Nonlinearities and Noise Identification in an Active Suspension System

Ethan Stubley 2128009

University of Warwick 2024

Table of Contents

List of Figures

1.Introduction

1.1. Background, Aims & Objectives

Suspensions systems are a crucial element to ensuring a safe and pleasant driving experience, not only improving a passenger's comfort, but also reducing the severity of impact in the unfortunate event of an accident. There are three main types of suspension systems used in vehicles; passive, semi-active and active.

'Contemporary car suspension systems predominantly contain passive control elements, namely springs and dampers, and have evolved to the point at which it seems reasonable to suppose that they will not improve much without changes in principle" (Sharp et al., 1987). This has led to much more research into active suspension, such as Fayyad's study (2012), into constructing a control system for active suspension and the study done by Milanese and Novara (2004) into 'set membership identification of nonlinear systems', and more recently, the study into the application of multi-input uncorrelated periodic signals for identification of active suspension systems (Kioutsoukis et al., 2022).

The aim of this project is to try to identify the nonlinearities in an active suspension system as their presence was proven in the study by Kioutsoukis et al., (2022). If these nonlinearities can be identified, they can be reproduced in simulated environments, which can advance the development of active suspension systems in the future. One practical application of this data would be developing a nonlinear compensator with appropriate noise filtering techniques, this could then be integrated into a suspension system and would be able to further improve the performance of that suspension system.

The project's primary method for identification will be using the Hammerstein-Weiner model to attempt to identify these nonlinearities from the experimental data collected in Kioutsoukis et al., (2022). A Hammerstein-Wiener model 'consists of three subsystems, where a linear block is embedded between two nonlinear subsystems' (Hammar et al., 2019). This model is a particular kind of nonlinear system 'where the nonlinear block is static and follows or is followed by a linear system' (Bai 2002). The model in question will be a block-oriented model and there are several advantages to this: '(1) low cost in identification tests; (2) low cost in identification computation; (3) it is easy to comprehend and to incorporate a priori process knowledge and (4) they are easy to use in control' (Zhu 2002).

The initial hypothesis for this study is that the experimental data comprises of a linear component, a nonlinear component and some noise component. It is my aim to identify and isolate this nonlinear component.

1.2 Risk Management

Due to the nature and the time-constraint placed upon the project, the main risk to the project's level of success is finding an appropriate model for the nonlinearities. With this in mind, all results and findings, positive or negative will be recorded in this report so that this project may continue in future, with the added benefit of having the additional research covered in this report.

The other major risk in this report is that to personal health and well-being - due to long periods of time sat down at a desk, testing models in software on a laptop. The best way to mitigate this is to ensure frequent breaks and exercise.

1.3 Remaining Structure of the Paper

The remainder of the paper will follow the following structure: Chapter 2 discusses the background of the project, going into detail on different suspension types, vehicle models, the Hammerstein-Weiner model and noise filters. Chapter 3 discusses how the experimental data was gathered from the previous study that this project is based upon, and Chapter 4 discusses how the tools available in MATLAB are utilised in this project. Chapter 5 gives more detail into optimising a noise filter and Chapter 6 contains the results from all the nonlinear models used in this project. Chapter 7 offers a conclusion and suggestions for future works, followed by the references given in full in Chapter 8 which have been cited throughout the paper using the Harvard convention. Appendices are given in Chapter 9.

2. Background & Literature Review

2.1. Suspension Types

A suspension system in a passenger vehicle is crucial to improving ride comfort and passenger experience (Jiregna et al., 2020). Suspension systems can typically be broken down into three categories: passive, semi-active and active suspension. A passive suspension system will consist of a spring and a damper, and ‘cannot satisfy the comfort requirements when subjected to different road profiles’ unlike a semi-active or active suspension system may be able to (Kumar et al., 2020), this is because the characteristics of the springs and dampers are fixed (Ahmadian, 2001). These characteristics would be set by the designer, usually with a specific use in mind. A typical passive suspension system is shown in figure 1.

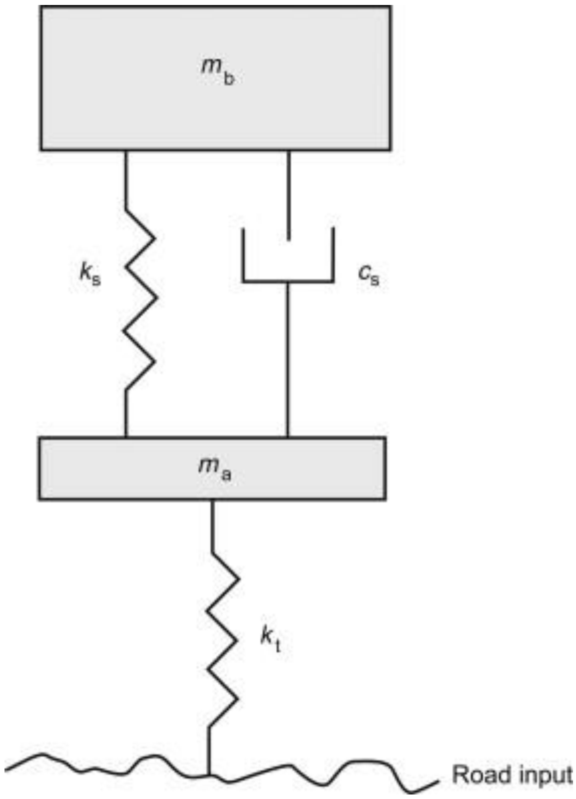


Figure 1: Passive Suspension System (Ahmadian, 2001)

In figure 1, m_b represents the mass of the vehicle body (sprung mass) and m_a represents the tyre-axle assembly (unsprung mass), k_s is the suspension spring and the damper is c_s which is positioned between the vehicle body and axle. The stiffness of the tyre is represented by k_t (Ahmadian, 2001).

Semi-active suspension consists of a spring and damper much like a passive system, however the difference is semi-active suspension has ‘’elastic parameter stiffness and shock absorber damping [that] can adjust according to the need for adjustment and control’ (Jibril et al., 2020).

A semi-active system only needs a low power controller which is cheaper than a fully active system however semi-active system does lack other ‘important secondary advantages’ when compared to a fully active system (Giua et al., 2004).

