

Electrical and Computer Engineering

Comparing Multi-Step Approaches in Load Forecasting

A proposal in partial fulfilment of the MScE

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Comparing Multi-Step Approaches in Load Forecasting

Updated: 2020 Jun-25 by Tolulope Olugbenga

# Focus

// Make this as detailed as you can

// Try to make it about 5 pages

* Multi step load forecasting in context – What is it, and what makes it important. The difference between it and single step forecasting; and when one is more important or needed than the other. Different load forecasting horizons, and how they differ from one another.
* Different multi step forecasting approaches – Shallow (Jha et al., 2019) and deep approaches.
* What makes an approach good and how do we measure it? (Detail the most used metrics (MAPE, MAE, RMSE…)). What are these metrics (Mathematically, …), and what do they tell you? What are the disadvantages or the limitations of using each metric?
* How do you propose to solve the problem?

<Pose the research problem here – aim for 3 pages. Provide enough background information for the reader to understand why the problem exists, and why it is useful to solve – make sure you back up all your information with literature references. Conclude this section with a brief explanation about the approach you are researching to solve the problem.>

## General Overview of Load Forecasting

Electricity is one of the driving forces of economic development and is essential to our daily life and wellbeing. Load forecasting is an integral part in the process of the planning and operation of electric utilities; it has played a vital role in the power industry for over a century. In terms of power supply and demand; for the stable supply of electricity, the reserve power must be prepared. Businesses needs of load forecasting includes power systems planning/operations, revenue projection, rate design, energy trading, and so on. Load forecasting is needed by many business entities other than electric utilities, such as load aggregators, power marketers, independent system operators, regulatory commissions, industrial/commercial companies, banks, trading firms, and insurance companies (Hong & Fan, 2016)(Saurabh et al., 2017). Electricity load forecasting still receives attention from researchers today, because the need of more accurate forecasts arises, particularly with the advent of new smart grid technologies.

The demand pattern is very complex due to the deregulation of energy markets; therefore finding an appropriate forecasting model for a specific electricity network is not a trivial task (Almeshaiei & Soltan, 2011). Electric load forecasting is not a trivial task due to the number of the different random variables that needs to be taken into consideration to predict human behavior. People often use electricity at any time that suits their lifestyle, and for the most part we all happen to use electricity at the same time. Most people share a similar lifestyle pattern, from when we wake up, to having a shower, making some breakfast, leaving for work, coming back at night, going to bed, doing our laundry on weekends and so on.

Electricity demand is accessed by accumulating the consumption periodically; it can be considered for hourly, daily, weekly, monthly, and yearly periods. The forecasting processes can be grouped into four categories based on their horizons namely: very short-term load forecasting (VSTLF), short term load forecasting (STLF), medium term load forecasting (MTLF), and long-term load forecasting (LTLF). The cut-off for these categories are, 1 day, 2 weeks, and 3 years respectively (Deng et al., 2019). A rougher classification would consider only two categories: STLF and LTLF, with a cut-off at two weeks. Short term load forecasting has been the major point of focus in most literatures (Hong et al., 2014).

Different factors can affect load forecasting such as; the location of the area, the type of customers in the region, weather factors (temperature, etc.), trend in the data, the time of the day, day of the week, and other unpredictable factors (coronavirus outbreak, etc.).

## Literature Review

## Multi-Step Load Forecasting

* Multi step load forecasting in context – What is it, and what makes it important. The difference between it and single step forecasting; and when one is more important or needed than the other.

////////////

Multi-Step forecasting can be defined as a method that predicts a sequence of values in a time series. In the area of load forecasting, the sequence of values refers to the future demand values in relation to the time horizon used for prediction. Majority of authors in the load forecasting literature focused on short term load forecasting, and also on single-step ahead forecasting. Single-step forecasting on the other hand is a method that predicts only one step in the future.

Single-step forecasting could be useful in cases where only one value needs to be forecasted e.g. predicts the peak power consumption of the next day. Multi-step on the other hand is a much broader approach which is more essential when we need to predicts multiple times in the future e.g. the demand for the next 24 hours. As the time interval for prediction gets wider, the accuracy of the multi-step prediction diminishes. This is because several factors affect the demand for electricity; the farther in time we need to predict the harder it becomes. Single-step is generally more accurate as it is easy to predict a single point in time.

### Types of Multi-Step Approaches

There are three major strategies used for multi-step forecasting namely; the direct approach, the recursive approach, and the direct-recursive approach (Bonetto & Rossi, 2016; Jha et al., 2019). Details of each this approach would be detailed below.

1. **The Direct Approach:** In order to forecast the  hour ahead demand, separate models need to be developed to forecast each hour specifically,.

