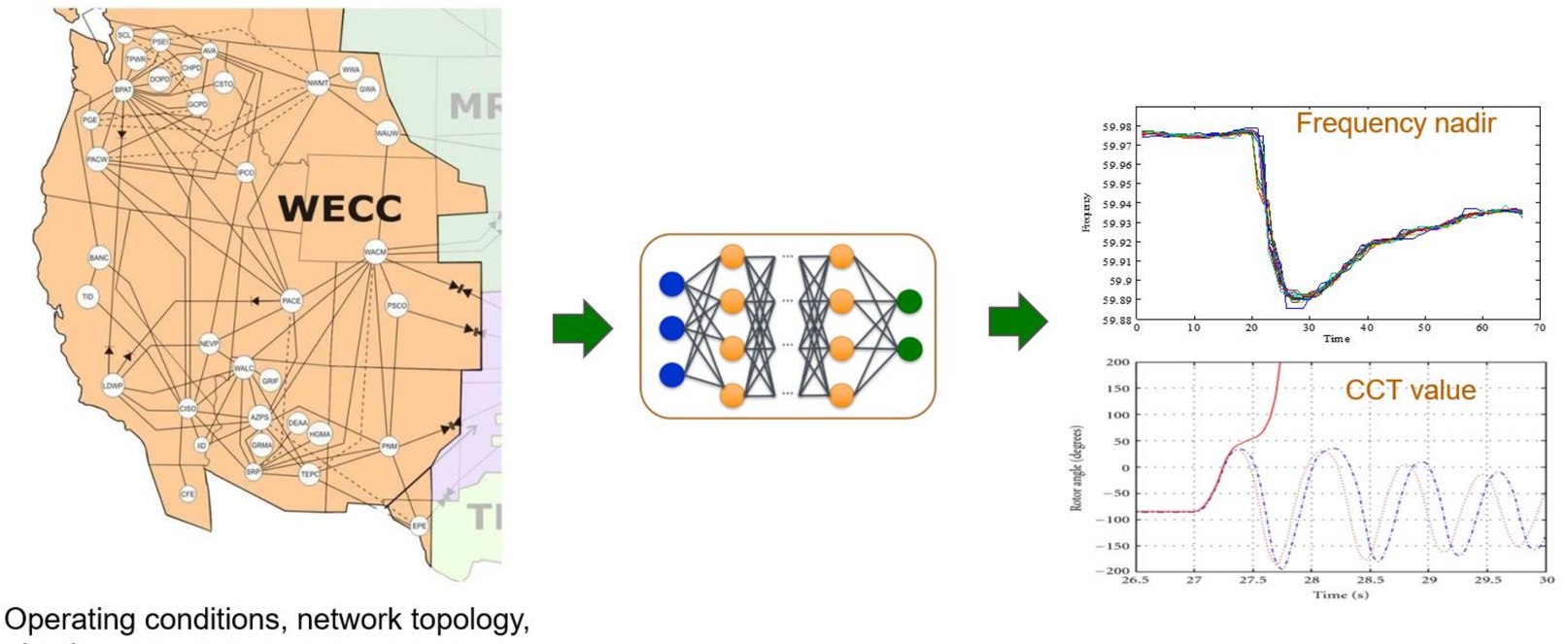
AI-Based Faster-Than-Real-Time Stability Assessment of Large Power Systems with Applications on WECC System

Jiaojiao Dong[1], Miraka Mandich[1] , Yinfeng Zhao[1],Yang Liu[1] ,Shutang You[1] ,Yilu Liu[1,2] ,Hongming Zhang[3]
[1] The University of Tennessee, Knoxville [2] Oak Ridge National Laboratory
[3] Stronghold Resource Partners

Introduction

- Faster-than-real-time stability assessment technology is needed for operating future power grids
- Proposed an AI-based method to predict the system's stability margin information from operating conditions
  - The frequency nadir in frequency stability assessment
  - The critical clearing time (CCT) in transient stability assessment
  - No need to perform time-domain simulations
- Tested the method using actual dispatch cases of the WECC system
- The trained AI agent can predict stability margins of WECC system in less than 0.2 milliseconds

Method



Operating conditions, network topology, circuit parameters, measurements, etc.

Figure 1. Illustration of the proposed AI-based stability assessment method.