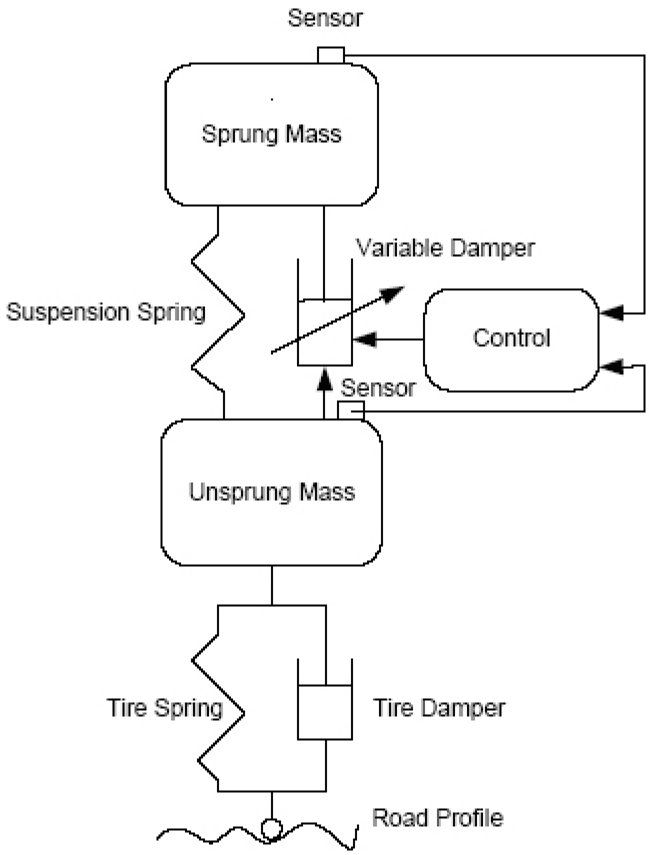


Figure 2: Semi-active Suspension System (Khajavi et al., 2007)

As shown in figure 2, a semi-active system contains an additional controller and a sensor, compared with a passive system, allowing for the damper coefficient to be adjusted. In this example only the damper is adjustable.

An active suspension system improves ride comfort, stability and handling of a passenger vehicle to a greater extent than semi-active or passive can. Active suspension systems can be adjusted to the designer’s desires of performance (El-Beheiry, 2000), as well as being more elastic and efficient than a semi-active or passive system (Lin et al., 2011). These suspension systems do however have a higher production cost (Yoshimura et al., 2001).

Active suspension systems make use of control algorithms to improve ride comfort ‘such that the effect of the rough road surfaces will be minimally felt by the passengers’ (Kioutsoukis et al., 2022). ‘Active suspension systems dynamically respond to changes in the road profile because of their ability to supply energy that can be used to produce relative motion between the body and wheel’ (Sam et al., 2004). These suspension systems usually ‘include sensors to measure suspension variables such as body velocity, suspension displacement, wheel velocity and wheel or body acceleration' (Sam et al., 2004). A diagram for an active suspension system is shown in figure 3.

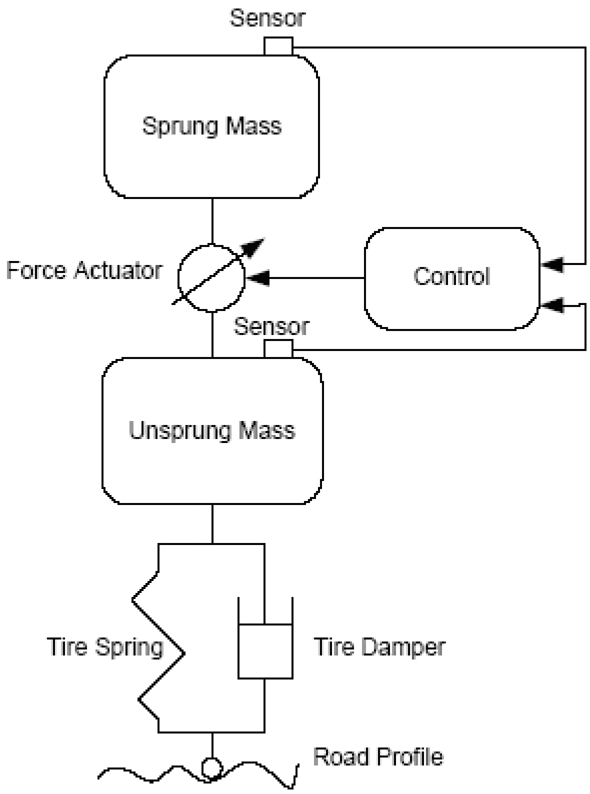


Figure 3: Active Suspension System (Khajavi et al., 2007)

One drawback to an active suspension system is that if it is subject to a surface that excites certain frequencies, these frequencies can resonate and cause discomfort (Majjad, 1997). The challenge lies within identifying these resonant frequencies in order to counter them, therefore reducing the effects of the excited frequencies. Currently, this has only been proven possible with a 'noise-free linear system', since 'one can easily obtain the transfer function and compute the [frequency response function] in a straightforward manner' (Kioutsoukis et al., 2022). However, in practice, a system in the real world will never be noise-free so this does not provide a practical solution for everyday use, which is where the main challenge for this project arises – attempting to identify these noise and nonlinearities effects.

2.2. Vehicle Modelling Types

There are three main modelling approaches when it comes to suspension systems full-car model, half-car and quarter-car model. A 'full vehicle model consists of the car body (spring mass) connected by the suspension system to four wheels (unsprung masses)' (Chamseddine et al., 2007). As demonstrated in figure 4, each 'active suspension system is modelled as a linear viscous damper, a linear spring and a force actuator', with each wheel being modelled as a linear spring.

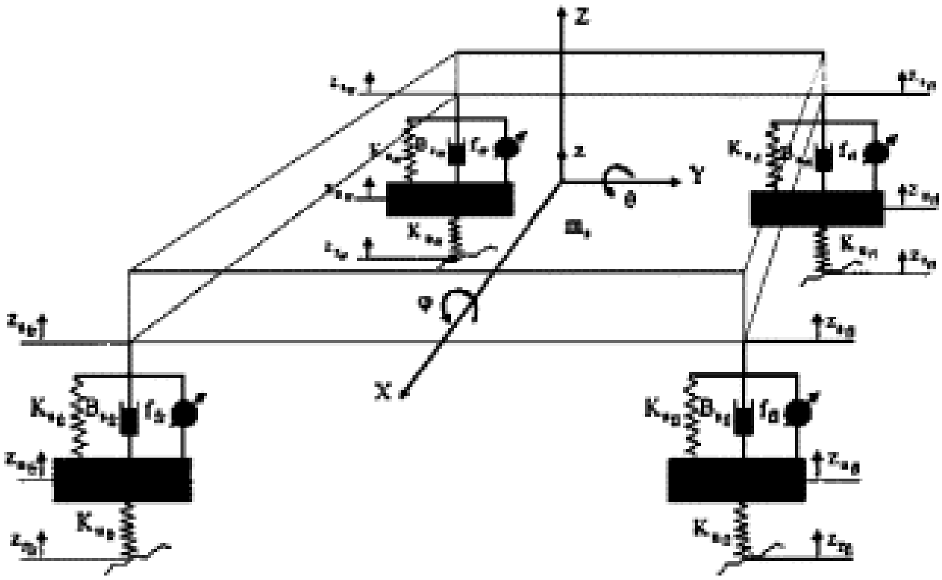


Figure 4: Full-car model (Chamseddine et al., 2007)

In this full-car model the car body is free to heave, pitch and roll and the wheels are free to bounce vertically with respect to the car body (Chamseddine et al., 2007). A full-car model has 7 degrees of freedom.

