Feature combination analysis in smart grid based using SOM for Sudan national grid

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Abstract. In the investigation of power grid security, the cascading failure in multi-contingency situations has been a test because of its topological unpredictability and computational expense. Both system investigations and burden positioning routines have their limits. In this project, in view of sorting toward Self Organizing Maps (SOM), incorporated methodology consolidating spatial feature (distance)-based grouping with electrical attributes (load) to evaluate the vulnerability and cascading impact of various part sets in the force lattice. Utilizing the grouping result from SOM, sets of overwhelming stacked beginning victimized people to perform assault conspires and asses the consequent falling impact of their failures, and this SOM-based approach viably distinguishes the more powerless sets of substations than those from the conventional burden positioning and other bunching strategies. The robustness of power grids is a central topic in the design of the so called "smart grid". In this paper, to analyze the measures of importance of the nodes in a power grid under cascading failure. With these efforts, we can distinguish the most vulnerable nodes and protect them, improving the safety of the power grid. Also we can measure if a structure is proper for power grids.

1. Introduction
Power systems are worked with the goal that over-burdens don't happen either progressively or under any measurably likely contingency. This is regularly called keeping up framework “security”. Test system is outfitted with devices for dissecting possibilities in a programmed manner. Contingency can comprise of a few activities or components that are straightforward case for blackout of a solitary transmission line and intricate for blackout of single of a few lines, various generators, and the conclusion of typically open transmission line. The Power grid security is one of the huge perspectives, where the correct move needs to be made by the operational specialists for the unseen contingency. In this way the contingency investigation is key for the power grid security. The contingency positioning utilizing the execution list is a strategy for the line blackouts in a power grid, which positions the most noteworthy execution record line first and returns in a plummeting way focused around the computed PI for all the line blackouts [1].

A self organizing map (SOM) is a sort of artificial neural network (ANN) that is prepared utilizing unsupervised figuring out how to create a low-dimensional (ordinarily two-dimensional), discretized representation of the information space of the preparation examples, called a map. "Self Organizing" is on the grounds that no supervision is needed [2]. SOMs learn all alone through unsupervised aggressive learning. "Maps" is because they attempt to map their weights to conform to the given input
data [3, 4]. Smart grid is conveys electrical power to the shoppers utilizing two way computerized engineering. Monitors are the supply to the customers and estimations. Numerous nations and power markets are taking a gander at Smart Grid as progressive arrangements in conveying blend of upgraded qualities going from higher security, dependability and power quality, lower expense of conveyance, interest streamlining and vitality productivity. Smart grid arrangements empower utilities to build vitality profit and power dependability while permitting the clients to deal with the use and expenses through on going data trade [5]. It affects all the parts of the power grid like generation, transmission and distribution.

As the result, the main of this research are understand the various types of transients and its analysis in power system and illustrate the concept and design of self organizing maps in smart grid.

2. Methodology
The flowchart as shown in figure 1 describes all the activities or tasks to be done at each stage of the project. It is important to make sure the project complete at the specific time.

![Flow Chart of Methodology](image-url)
3. Result
Analysis and simulation there were using MATLAB software to determine the analysis. From the analysis, based on the Self Organizing Map, U-matrix is shown and easy to see that the top three rows of the SOM form a very clear cluster[6]. There are four types of normalization method that are Log, Logistic, Range and Var. For the data, previous work paper from Sudan National Grid will be selected to determine the analysis [7]. Optimized number of neurons value at 200 neurons is selected for analysis and simulate to determine the result.

From this load data table, the comparison U-matrix result between parameters ‘P and Q’, ‘P,Q and S’, and ‘P,Q,S and θ’ with four types of normalization method that is Log, Logistic, Range and Var will be shown in figure 2, figure 3 and figure 4 below:

![Figure 2. U-matrix result using parameters P and Q.](image)

