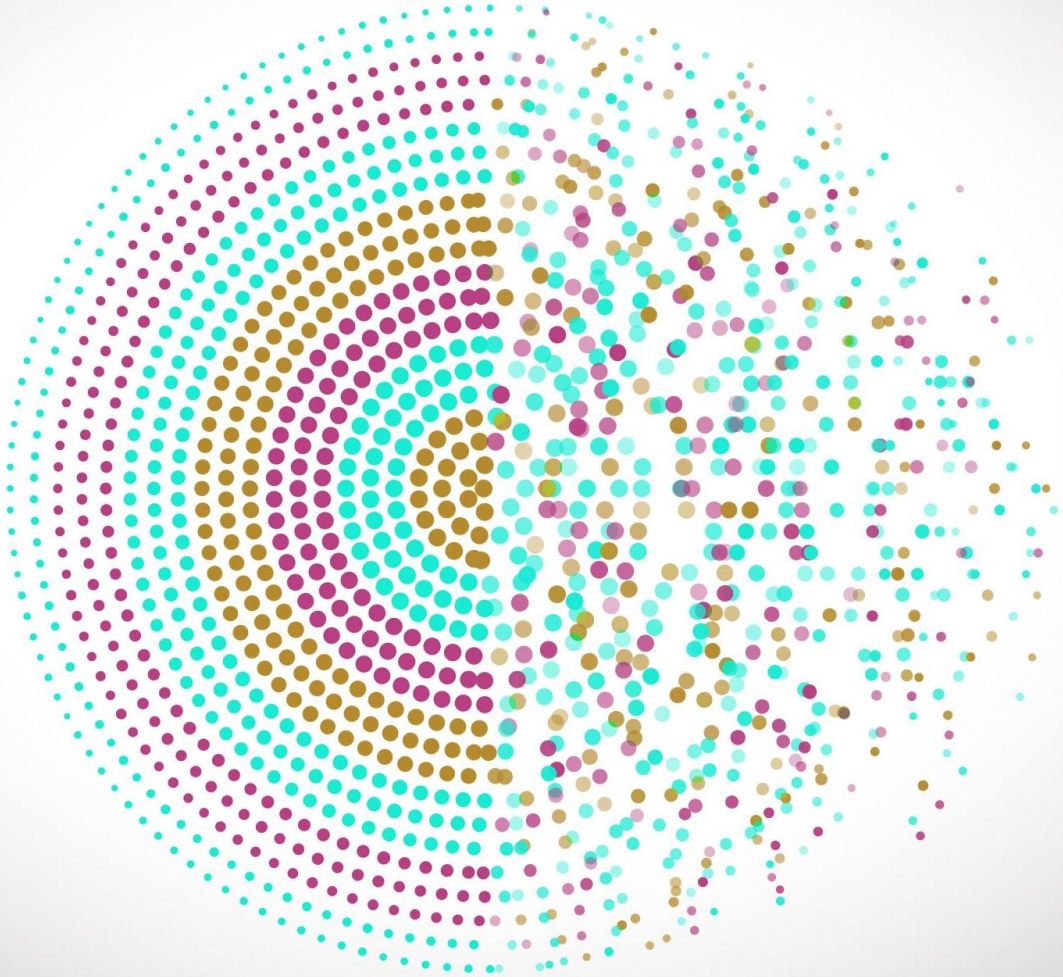

EXERGY 2025 OPTIMIZATION CHALLENGE

By Team Chemievolve:

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INTRODUCTION TO THE OPTIMIZATION CHALLENGE

- **Title:** Exergy 2025 Optimization Challenge
- **Hosted by:** Kanopy Techno Solutions
- **Focus Area:** Electrochemical Impedance Spectroscopy (EIS)
- **Objective:** Find the **optimum equivalent circuit** model that best fits given impedance data.
- **Key Application Areas:**
  - Bio-recognition events (e.g., antibody–antigen recognition)
  - Electrochemical reaction engineering
  - Sensor technology