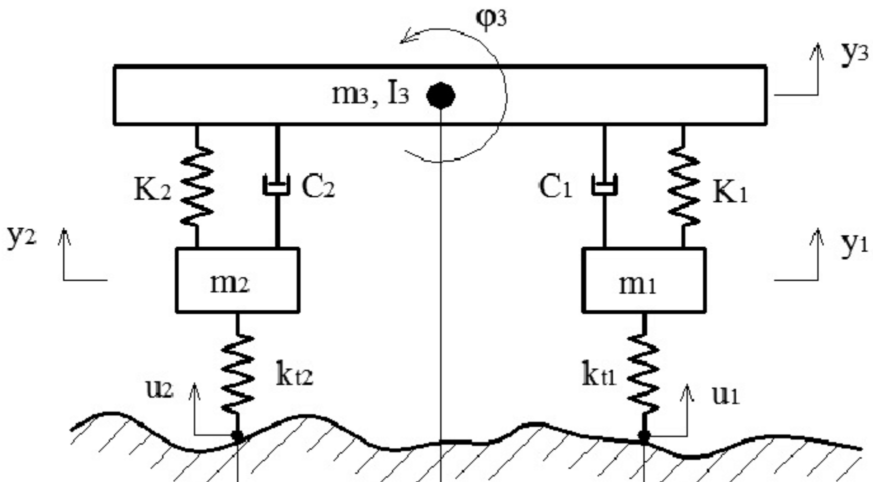


Figure 5: Half-car model (Goga et al., 2012)

A half-car model (shown in figure 5) only has 4 degrees of freedom and uses half of a full model for simplicity. However, seeing as we only are interested in analysing the vertical acceleration of the system a quarter-car model is more appropriate. By using a quarter-car model we are reducing the complexity as much as possible, a 'quarter vehicle model is the simplest representation of a vehicle in dynamic analysis' (Soong et al., 2017). This was also the conclusion in a recent study by Desai et al. (2021), 'for a bump road profile, the quarter car model, which is considerably simpler, maybe preferred if computing time or complexity is a constraint'. Quarter-car models are typically used for suspension analysis due to their simplicity whilst filtering out unnecessary features of the full-car model such as pitch and roll, and still retaining the useful information regarding the vertical accelerations of the tyre and body, as shown in figure 6.

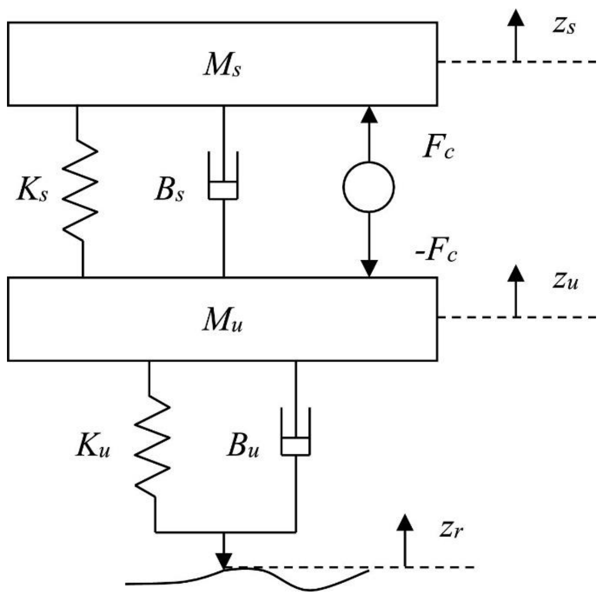


Figure 6: Quarter-car model (Tan et al., 2022)

2.3. Hammerstein-Weiner Model

A Hammerstein-Wiener model (sometimes referred to as N-L-N model) is going to be used to try and identify nonlinearities within the experimental data. Hammerstein-Weiner models are 'known as a particular class of block-oriented nonlinear models where a Linear (L) subsystem is embedded in two static Nonlinear subsystems (N)' (Sun et al., 2022). The Hammerstein model was first discussed in Narendra et al. (1966) and the Wiener model was first developed in a study relating to an interest in 'a nonlinear system using Volterra expansions' (Wills et al., 2013).

The N-L-N model works by attempting to model the data through the `nlhw` function in MATLAB, this can also be achieved using the MATLAB System Identification (SysID) Toolbox. The model takes an input *u(t)* and passes it through the input nonlinearity function block which then is passed to a linear block before being passed through the output nonlinearity block to give an output *y(t)* as depicted in figure 7.

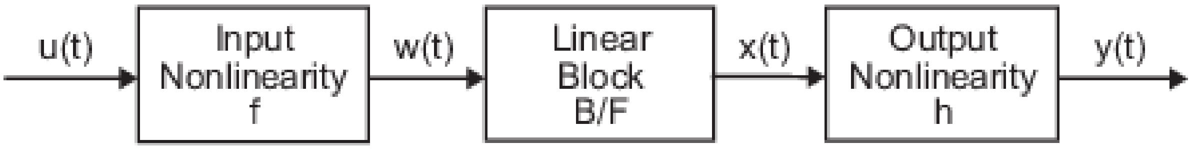


Figure 7: Hammerstein-Weiner model (Mathworks Inc., 2023)

The Hammerstein-Weiner model was chosen as a starting point over other modelling techniques such a Nonlinear ARX model or sparse identification of nonlinear dynamics (SINDy) as, within MATLAB, there are many modelling options for nonlinearity block choice in the MATLAB SysID toolbox. Another reason for choosing Hammerstein-Weiner model is that it uses 'two nonlinear elements instead of one', meaning that the model 'offers convenient higher modelling capabilities for nonlinear systems' (Sun et al., 2022).

The Hammerstein-Weiner model has been successful in identifying nonlinearities in previous studies, for example the study by Sasai et al. (2020) into optical transmitters, which made use of the Hammerstein-Weiner model for nonlinear identification. This model has not yet been applied to an active suspension system and the MATLAB SysID toolbox is specifically designed towards estimating nonlinear system dynamics through various options of modelling techniques, suggesting that the N-L-N model may prove useful in identifying nonlinearities in the experimental data.

2.4. Noise

There is also noise present in the experimental data that will need to be filtered out, several approaches could be taken to tackle this problem. The first approach is to use a moving average filter and see if that reduces the noise present in the data. A moving average filter is one of the most popular and widely used techniques owing to its simple digital realization, low computational burden, and overall effectiveness (Golestan et al., 2014).

A moving average filter works excellently with time-domain encoded signals however, it struggles with frequency domain encoded signals, the experimental data is time-domain encoded so this works well for what the filter needs to achieve (Analog.com, n.d). If this approach does not yield any positive results, there are also other filters that could be used instead such as the Gaussian filter (Cahill et al., 1993) or the multiple-pass moving average filter (Solis et al., 2007).

3. Experimental Data

3.1. Quanser Laboratory-scale Suspension System

The experimental data used in this project was collected using the active suspension system described in Kioutsoukis et al., 2022 (figure 8), which is a laboratory-scale system developed by Quanser (which is based on the quarter-car model). The 'platform can also be used to teach mass-spring-damper modelling and control at a fundamental level, as well as applications of IMU measurement and processing' (Quanser, 2023). The dimensions of the suspension system are 30.5cm in length, 30.5cm in width and 61cm in height with a total weight of 15kg (Kioutsoukis et al., 2022). The scaled down system uses three masses to represent the road (silver plate), vehicle tyre (red plate) and body (blue plate). These masses move along stainless steel shafts using linear bearings. 'The upper mass is connected to a high-quality DC motor through a capstan to emulate an active suspension system' (Quanser, 2023), 'the lower plate is driven by a powerful DC motor connected to a lead screw and cable transmission system'. The system features adjustable weight and spring stiffness as well as an accelerometer mounted to the top plate to measure vehicle body acceleration.