![Figure 3. U-matrix result using parameters P,Q and S.](image)
| Bus Number | Active Power (MW) | Reactive Power (MVAR) | Apparent Power (MVA) | Angle (°) |
|------------|------------------|-----------------------|---------------------|-----------|
| 1          | 35.5             | 21                    | 41.3                | 30.6      |
| 2          | 0                | 0                     | 0                   | 0         |
| 3          | 0                | 0                     | 0                   | 0         |
| 4          | 0                | 0                     | 0                   | 0         |
| 5          | 0                | 0                     | 0                   | 0         |
| 6          | 30               | 15                    | 33.5                | 26.6      |
| 7          | 0                | 0                     | 0                   | 0         |
| 8          | 0                | 0                     | 0                   | 0         |
| 9          | 0                | 0                     | 0                   | 0         |
| 10         | 0                | 0                     | 0                   | 0         |
| 11         | 24               | 12                    | 28.8                | 26.6      |
| 12         | 0                | 0                     | 0                   | 0         |
| 13         | 6                | 3                     | 6.7                 | 26.6      |
| 14         | 15               | 6                     | 16.2                | 21.8      |
| 15         | 49               | 33                    | 59.1                | 33.96     |
| 16         | 0                | 0                     | 0                   | 0         |
| 17         | 40               | 15                    | 42.7                | 20.6      |
| 18         | 35               | 25                    | 43                  | 35.54     |
| 19         | 35.1             | 20.2                  | 40.5                | 30        |
| 20         | 93               | 52                    | 106.6               | 29.2      |
| 21         | 52               | 32                    | 61.1                | 31.6      |
| 22         | 43               | 28                    | 51.3                | 33.1      |
| 23         | 40               | 21                    | 45.2                | 27.7      |
| 24         | 39               | 12                    | 40.8                | 17.1      |
| 25         | 83               | 45                    | 94.4                | 28.5      |
| 26         | 40               | 21                    | 45.2                | 27.7      |
| 27         | 40               | 24                    | 46.7                | 31        |
| 28         | 44               | 30                    | 53.3                | 34.3      |
| 29         | 14               | 7                     | 15.7                | 26.6      |
| 30         | 10               | 14                    | 17.2                | 54.5      |
| 31         | 24               | 10                    | 26                  | 22.6      |
| 32         | 37               | 15                    | 40                  | 22.1      |
| 33         | 30               | 20                    | 36                  | 33.7      |
| 34         | 38               | 18                    | 42                  | 25.4      |
| 35         | 12               | 5                     | 13                  | 22.6      |
Table 2. SOM Result Using Hexagonal Topology using parameters P and Q.

| Normalization Method | Classification Result (P,Q) | Map Size | Quantization Error | Topographic Error | Training Time (sec) |
|----------------------|-----------------------------|----------|--------------------|-------------------|---------------------|
| Log                  |                             | [50, 4]  | 0.005              | 0.029             | 0                   |
| Logistic             |                             | [40, 5]  | 0.002              | 0.086             | 0                   |
| Range                |                             | [40, 5]  | 0.002              | 0.000             | 0                   |
| Var                  |                             | [40, 5]  | 0.007              | 0.029             | 0                   |

Table 3. SOM Result Using Hexagonal Topology using parameters P, Q and S.

| Normalization Method | Classification Result (P,Q,S) | Map Size | Quantization Error | Topographic Error | Training Time (sec) |
|----------------------|--------------------------------|----------|--------------------|-------------------|---------------------|
| Log                  |                                | [15, 13] | 0.011              | 0.086             | 0                   |
| Logistic             |                                | [40, 5]  | 0.002              | 0.057             | 0                   |
| Range                |                                | [50, 4]  | 0.001              | 0.000             | 0                   |
| Var                  |                                | [50, 4]  | 0.005              | 0.000             | 0                   |

Table 4. SOM Result Using Hexagonal Topology using parameters P, Q, S and θ.

| Normalization Method | Classification Result (P,Q,S, θ) | Map Size | Quantization Error | Topographic Error | Training Time (sec) |
|----------------------|---------------------------------|----------|--------------------|-------------------|---------------------|
| Log                  |                                 | [40, 5]  | 0.009              | 0.000             | 0                   |
| Logistic             |                                 | [25, 8]  | 0.002              | 0.057             | 0                   |
| Range                |                                 | [25, 8]  | 0.002              | 0.029             | 0                   |
| Var                  |                                 | [25, 8]  | 0.009              | 0.029             | 0                   |
4. Discussion
Based on theoretical, the best value of Quantization error must nearly ‘0’, Topographic error also must nearly ‘0’ and Training time must be ‘5’ and below The recreation of SOM programming comprises of the mix between the different normalization methods ('var', 'range', 'log' or 'logistic') and the optimum number of neurons. The 'var' data input will normalize the variance variable to unity and the means to zero. For the 'range' input data will scale the variable values between zero and one. The 'log' is a logarithmic change and the 'logistic' softmax change scales all expected values somewhere around zero and one[8]. The challenges of multi-contingency analysis for smart grid attacks can be investigation in the following perspectives that the restricted scalability of parameter P,Q,S and θ many contingency analyses which are validated mostly on relatively small power system benchmarks. The constrained learning of attackers on the complex dynamics in real-time power systems, in contrast to the power system managers, that restricts their strength in modeling the power system and the estimation of the impact of their attacks. The difficulties in solving both linear and nonlinear equations in bulk power systems with inadequate data and intensive computational burden.

5. Conclusion
This paper proposes a topological technique to study the vulnerability of subsets of substations in power grids focused around SOM clustering. While the physical attributes is considered as the premise in the assessment of power grid security, partner falling investigation with spatial feature based clustering demonstrates that the joined methodology has the capacity spot the more basic segments in a substantial scale power lattice than conventional routines, giving a proficient device to the contingency analysis. In our methodology, the potential victimized people are prepared by the powerful SOM clustering so the applicants of pursuit are refined to a restricted extent, which essentially decreases the computational cost while keeping the capacity to recognize the absolute most powerless sets or assault conspires in the lattice. SOM is a compelling stage for visualization of high-dimensional information. However, to have the capacity to completely comprehend substance of an information set, it is basic to see whether the information has cluster structure. In the event that this is the situation, the clusters need to be concentrated to have the capacity to completely abuse the properties of the information set by delivering synopsis data.

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