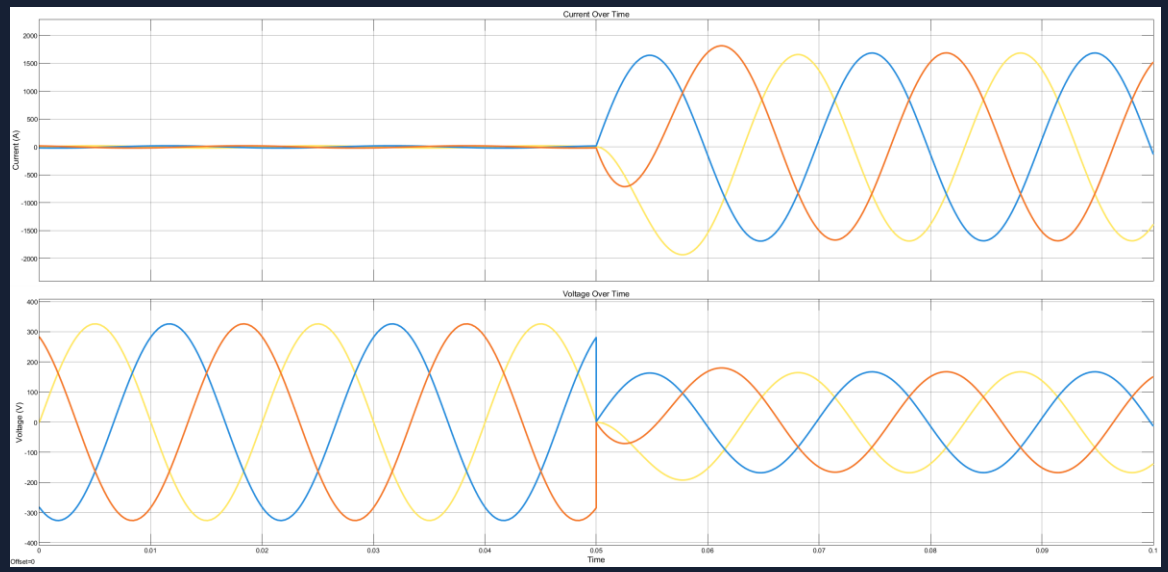
- 55 buses
- 1 fault sequence per bus
- Common in offices and houses

Different Types of Faults



Build Circuits and Inject Faults





Classification Algorithm

- Why is this important?
  - Equipment lifecycle benefit to being able to classify faults early and accurately
  - Assess the working condition of machinery, estimate a likely occurrence of next equipment failure
  - Could potentially save surrounding areas and human or animal lives as alluded to earlier with the California wildfires
- Approach:

Data Collection

- Bus 13
- Voltage and Current readings
- 12 simulations of data
- Package into a Table (6660 x 13)

Data Preparation

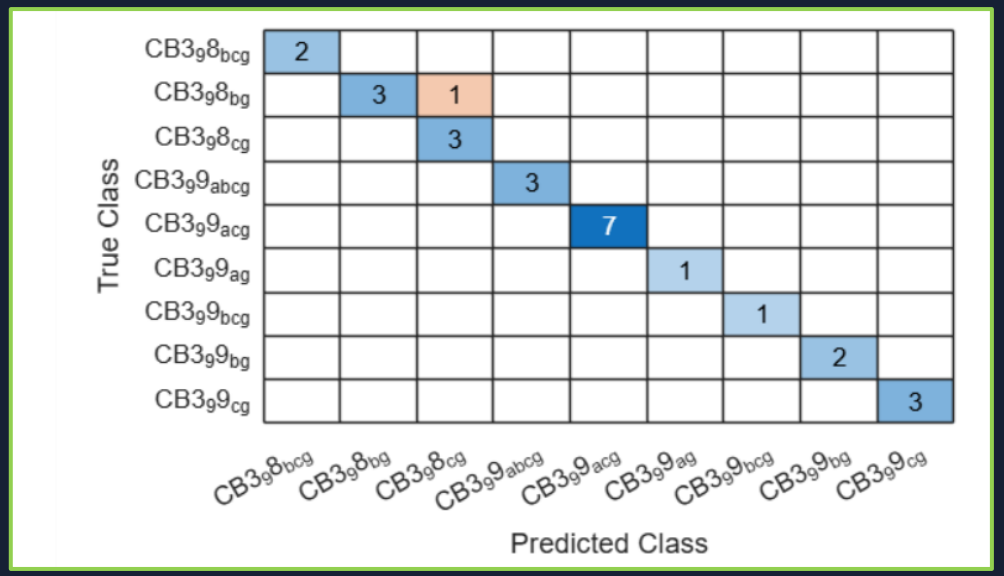
- Select unique fault categories
- Index into data
- Create new Table

Classification Learner App

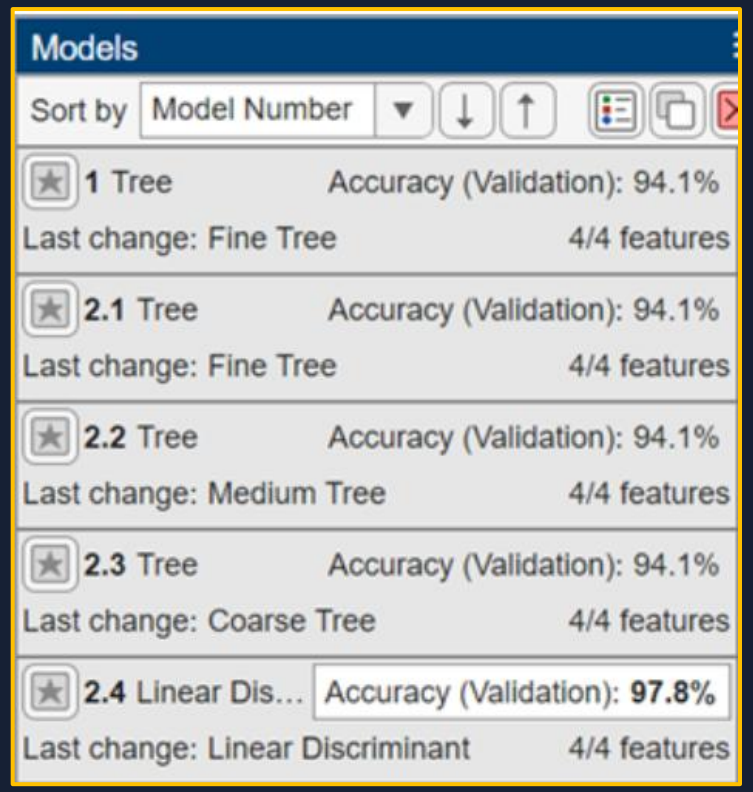
- Load in new Table
- Set aside a test dataset (if applicable)
- Train on available models

Displaying Data from Classifiers

- Confusion Matrix



- Training and Validation Metrics



Useful Links:

[Visualize and Assess Classifier Performance in Classification Learner](#)
[Model Metrics and Suggestions](#)

[Designing Algorithms for Condition Monitoring and Predictive Maintenance](#)

Questions?

Continue your journey with Optinum

Agentic AI Discovery Session

Explore the possibilities for your organisation

- Identify practical engineering use cases
- Explore opportunities to automate workflows
- Define the right next steps with our team

Book a Discovery Session

CPD-Accredited Training

Predictive Maintenance with MATLAB

- Build practical predictive maintenance skills
- Work with real engineering data
- Earn CPD points while developing your capabilities

Find Out More

Contact us to start building solutions.

- http://optinum.ai/
- sales@optinum.co.za
- info@optinum.co.za

Optinum