Figure 8: Laboratory-scale active suspension system developed by Quanser (Quanser, 2023)

The system is then fed multisine signals that are 'uncorrelated and orthogonal with one another' (Kioutsoukis et al., 2022). A multisine signal is defined by

$$u(n) = \sum A_p \cos \omega_p n + \emptyset_p$$

'where n denotes the discrete time index, γ represents the set consisting of nonzero harmonics (excluding zero harmonics), A_p is the amplitude, $\omega_p = \frac{2\pi p}{N}$ is the normalised angular frequency with period N and ϕ_p is the phase associated with harmonic p' (Kioutsoukis et al., 2022).

3.2 System Equations

The system of differential for a quarter car suspension model is as follows (x-engineer.org, n.d.):

$$m_1\ddot{z}_1 = k_1(z_2 - z_1) + c_1(\dot{z}_2 - \dot{z}_1)$$

$$m_2\ddot{z}_2 = k_2(u - z_2) + c_2(\dot{u} - \dot{z}_2) - k_1(z_2 - z_1) - c_1(\dot{z}_2 - \dot{z}_1)$$

In this equation, m_1 is the mass [kg] of the vehicle body and m_2 is the mass [kg] of the wheel and suspension. The spring constant of the suspension system [N/m] is represented by k_1, k_2 is the spring constant [N/m] of the wheel and tyre. The damping constants [Ns/m], c_1 and c_2 are for the suspension system and the wheel and tyre respectively. The displacement [m] of the vehicle body is denoted by z_1 and displacement [m] of the wheel is denoted by z_2, these displacements are considered the outputs. The road profile change [m], u, is the input.

By treating initial conditions as zero and applying Laplace's transform to these equations we can obtain a transfer function for the displacement of the vehicle body mass (x-engineer.org, n.d.):

$$Z_1(s) = (m_1s^2 + c_1s + k_1) = Z_2(s)(c_1s + k_1)$$

$$Z_2(s) = (m_2s^2 + k_2 + c_2s + c_1s + k_1) = U(s)(c_2s + k_2) + Z_1(s)(c_1s + k_1)$$

$$Z_2(s) = Z_1(s)\frac{m_1s^2 + c_1s + k_1}{c_1s + k_1}$$

$$H_1(s) = \frac{Z_1(s)}{U(s)}$$

$$= \frac{c_1c_2s^2 + (k_1c_2 + k_2c_1)s + k_1k_2}{m_1m_2s^4 + (m_1c_1 + m_1c_2 + m_2c_1)s^3 + (m_1k_1 + m_1k_2 + k_1m_2 + c_1c_2)s^2 + (c_1c_2 + c_1k_2 + k_1c_2)s + k_1k_2}$$

The displacement for the tyre can also be obtained through this method, however the rest of the project focuses on the displacement of the body and the experimental data containing the tyre displacement is not used.

This displacement data obtained in the study conducted by Kioutsoukis et al. (2022), was based upon a Simulink model used in the study which can be found in appendix 9A, as this project was continuation of the study the experimental data had been provided by M. Foo. The experimental data for the displacement of the body can be seen in figure 9.

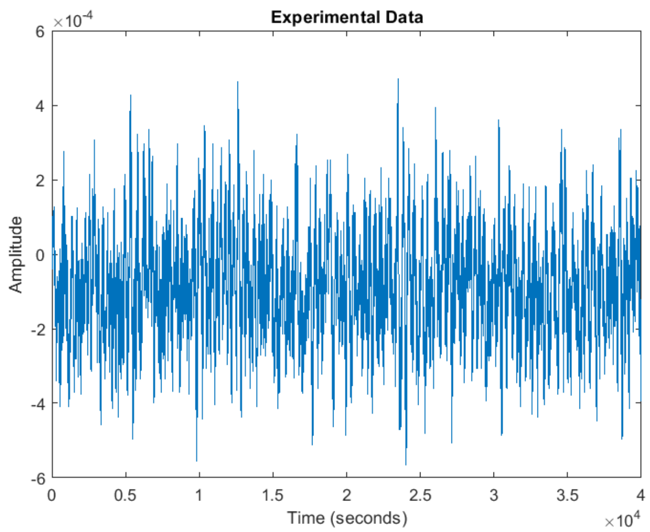


Figure 9: Experimental Data collected in the previous study

4.MATLAB System Identification Toolbox

4.1. GUI Toolbox

The project commenced with exploring what the MATLAB System Identification toolbox had to offer. The toolbox allows the user to import a dataset, set parameters for a chosen model and estimate a predicted model based on the input. Within these model choices in the toolbox there is a section which allows you to select Hammerstein-Weiner models. Within the Hammerstein-Weiner window there are options to select 7 types of nonlinear blocks (piecewise linear, sigmoid network, saturation, dead zone, wavelet network and one-dimensional network, you also have the option to select 'none') for input and output nonlinearities. You would also have to dictate the properties of the linear block (numerator order, denominator order and delay).

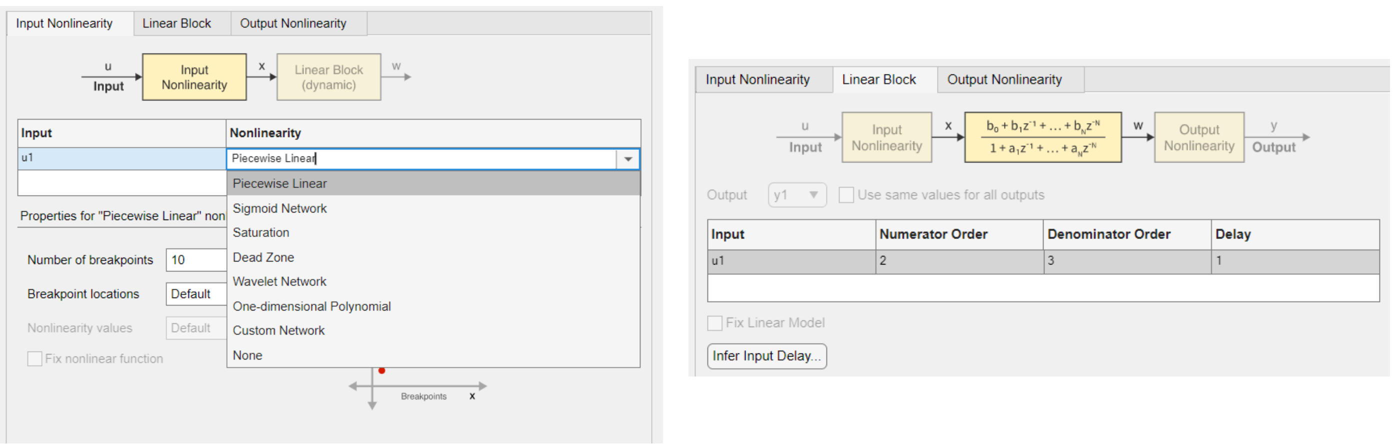


Figure 10: Left: SysID Nonlinear input options. Right: SysID linear block options

To begin, we wanted to find how altering different parameters on a small portion of the data affects how well the model fits to the data. Datapoints between 200000 and 200200 from the data collected from the vehicle 'body' were chosen to start with. Then the sigmoid network was selected as a starting point for the nonlinear blocks, however the focus at this point was finding the best order and delay for the linear block. During this testing, the units for the sigmoid blocks were also altered just to see what effect this would have on the fit value for the model.

