

Computer Graphics - 1

Literature Review - 2

The primary article chosen by me for the literature review is **Future Challenges for Ensemble Visualization**, by the authors- Harald Obermaier and Kenneth I. Joy. from the University of California, The above article was published in the journal “[IEEE Computer Graphics and Applications](#)” [2014vol.34](#) IssueNo.03-May-June.

I choose this article for my final review as this article talks about the same difficulty we face while executing an algorithm, and not getting desired results so we keep on changing the parameters and restarting. Everyone who works or codes with computers faces this problem so scientists have started sorting out this problem. So, imagine how much more of a problem these engineers or scientists must be facing who work with visualization data. Nowadays, due to the increased availability of vast computation resources and new computation strategies they help in offering a solution to this dilemma which has long tormented all of the computer engineers working in this field of visualization. The paper then talks that after various discussions, meetings with simulation scientists and visualization researchers, the visual analysis of ensemble data has repeatedly come up as visualization's most important field, and the researchers expect it to have a wide impact on visualization field in the next few years. Their goal is to develop expressive visualizations of an ensemble's properties to support scientists in this demanding parameter-space exploration.

This objective to visualize a single solution is not entirely new to scientists as they had started visualization to a single concrete solution back in the mid-90s. However, there is a key difference between uncertain data and ensemble data. Uncertain data encodes the probability distributions of values throughout a dataset, allowing identification of the most likely or most common output, while containing no information about how different outcomes relate. Ensembles, on the other hand, present concrete distributions of data, in which each outcome can be uniquely associated with a specific run or set of simulation parameters.

The article further states that there are two major challenges or hurdles faced by them currently, firstly to develop visualization techniques and tools to extract and highlight commonalities, differences and trends in ensemble members. And secondly is to enable scientists to discover conceptual drawbacks, the value of simulation models or specific parameter choices. Also, there are two major approaches for Visualizing Ensemble Data, first is Feature-based visualization which extracts features from individual ensemble members

and compares them across the ensemble and second is Location-based visualization compares ensemble properties at fixed locations in the dataset.

Also, there are a variety of prediction models but weather and climate research are a central driving force behind the creation of simulation ensembles. It further describes in detail Feature based Visualization and Location based Visualization. The article and on a note saying that in the future there is the need for effective visual-analysis tools for ensembles could open and extend a variety of research directions and application scenarios. Also the challenges that will be faced as these techniques further develop and need for new solutions and methods that will be needed to tackle them.

The secondary article chosen by me which is referred in the primary article is **Noodles: A Tool for Visualization of Numerical Weather Model Ensemble Uncertainty** which was published in [IEEE Transactions on Visualization & Computer Graphics](#) 2010 vol.16 Issue No.06 - November/December the authors of this article are all from Mississippi State University. [Jibonananda Sanyal](#), [Song Zhang](#), [Jamie Dyer](#), [Andrew Mercer](#), [Philip Amburn](#), [Robert Moorhead](#).

While in the primary article it is written in detail about ensemble visualization its methods and approach, challenges etc. The second article talks in about Numerical weather model ensemble uncertainty. The secondary article states that numerical weather prediction ensembles are routinely used for operational weather forecasting. It states that the members of these ensembles are individual simulations with either slightly perturbed initial conditions or different model parameterizations, or frequently both. Also, that multi- member ensemble is usually large.

It states that in general forecast meteorologists are interested in understanding the uncertainties associated with numerical weather prediction. Specifically, the variability between the ensemble members. It states that during that time when the article was written, visualization of ensemble members is mostly accomplished through spaghetti plots of a single mid-troposphere pressure surface height contour. And in order to explore new uncertainty visualization methods, it talks about the set up for the Weather Research and Forecasting (WRF), was used to create a 48-hour, 18-member parameterization ensemble of the 13 March 1993 'Super storm'.

The article further states that a tool was designed to interactively explore the ensemble uncertainty of three important weather variables: water-vapor mixing ratio, perturbation potential temperature, and perturbation pressure. Uncertainty was quantified using individual ensemble member standard deviation, inter-quartile range, and the width of the 95% confidence

interval. To further enhance the study and get to a more accurate result Bootstrapping was employed to overcome the dependence on normality in the uncertainty metrics. A coordinated view of ribbon and glyph-based uncertainty visualization, spaghetti plots, and data transect plots was provided to two meteorologists for expert evaluation. They found it useful in assessing uncertainty in the data, especially in finding outliers in the ensemble run and therefore avoiding the WRF parameterizations that lead to these outliers.

Additionally, later with the new techniques the meteorologists could identify spatial regions where the uncertainty was significantly high, allowing for identification of poorly simulated storm environments and physical interpretation of these model issues. The article was written at a time when there was a need for better and perfect weather predicting methods to forecast weather and climate changes so that precautions can be taken before hand to protect and equip ourselves with the change in weather .

From the two articles I can understand that the primary article is written in detail about ensemble visualization its methods, approach, challenges ,future problems, solutions, technology and manpower needed to tackle it effectively so that we get better visualization techniques. Whereas, the second article talks in detail about Numerical weather model ensemble uncertainty. The part of the second article is mentioned in passing in the primary article and its problems now are solved too, but at the time of the release of the second article they were problems which needed attention, but now they are hopefully solved as it states in the primary article.