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Changyu Deng

A PhD with experience in battery algorithms, modeling and data analysis (including machine learning). Interested in physics-based or data-driven modeling or optimization of battery.

Education

Aug. 2018– present **University of Michigan, Ann Arbor**
PhD Candidate (expect to graduate in May 2023), Mechanical Engineering GPA: 4.00/4.00
Research focus: battery cell design, modeling and optimization algorithm
- Master of Science in Engineering, Electrical and Computer Engineering (conferred in Dec. 2021)
- Master of Science in Engineering, Mechanical Engineering (conferred in Dec. 2019)

Aug. 2014– Jun. 2018 **Xi'an Jiaotong University (China)**
B. Eng., Energy and Power Engineering & B. Eco., Economics GPA: 4.01/4.30 Ranking: 1/113

Work Experience

May 2022– Aug. 2022 **Battery Algorithm Engineer (Intern)**, *Apple Inc.*, Cupertino, CA
Worked in the Battery Algorithm Engineering team to develop algorithms to analyze and diagnose batteries.
- Aimed to analyze degradation performance of batteries from cycling tests.
- Proposed algorithms to infer unknown knowledge and reduce measurement noise.
- Modified existing methods to deconvolute and interpret data.

Research Experiences

Jun. 2019– present **Gradient–Free Battery Optimization Algorithm**
- Reduced the number of trials (queries) in simulation or experiment for parameter optimization.
- Chose parameter configurations by a machine learning model trained on existing cycling data.
- Considered early-stopping and asynchronous parallelism during cycling.

Jun. 2019– present **Self–Supervised Object Detection Algorithm for Autonomous Driving**
- Reduced the amount labeled data by making use of unlabeled data via semi-supervised learning.
- Trained an encoder on all data to enforce consistency after augmentation and a detector on labeled data.
- Tested on multiple datasets such as Pascal VOC and COCO to demonstrate improved performance.

Sep. 2019– Apr. 2022 **Solid State Electrolyte Diffusion Enhancement by Electromagnetic Wave**
- Tried to increase diffusivity of solid state electrolyte by imposing an electromagnetic wave for resonance.
- Simulated scholastic resonance between diffusion and electromagnetic wave by Fokker-Planck equation.
- Built a physics-based model to describe lithium ion and electron transport in solid-state electrolyte.

Mar. 2019– Mar. 2020 **Modeling and Parameterization of Li-ion Batteries**
- Aimed at a calibrated model to analyze and predict the degradation of graphite/NMC cells.
- Considered SEI, lithium plating, solvent oxidation and NMC particle cracks.
- Obtained the physical parameters used in the model by experiment and fitting.

Aug. 2018– Aug. 2020 **Synthesis of Phosphorus Anode for Sodium-ion Batteries**
- Synthesized sodium ion batteries with phosphorus as the anode active material.
- Condensed red P in carbon skeleton with low cost.
- Maintained 90% capacity after 100 cycles at 1.5A/g (based on P).

Publications

Article B. Wu†, B. Zhang†, **C. Deng**†, W. Lu, Physics-encoded deep learning in identifying battery parameters without direct knowledge of ground truth, *Applied Energy*, 2022, 321, 119390

Article **C. Deng**, et al., A generic battery-cycling optimization framework with learned sampling and early stopping strategies, *Patterns*, 2022, 3(7), 100531

Article **C. Deng**, et al., Self-Directed Online Machine Learning for Topology Optimization, *Nature Communications*, 2022, 13, 388

Preprint **C. Deng** and W. Lu, A Minimal Physics-Based Model on the Electrochemical Impedance Spectroscopy of Solid-State Electrolyte, *arXiv preprint, arXiv:2110.00551*

Article **C. Deng** and W. Lu, A Facile Process to Fabricate Phosphorus/Carbon Xerogel Composite as Anode for Sodium Ion Batteries, *Journal of the Electrochemical Society*, 2021, 168(8), 080529

Article **C. Deng**, et al., Thermal Conductivity of 1, 2-Ethanediol and 1, 2-Propanediol Binary Aqueous Solutions at Temperature from 253 K to 373 K, *Int J of Thermophysics*, 2021, 42(6), 1-12

Article **C. Deng**, et al., Integrating Machine Learning with Human Knowledge, *iScience*, 2020, 101656

Article **C. Deng** and W. Lu, Measuring Consistent Diffusivity from Galvanostatic Intermittent Titration Technique and Electrochemical Impedance Spectroscopy, *J of Power Sources*, 2020, 473, 228613

Proceeding **C. Deng** and W. Lu, Geometry Optimization of Porous Electrode for Lithium-Ion Batteries, *ECS Transactions*, 2020, 97(7), 249

Article **C. Deng**, et al., Numerical Study on Equilibrium Stability of Objects in Fluid Flow — A Case Study on Constructal Law, *Case Studies in Thermal Engineering*, 2019, 100539

Article M. Li, Z. Qin, Y. Cui, C. Yang, **C. Deng**, et al., Ultralight and Flexible Monolithic Polymer Aerogel with Extraordinary Thermal Insulation by A Facile Ambient Process, *Advanced Materials Interfaces*, 2019, 1900314

Article **C. Deng**, et al., Development of a Vapor Pressure Measuring Apparatus for Experimental Teaching, *Research and Exploration in Laboratory*, 2018, 37(07), 69-71+86

Skills

Experimental Electrode preparation, Coin cell assembly, CVD, Characterization: SEM, XRD, EDS, EIS, GITT

Software COMSOL Multiphysics (li-ion battery, electrochemistry, CFD, optimization), ANSYS Fluent, SolidWorks, AutoCAD, LaTeX, 3ds Max, Cenima 4D, Adobe Photoshop/Premiere/Illustrator

Programming Python (PyTorch for deep learning, Optuna for non-gradient optimization, NumPy for data processing), Matlab, C/C++, Fortran, Shell script

Honors and Awards

Jul. 2022 Chinese Government Award for Outstanding Self–Financed Students Abroad

Mar. 2022 Rackham Predoctoral Fellowship (one-year full support, news)

Oct. 2020 ME Rising Star (by MIT, Stanford & Berkeley, based on research, service and teaching)

Nov. 2017 National Scholarship of China (2%, also received in 2015 and 2016)

Sep. 2017 UCLA CSST Award (with an invited speech at the reception)

Oct. 2017 Outstanding Student Award (10 undergrads per year in XJTU)

Feb. 2016 Meritorious Winner in the Interdisciplinary Contest in Modeling

Oct. 2016 Best Design Award in Honda Eco-Mileage Challenge (1/149)