	Input NL	Linear Block	Output NL		fit
input(u)	sigmoid (10 units)	1.2.1	sigmoid (10 units)	output(y)	58.14
	sigmoid (10 units)	2.3.1	sigmoid (10 units)		59.56
	sigmoid (20 units)	1.2.1	signoid (20 units)		3.948
	sigmoid (10 units)	2.4.1	sigmoid (10 units)		34.68
	sigmoid (10 units)	3.4.1	sigmoid (10 units)		45.32
	sigmoid (10 units)	1.4.1	sigmoid (10 units)		70.05
	sigmoid (5 units)	1.4.1	sigmoid (5 units)		68.06
	sigmoid (20 units)	1.4.1	sigmoid (20 units)		70.92
	sigmoid (50 units)	1.4.1	sigmoid (50 units)		35.85
	sigmoid (30 units)	1.4.1	sigmoid (30 units)		40.07
	sigmoid (20 units)	2.4.1	sigmoid (20 units)		31.35
	sigmoid (10 units)	2.4.1	sigmoid (10 units)		34.68
	sigmoid (10 units)	1.8.1	sigmoid (10 units)		36.9
	sigmoid (10 units)	2.8.1	sigmoid (10 units)		2.827
	sigmoid (20 units)	1.4.5	sigmoid (20 units)		57.31
	sigmoid (20 units)	1.4.2	sigmoid (20 units)		13.97
	sigmoid (20 units)	1.4.10	sigmoid (20 units)		38.99
	sigmoid (20 units)	4.8.1	sigmoid (20 units)		63
	sigmoid (20 units)	2.8.1	sigmoid (20 units)		9.743
	sigmoid (25 units)	1.4.1	sigmoid (25 units)		51.71
	sigmoid (15 units)	1.4.1	sigmoid (15 units)		79.26
	sigmoid (12 units)	1.4.1	sigmoid (12 units)		74.97
	sigmoid (16 units)	1.4.1	sigmoid (16 units)		70.06
	sigmoid (14 units)	1.4.1	sigmoid (14 units)		70.97

Figure 11: Initial test results from SysID toolbox for finding best linear order

From this set of trials (figure 11), we can see that a linear block with a numerator order of 1, denominator order of 4 and a delay size of 1 produces the best results when combined with a sigmoid input and output NL block with unit size 15 (79.26%, highlighted in green in figure 11, plotted against experimental data in figure 12). From this set of data, we can also see that increasing the numerator order has a negative effect on the fit value, likewise, increasing the denominator order past a value of 4 also has a negative effect on the fit. In instances where the delay size has been increased more than 1 the fit value also does not improve. From this initial test we can assume that, for now, a fourth order linear block with no delay is the optimal choice although this could be verified at a later stage with further testing. From this set of data, we can also observe that between the values of 5 to 50 units there is no obvious trend between unit size for the sigmoid network block and the fit value. The only thing we can say for sure is that for that range of units tested, the fit value peaks at 15 sigmoid units.

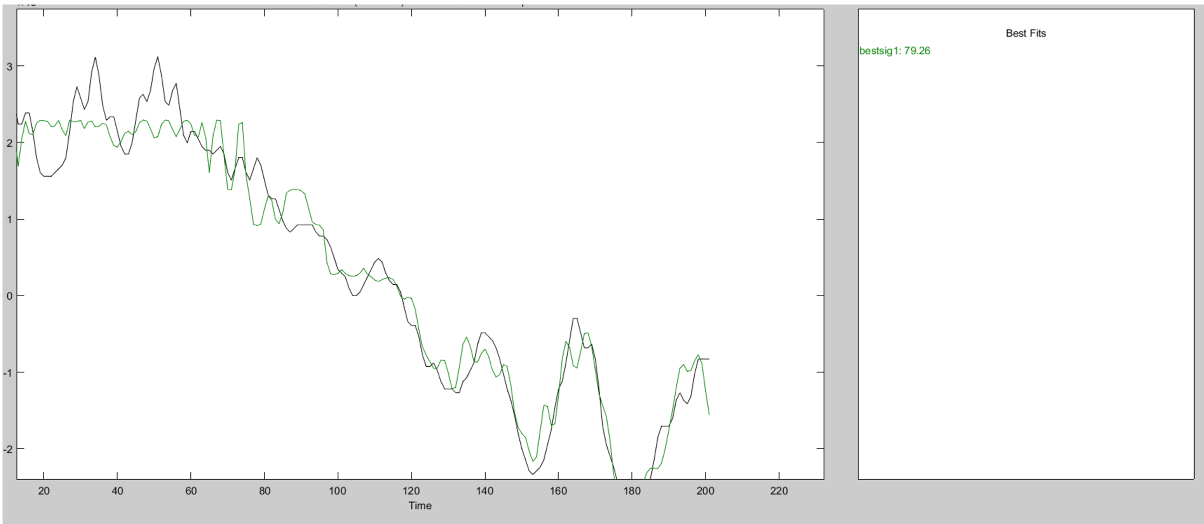


Figure 12: 4th order sigmoid network model fit against experimental data

The SysID toolbox was also used to test the effect of a moving average filter on the data to see if it makes any improvement to the fit value as the data exhibits a lot of high frequency noise which could be negatively affecting how well the models generated are fitting to the data. With a basic average noise filter applied to the data, the data was tested with sigmoid nonlinear blocks from units 1 to 100, with unfiltered versus filtered data to see if it had an improvement on the average fit (figure 13). The full set of this dataset can be found in appendix 9B.

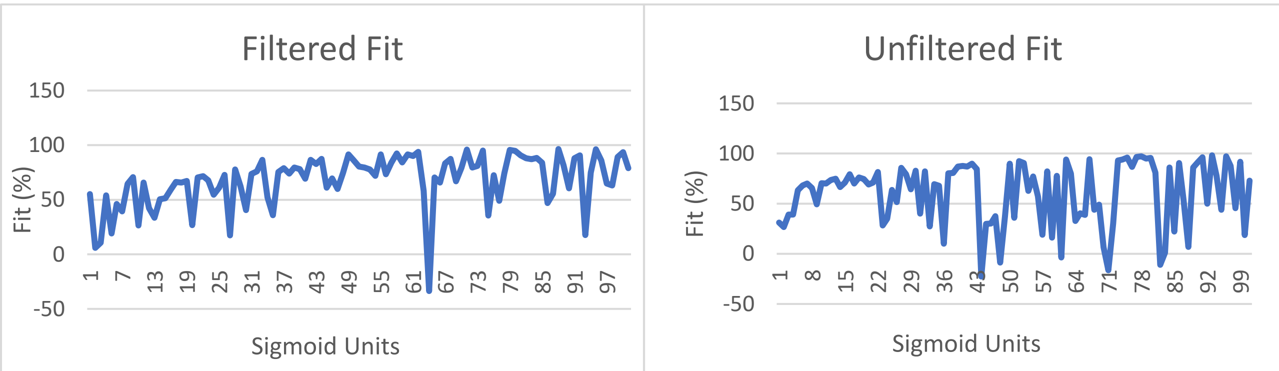


Figure 13: Left: Filtered data fit. Right: Unfiltered data fit.