UNDERSTANDING THE PROBLEM STATEMENT

- **Given Data:**

Three arrays containing

- **Frequency (Hz)**
- **Real Impedance (Ohm)**
- **Imaginary Impedance (Ohm)**

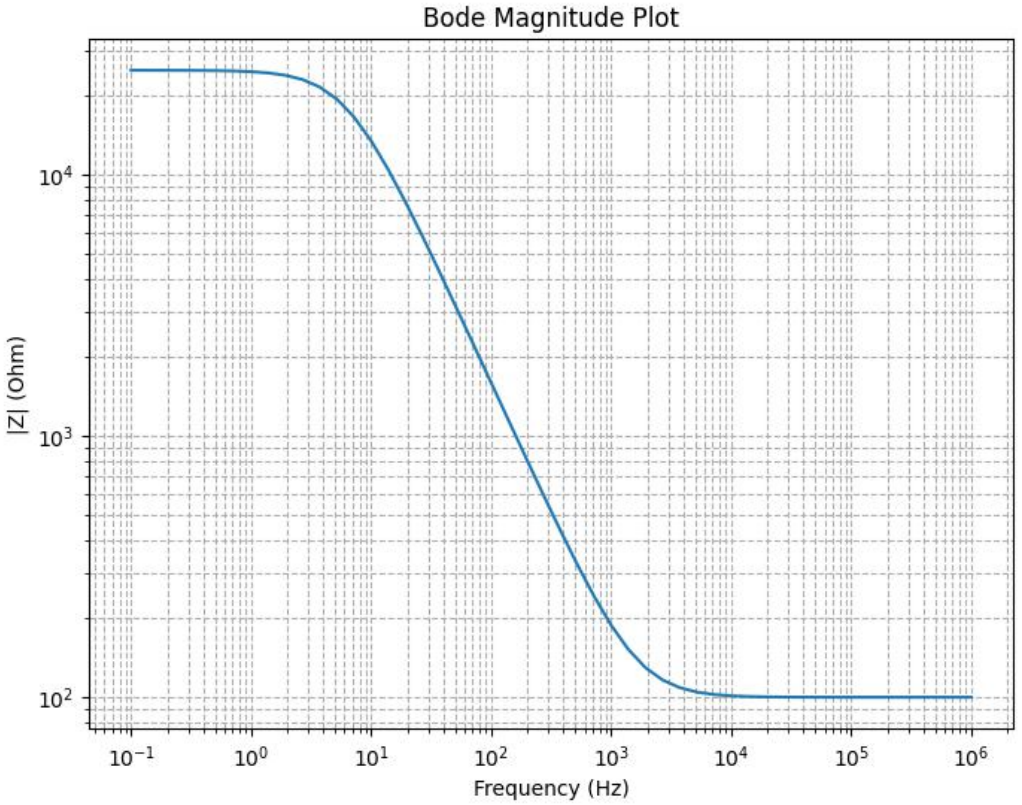
- **Expected Output:**

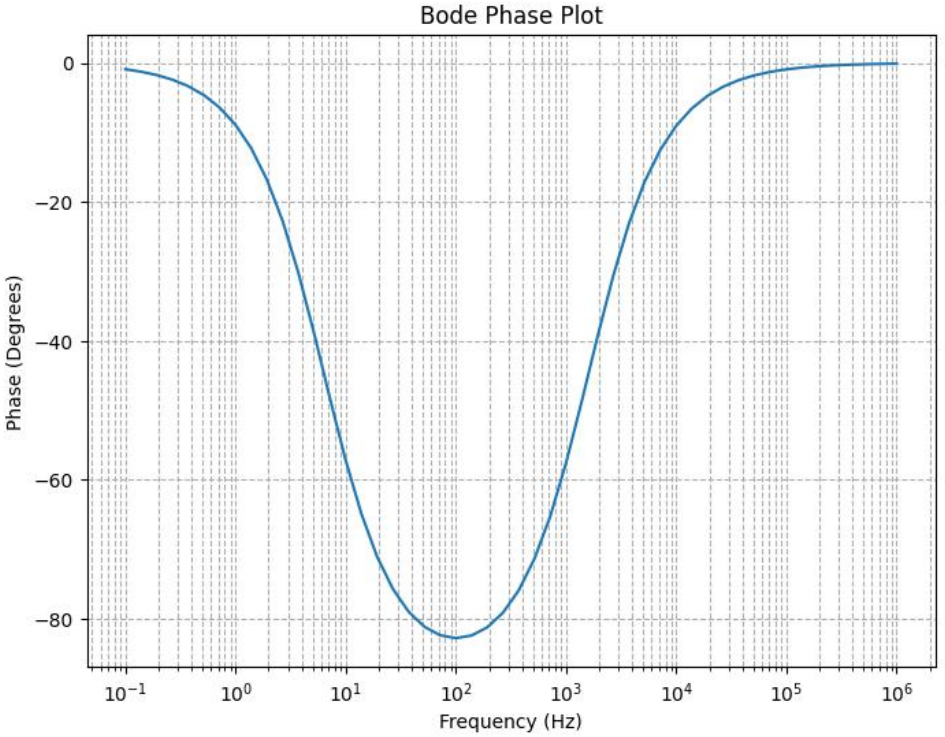
- Identify the best **circuit model** using **combinations of resistors (R), capacitors (C), inductors (L), and other elements.**
- Determine **optimal parameters** (e.g., R1 = 100Ω, C1 = 0.000001 F).
- Represent the circuit in a structured format (e.g., R1 - (R2 || C1)).