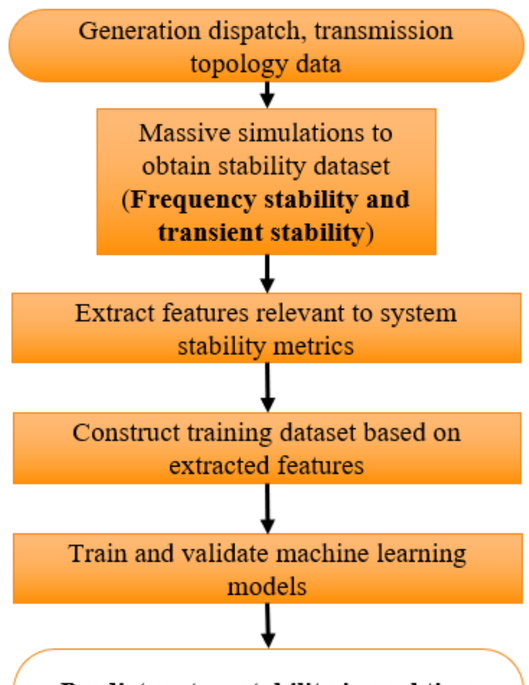


Figure 2. Implementation procedure

Results

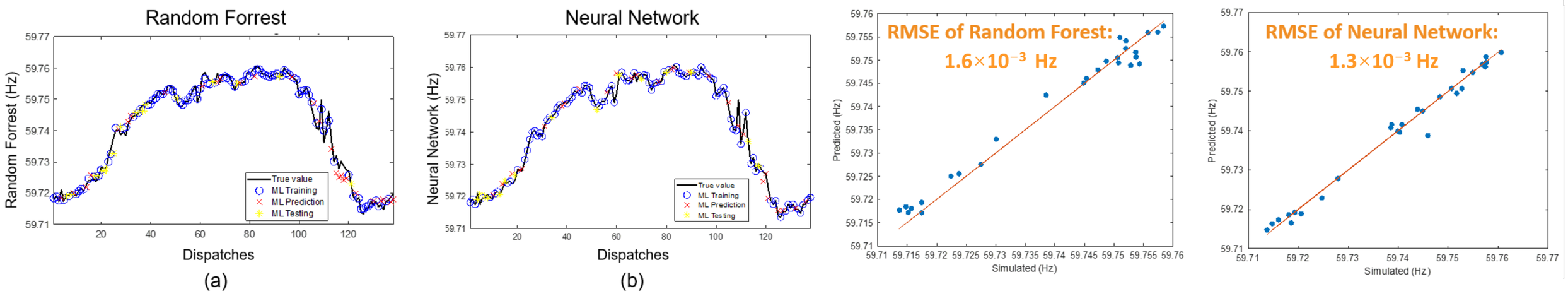


Figure 4. Error of the AI-based frequency stability prediction.

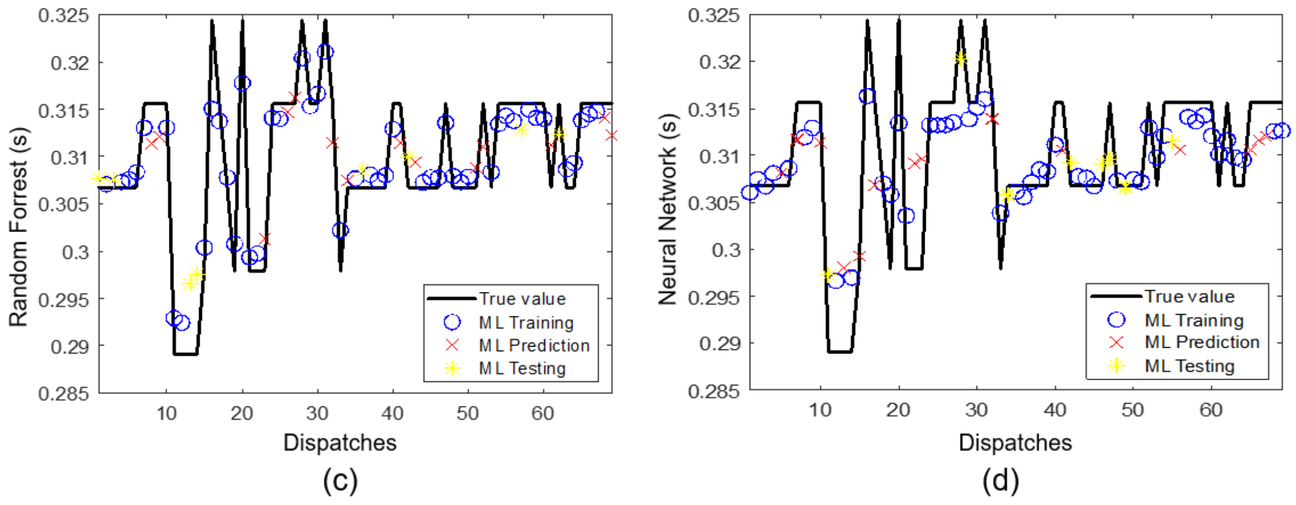


Table 1. Time performance

Conventional Method	AI Method (Offline)	AI Method (Online)
1.2 h	0.9 h	0.18 milliseconds

Figure 3. Performance of the developed AI-based stability assessment tool on the full 20,000-bus WECC system:

- (a) predicted frequency nadir using the random forest algorithm,
- (b) predicted frequency nadir using the neural network algorithm,
- (c) predicted CCT value using the random forest algorithm,
- (d) predicted CCT value using the neural network algorithm.