The results show an average increase in fit for the models generated where the data is pre-processed with a moving average filter, with an average fit of 68% for filtered data versus a 60.6% fit for unfiltered data. This demonstrates that a moving average filter does help with the high frequency noise to some degree. With additional testing the optimal window size for the filter could be found to see if the effects of the filter can be optimised any further.

4.2. Automation (Using MATLAB `nlhw` Function)

Testing the model repeatedly, from units 1-100 with the SysID toolbox, took a very long time to compute. This is because inputting the non-linear units and linear order for every model, then waiting for it to process and output a result which then needs to manually be stored is extremely time-consuming. Before continuing with testing, a more efficient way of generating the models was developed, which could save the fit values automatically, allowing me to process many combinations of nonlinear blocks in a shorter time frame.

The MATLAB code for generating the nonlinear Hammerstein-Weiner models automatically in MATLAB went through several iterations because there are multiple ways that you can create these models in a MATLAB script. After some testing and trial and error, using the `nlhw()` command appeared to be the simplest and most efficient way of doing this, as you can select the linear block parameters and the nonlinear blocks you want to use all in one line of code. The function `nlhw()` 'creates and estimates a Hammerstein-Wiener model using the estimation data, model orders and delays', you can then specify input and output nonlinearities as well, otherwise they will be the default piecewise linear functions (Mathworks, 2023b). The script is essentially a for loop which allows you to increment the parameters for the nonlinear blocks and then it will store the fit values in an array, meaning it is no longer required to have to record the results individually for every model generated. Much like the SysID toolbox, the script still takes a cut of the overall data to avoid it taking too long to process.

The MATLAB script also has the option to plot the model against the data to visually analyse how well a certain model might fit against the data. The script works by pre-processing and cutting the simulated (or linear) data and experimental data and then applying a noise filter to fit in line with the current hypothesis that the experimental data is made up of a combination of a linear component, a nonlinear component, and some unidentified noise component. The cut of experimental data and the filtered linear data is then fed into the `iddata` object along with the sampling interval T_s. The `iddata` object encapsulates input and output measurement data for a system, system identification functions can then be used to estimate a model using `nlhw` (Mathworks, 2023a).

With the script functioning as intended, it is then possible to test different combinations of nonlinear blocks and parameters to see what kind of fits would be achievable.

One issue with this method is that occasionally the script would produce an error with a few specific combinations of parameters, but this does not affect the overall results, so when an error is encountered, the for loop would have to be resumed manually, skipping over the iteration that causes the error. The script can be found in full in appendix 9C, only the sigmoid network function is displayed in the appendix, however this can be easily changed to whichever nonlinear block needs to be used in the N-L-N model.

5. Noise Filter Testing

5.1. Moving Average Filter

A moving average filter was tested to see how well the high frequency noise could be removed from the experimental data, with the aim of creating a better fit for the nonlinear models that would be tested against this data. A moving average filter in MATLAB can be achieved with the `movmean` function with the input parameters being the input data and the window size. Using the automated MATLAB script, the optimal window size was found to be 25. The results from this test can be seen in figure 14.

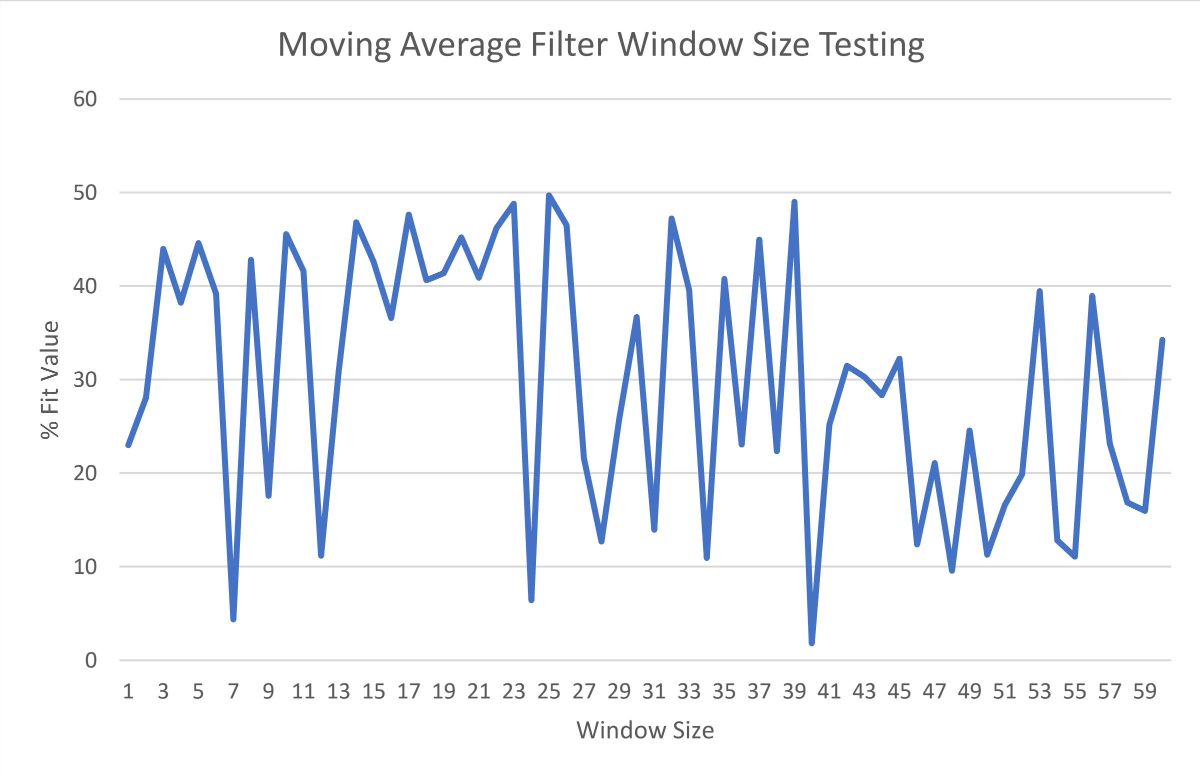


Figure 14: Moving Average Filter test results for changing Window Size

6. Nonlinear Models

This chapter details the process and results for testing different nonlinear blocks in MATLAB. Unless stated otherwise, all models in this chapter were generated using a dataset cut from 200000 to 201200 datapoints to ensure some consistency between tests. Each model was then validated with a cut of data the same size from the next period (+100000 datapoints) due to the periodic nature of the data. Tables for these test results in full can be found in appendix 9D.

6.1. Sigmoid Network

The first set of models created were done with the Sigmoid Network nonlinear blocks. The default unit option is 10 (see figure 15) however this can be altered. Initially, models were created using units from 1 to 300 and having the input and output nonlinearities exhibit the same unit value at any given instance.