- **Constraints:**

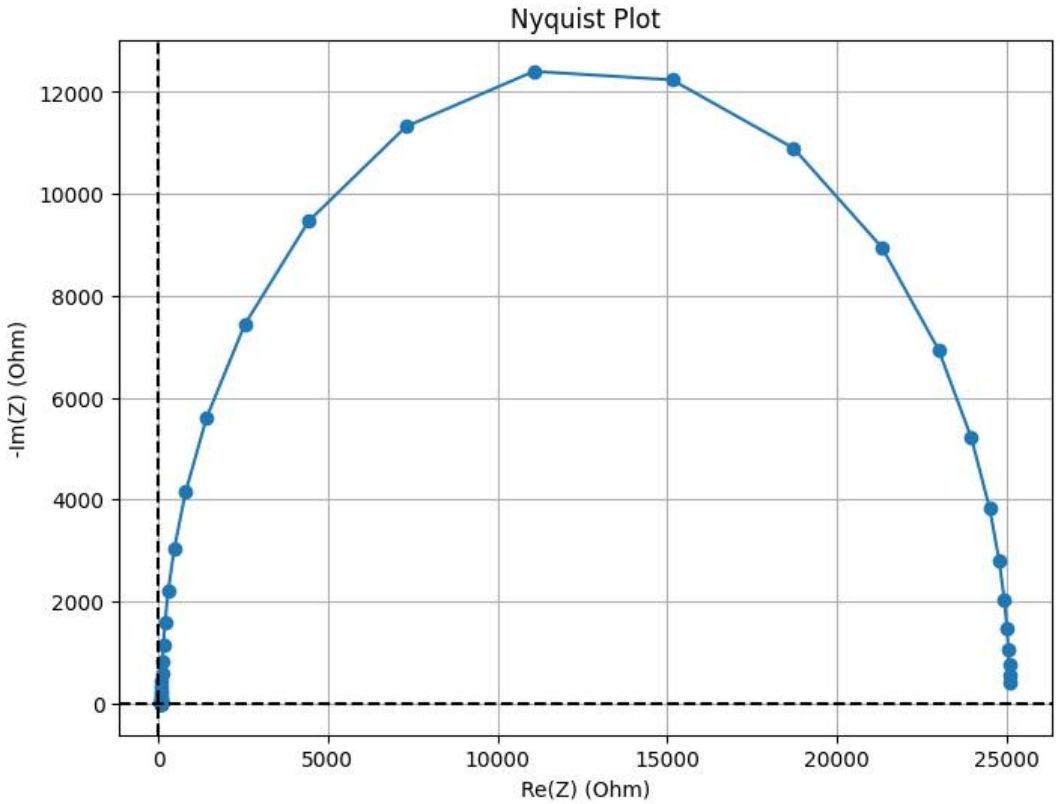
- Maximum **5 circuit elements** per model.
- Output should minimize error between experimental and modeled impedance.

RESULTS


Bode Magnitude Plot
|Z| (Ohm)
10^4
10^3
10^2
10^{-1} 10^0 10^1 10^2 10^3 10^4 10^5 10^6
Frequency (Hz)


Bode Phase Plot
Phase (Degrees)
0
−20
−40
−60
−80
10^{-1} 10^0 10^1 10^2 10^3 10^4 10^5 10^6
Frequency (Hz)

RESULTS


Nyquist Plot
-Im(Z) (Ohm)
Re(Z) (Ohm)
0
2000
4000
6000
8000
10000
12000
0
5000
10000
15000
20000
25000

APPROACH & ALGORITHMS

- Recursive Function for Series-Parallel Combinations
- Model complex series-parallel structures generated using a recursive function.
- Use Non-Linear Regression (NLR) and Neural Networks (NN) to fit the data.
- Incorporate initial guesses, upper & lower bounds, and optimize parameters.
- Evaluate model performance using R^2 values.

THANK YOU