Open-Software Tools for the Analysis of Electrochemical Impedance Spectra

AiMES ECS Data Science Showcase

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1 October 2018

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Goal: extract *physically meaningful* and *reliable* insights from data

- Battery health
- Relative impact of kinetics/transport
- Quantitative parameters
- ...

Goal: extract *physically meaningful* and *reliable* insights from data

Current analysis options:

- Potentiostat software
- Proprietary 3rd party software
- Code written in individual labs

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Current analysis options:

- Typically clunky to use
- Proprietary/hidden algorithms (can't reproduce!)
- Difficult to share and improve

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Community-driven, open-source tools improve reproducibility and accelerate science

What will the future of impedance analysis look like?

- Fast, **reproducible** analysis of impedance spectra
- Easy-to-use software that encourages **best practice**
- **Community-driven** toolkit grows with improved methods for interpretation and analysis
An example: Scikit-learn has made high-quality machine learning available to all

- machine learning made easy-to-use
- Easy to apply and compare different models, open and powerful enough to accomplish real tasks
- The key is the community-driven api
1st steps: Python package + web-based GUI

impedance.py

ImpedanceAnalyzer

impedance.py demo
https://github.com/ECSHackWeek/impedance.py
ImpedanceAnalyzer demo

https://github.com/mdmurbach/ImpedanceAnalyzer

Moving from beta to ImpedanceAnalyzer v1.0

- Login/save data and settings
- Additional physics-based datasets
- Implement confidence interval estimation and visualization
- Drag-n-drop circuit creation
- Desktop vs. web application
Expanding usability and features of impedance.py

- Incorporate interactive visualizations
- Additional equivalent circuit and physics-based models and elements
- Improve initialization of smart parameter guesses
- Improve data validation methods
- ...
longer-term vision:

open API for data, analysis, and interpretation pipeline
Thank you!

- Neal Dawson-Elli
- Qin Pang
- Simon Timbillah
- Prince Sarfo
- Jason Bonezzi
- Prof. David Beck
- Prof. Dan Schwartz
- Victor Hu
- Erica Eggleton
- Linnette Teo
- Yanbo Qi