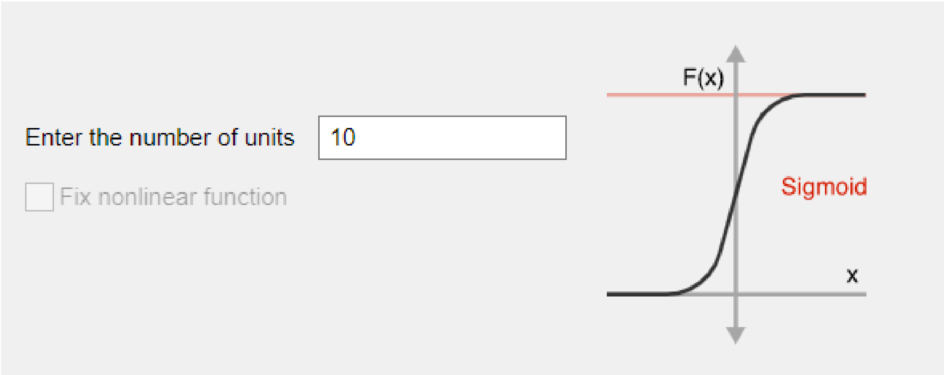


Figure 15: Sigmoid Network Parameters

The purpose of increasing the unit value over a range was to see if any trends became apparent as the value increased. In figure 16, 'Series1' is how well the model fits the estimation (or training) data, 'Series2' is how well the model fits the validation (or testing) data (this applies for all further instances in the paper where 'Series1' and 'Series2' are used in plots). This is for the cut of data between datapoints 200000 and 201200. The validation data set is the same size as the estimation data but from datapoints 300000-301200 as the data follows a periodic trend.

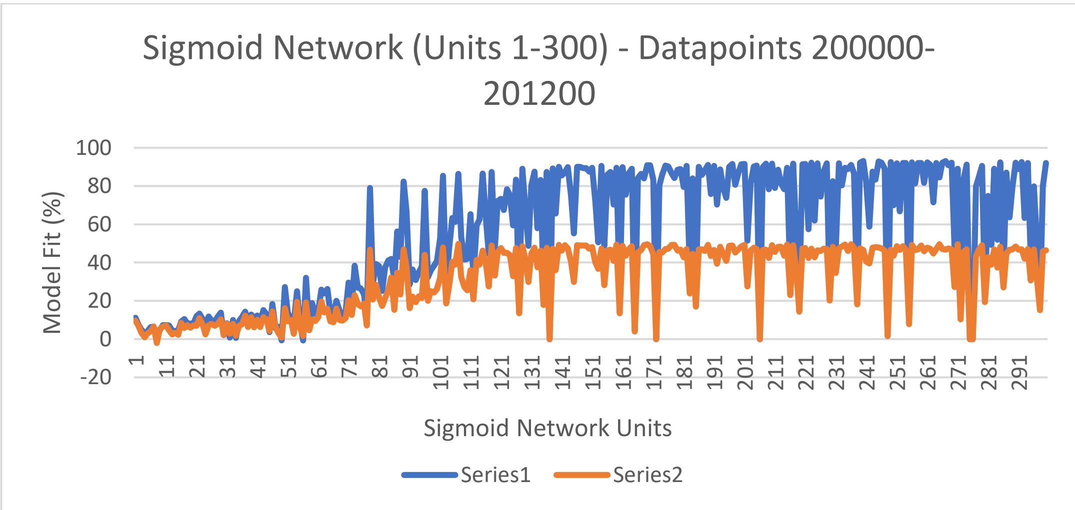


Figure 16: Sigmoid Network Models (Units 1-300, Datapoints 200000-201200)

The overall trend observed is that increasing the units in the sigmoid network does improve the model fit up to around 130 units and after that the improvement to the model fit is minimal. Despite this, the results are not very consistent, with a lot of dips in the data, however these results are still useful as they demonstrate a rough correlation between the sigmoid network units and the model fit which can be seen in figure 17.

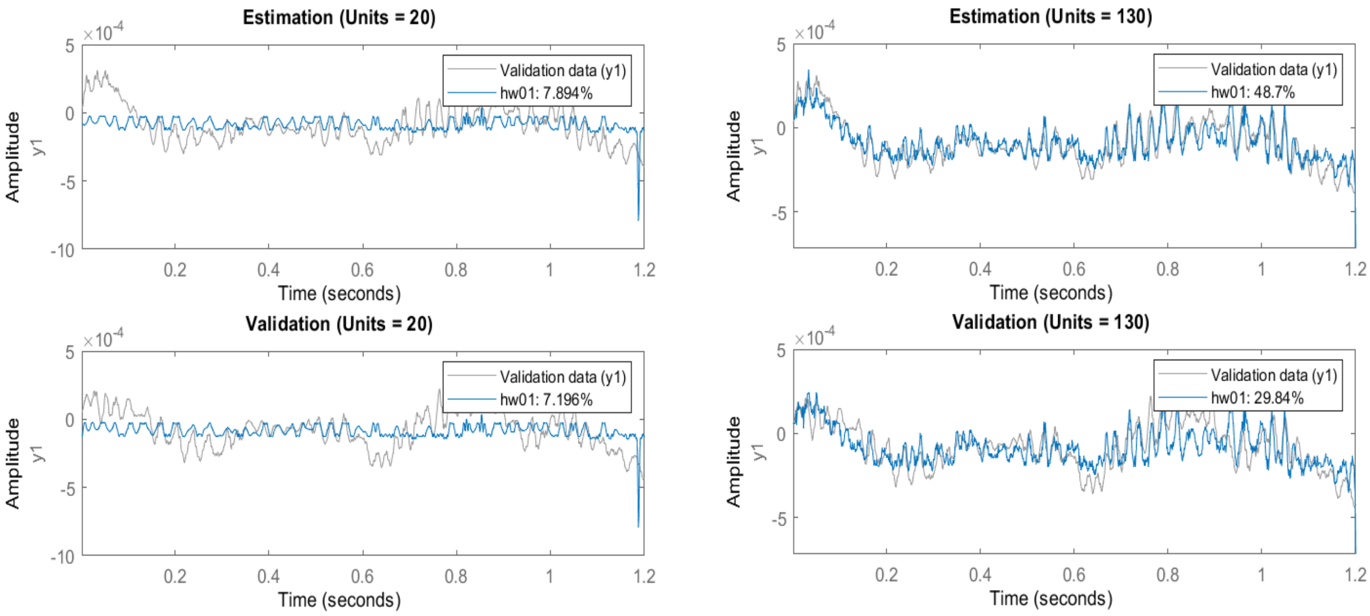


Figure 17: Comparison of Sigmoid Models (Units 20 and 130) against validation data

