**Region-Aware Cross-Condition Parameter Identification of High-Capacity Lithium-Ion Battery Through Synergistic Global-Local Optimization**

**1. Introduction**

* **Background**: Current challenges in lithium-ion battery parameter identification, particularly for high-capacity cells
* **Literature Review**:
  + Current parameter identification methods for LIB models (emphasize gaps for high-capacity batteries)
  + Review of conventional optimization methods (highlight limitations in cross-rate robustness)
  + Review of existing work using Bayesian optimization in battery applications
* **Research Gap**: Limited research on parameter identification for high-capacity batteries (>200Ah) and lack of robust methods across multiple C-rates
* **Innovation Points**:
  + Novel application to high-capacity (280Ah) lithium-ion batteries
  + Cross-Condition robustness through min-max optimization approach
  + Hybrid optimization methodology combining global Bayesian search with local refinement
* **Paper Structure**: Brief outline of subsequent sections

**2. Doyle-Fuller-Newman (DFN) Model Development**

* **Theoretical Foundation**: Governing equations of the DFN model
  + Mass conservation (solid and electrolyte phases)
  + Charge conservation (solid and electrolyte phases)
  + Butler-Volmer kinetics
  + Heat generation and thermal effects
* **Model Implementation**: Using PyBaMM framework
* **Boundary and Initial Conditions**: For different discharge rates
* **Parameters to be Identified**: List of electrochemical, transport, and geometric parameters

**3. Sensitivity Analysis**

* **Methodology**: Sobol sensitivity analysis framework
  + First-order and total-order sensitivity indices
  + Sampling strategy for parameter space exploration
* **Parameter Space Definition**: Reasonable ranges for all parameters based on literature
* **Results Visualization**: Tornado plots or heat maps showing parameter sensitivity
* **Parameter Selection**: Criteria for selecting the most sensitive parameters for identification
* **Cross-Condition Sensitivity Analysis**: How parameter sensitivity changes across different C-rates

**4. Region-Aware Min-Max Optimization Algorithm**

* **Problem Formulation**:
  + Multi-objective function definition (RMSE at different C-rates)
  + Min-max optimization concept and mathematical formulation
  + Constraints definition based on physical bounds
* **Bayesian Optimization Framework**:
  + Gaussian process surrogate modeling
  + Acquisition function selection and justification
  + Exploration-exploitation trade-off strategy
  + Implementation details using Bayesian optimization libraries
* **Local Refinement**:
  + Interior-point method formulation
  + Sequential quadratic programming considerations
  + Convergence criteria
* **Global-Local Synergistic Approach**:
  + Transition criteria from global to local search
  + Region-aware strategy implementation
  + Algorithm workflow and pseudocode

**5. Experimental Methods**

* **Cell Specifications**: Detailed 280Ah lithium-ion battery characteristics
* **Test Equipment**: Battery testing system specifications
* **Experimental Protocols**:
  + Discharge tests at various C-rates (0.1C, 0.2C, 0.33C, etc.)
  + Temperature control and monitoring
  + Rest periods and test repetition for statistical significance
* **Data Processing**: Filtering and preparation methods

**6. Results and Discussion**

* **Parameter Identification Results**:
  + Identified parameter values and comparison with literature
  + Confidence intervals or uncertainty quantification
  + Parameter correlation analysis
* **Model Validation**:
  + Voltage prediction accuracy across different C-rates
  + Statistical error metrics (RMSE, MAE, R²)
  + Validation with separate test data not used for identification
* **Algorithm Performance**:
  + Convergence behavior of the proposed method
  + Computational efficiency comparison with traditional methods
  + Robustness analysis across different initial conditions
* **Cross-Rate Performance Analysis**:
  + Demonstration of model accuracy across all tested C-rates
  + Comparison with single-rate optimization results
* **Physical Interpretation**: Discussion on the physical meaning of identified parameters

**7. Conclusion and Future Work**

* **Key Findings**: Summary of main results and their significance
* **Contributions**:
  + First comprehensive parameter identification for high-capacity (280Ah) cells
  + Superior cross-rate robustness through the novel min-max approach
  + Methodological innovation in optimization through global-local synergy
* **Limitations**: Honest assessment of current approach limitations
* **Future Work**: Suggested extensions and applications
  + Application to other chemistries and cell formats
  + Extension to include aging effects
  + Real-time implementation possibilities