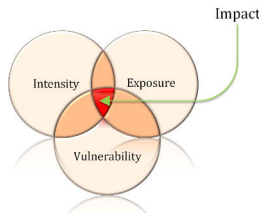


Abstract

Both the frequency and intensity of extreme weather events have been trending higher in recent years, leading to significant infrastructure damage in the electric grid. The impact of these extreme weather events is desired to be analyzed and quantified to help transmission and distribution system operators prepare for and prevent significant damage and subsequent loss of power. In this paper, we develop an approach that models the impact of extreme weather on the grid and identifies the worst impact zone using Q-learning (a reinforcement learning approach). The identification results reveal grid vulnerability to weather events and provide insights for system operators to help achieve optimal resource allocation and crew dispatch to minimize the adverse impacts of extreme weather. Simulation studies are conducted on the IEEE 123-node system to demonstrate the performance of the proposed approach.

Impact Modeling



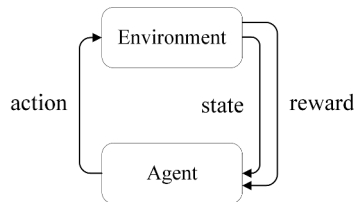
$$\text{Impact (Extreme Weather)} = f(\text{Intensity}, \text{Exposure}, \text{Vulnerability})$$

$$\text{Vulnerability (Grid)} = f(\text{generation loss}, \text{failure size})$$

$$\text{Exposure (Grid)} = f(\text{number of buses})$$

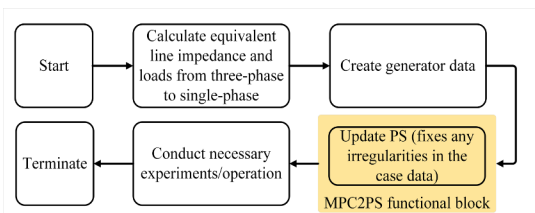
$$\begin{aligned} \text{Intensity (EW)} \\ = f(\text{wind}, \text{temp.}, \text{pressure}, \text{precipitation}, \text{humidity}) \end{aligned}$$

Q-Learning

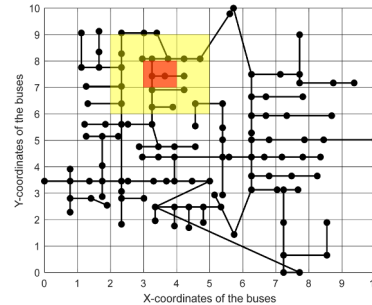


Q-learning agent learns the policy that tells the learning agent what action should be taken under different circumstances

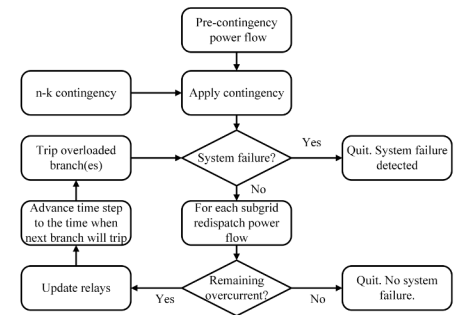
Test case preparation



Mesh Grid Representation



Generation loss and line failure



- Test case: IEEE – 123 nodes distribution system
- GIS information (coordinates) of the test case is used to represent the system in a 10×10 grid
- Red marked box showing the event epicenter and the yellow marked boxes are the edges of the event.
- Generation loss and line failures are used to calculate the vulnerability and vulnerability contributes to the calculation of impact.
- Impact is used as the reward for the Q-learning agent