// Continue here and write more about the different approaches

## Evaluation Metrics

# Investigation

<Describe in some detail how you plan to investigate your approach to solving the problem – aim for 4 pages. Be specific about exactly what aspects of the approach are under examination, and provide as many details as you can about the approach. Include any details you can provide about planned simulations or experiments, including the factors which are being evaluated, and performance metrics used for evaluation. If you borrow simulation/experimental data or methods from previous research, be sure to reference them.>

# Contributions

<Briefly list what contributions are made by completing this work – aim for 1 page. Don’t focus on what you learn by completing the work; instead, focus on what researchers will learn by reading the work.>

Appendix A: How to use this Template

# Styles

Use this template to handle all of your formatting issues. They will ensure consistent fonts, spacing between sections etc. To select a particular style, open the *styles* pain as depicted below:

|  |
| --- |
|  |
| Figure 1: a) Where to find the Formatting Styles b) where to find ‘references’ to insert captions |

## Regularly used styles

Avoid using the Normal style. It is in place as a reference for other styles. Here is a list of regularly used text styles:

Body Text: your main text should be formatted with this style

Block Text: used to indent content from the left and right

Captions: Use Figure Captions, Table Captions and Equation Captions by navigating to: >references>insert caption>…

Nlists and BLists (for numbered and bulleted lists)

Heading 1

Heading 2

Heading 3

Specialty formats: Strong, Emphasis, Subtle Emphasis, Intense Emphasis

There are also a set of styles included in the list for one-time use:

Cover styles: Pretitle, Title, Subtitle, authorship…

Header and Footer

Table of Contents styles, TOC1, TOC2, and TOC3 (These are linked to Sections to automate your table of contents)

## Heading and Numbering

This is a bit tricky, but here is a brief explanation. Section Headings should be formatted according to Heading 1, Heading 2 and Heading 3 (Heading 2 and 3 are sub-heading formats). These styles are linked to the ‘list style’ called Headings so when you use a Heading style they are properly numbered.

|  |
| --- |
|  |
| Figure 2: Example of Properly formatted 5th section headings |

The template should apply the list style automatically, but if it doesn’t, when you select your first heading, go to the list style menu and select the Headings list style to apply it.

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| --- |
|  |
| Figure 3: Where to find the List Style menu |

# Inserting Equations and Figures

Use the quick part tables to insert an equation or a figure. You can access these from the short cut icon indicated in Figure 1. When you navigate to this icon, it provides a list of tables. Use the Equation Table and the Figure Table as in the examples below: The first table is an equation table. The last column is an equation number, inserted by navigating to >references>captions>equation. The second table is a figure table. The last row is a combination of figure number with text describing the figure. To insert the number, navigate to >references>captions>Figure. Then add your text.

|  |  |  |
| --- | --- | --- |
|  | [use equation tool to place equation here] | ( 1 ) |

|  |
| --- |
| [place figure here] |
| [place caption here…if it is less than 1 line, center it] |

# Referencing

Use inline referencing according to IEEE referencing style [1, 2]. For instance, I have included the reference numbers after ‘IEEE referencing style’ and I will include a separate referencing section where I will list the sources in the order which I cite them. Use the *Rlist* style to create your reference list. If you want, you can automate their links with the inline citation by navigating to >references>cross-reference and choosing ‘Numbered Item’. Make sure you set ‘Insert Reference to’ paragraph number. The following are typical examples of items in a references list (I am not too particular about the detailed formatting in the citations, but include the standard information, and be consisten):

1. D Graffox (Sep-2009), IEEE Citation Reference, <http://www.ieee.org/documents/ieeecitationref.pdf>, last accessed, 2015-MAR-13.
2. (no author/date available), IEEE Citation Style, <http://library.queensu.ca/book/export/html/5846>, last accessed, 2015-MAR-13.
3. D MacIsaac, C Hrabi, “Our Favorite Topics”, Journal of Interesting Information, 1(24), 2010.

# Title Page and Headers and Footers

Don’t forget to update the standard content of each of these sections. Of special note is the #-of-pages field in the footer which should be updated manually at the completion of the document so that the Tite and Contents pages are not included. The Reference page should be included (even though it is NOT included in the page count of 10 pages). Also of special note are the ‘created’ and ‘updated’ fields on Title page AND in the footer. In the title page, these fields can be edited by double clicking them. In the footer they are linked to the title page fields through a cross-reference. To update them, simply double click them.

One final note – take a close look at the footer in this appendix compared to the footer in the main body. The paging is different in the appendix. This is because the appendix is a NEW SECTION and the footer for this section has been unlinked to the previous section. Be careful not to mess sections up, but if you do, you can reinstate them using >Page Layout>Breaks>(Section Break) next page. Another interesting thing about this Appendix is that its title uses the stye ‘Contents Heading’. If you don’t do this, it won’t show up in the table of contents properly.