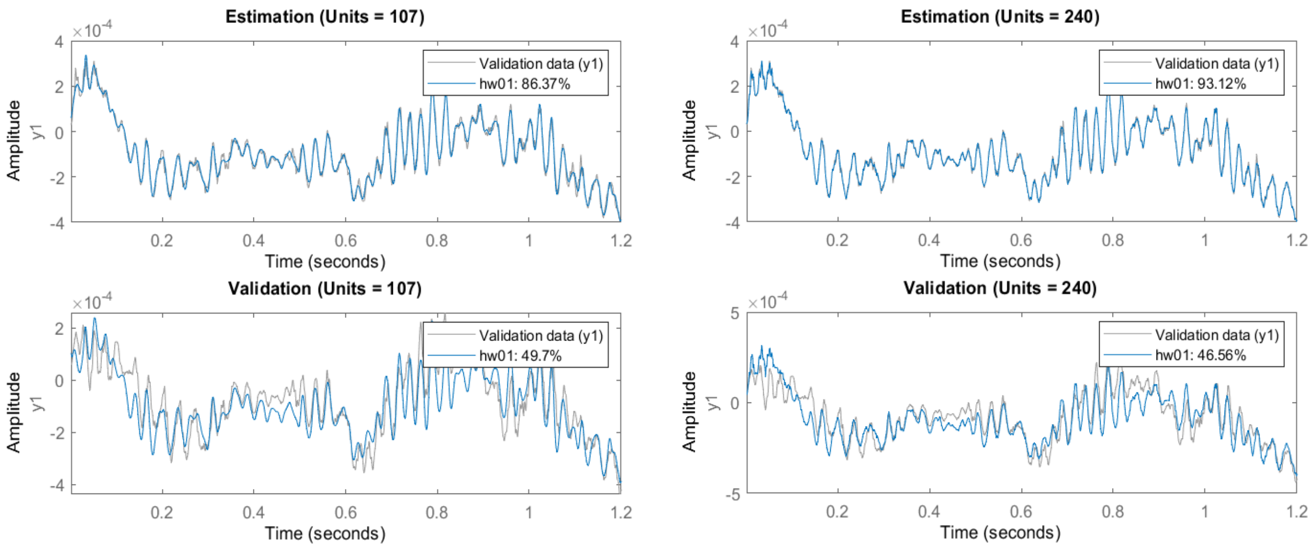


Figure 18: Comparison of Sigmoid Models (Units 107 and 240) against validation data

In figure 17, the 20-unit sigmoid network does not fit either dataset very well, but as the units increase to 130, there is an improved fit, not only numerically but also visually we can start to see it is picking up the trends in the estimation and validation data.

Two of the best models that were generated were done with 107 and 240 units (see figure 18), with 107 giving the best fit with the validation data numerically and 240 giving the best fit with the estimation data numerically. Despite the actual fit value being roughly half of the value given for the estimation data in more cases, the model does pick up on the overall trend of the validation data.

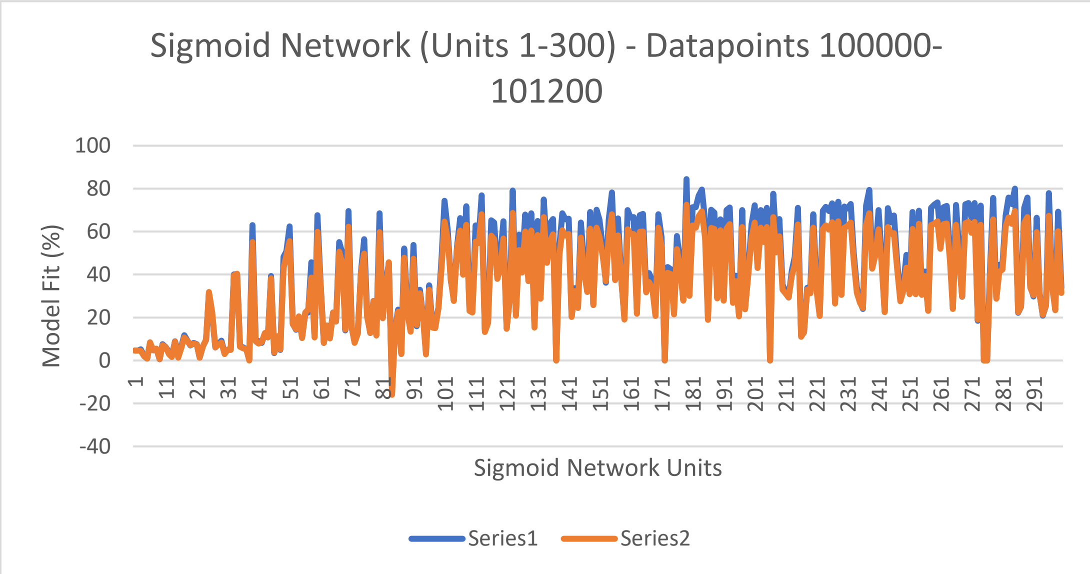


Figure 19: Sigmoid Network Models (Units 1-300, Datapoints 100000-101200)

As this nonlinear model produced the best fits out of all the models tested, further models were generated using different cuts of data to see how well the model held up with other sections of the data. A set of models were then generated using datapoints 100000-101200 (see figure 19), which followed a similar trend to the previous set of datapoints (figure 16), but the model fit for the validation data was closer to the estimation data this time around. In figure 19, 'Series1' is the model fit compared with the estimation data and 'Series2' is the model fit compared with the validation data.

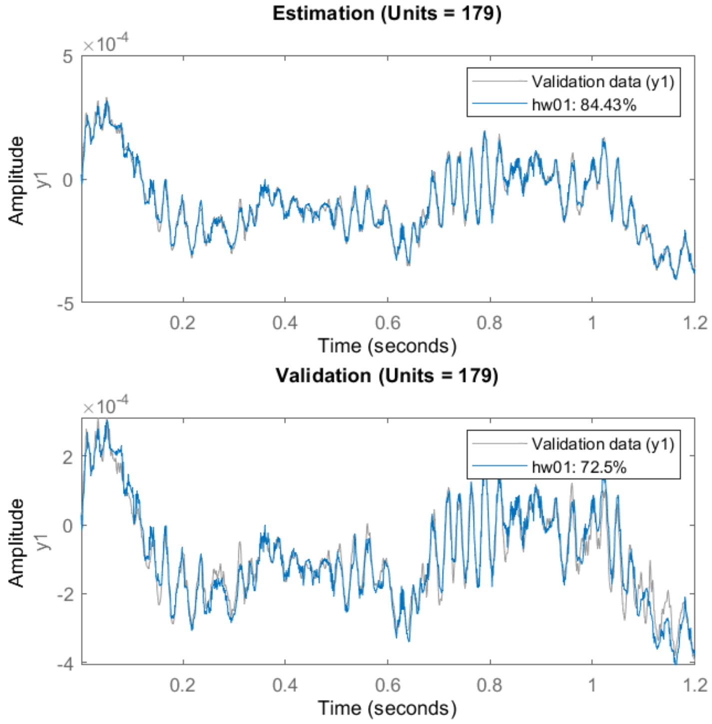


Figure 20: Sigmoid Model generated with 179 units (datapoints 100000-101200)

With the alternative dataset, the model in figure 20 follows the trend of both estimation and validation data well. If we compare the same units with the previous dataset (200000 – 201200) with a sigmoid network model with the 179 units (see figure 21), we see it fits the data well and follows the trends of the data well too.

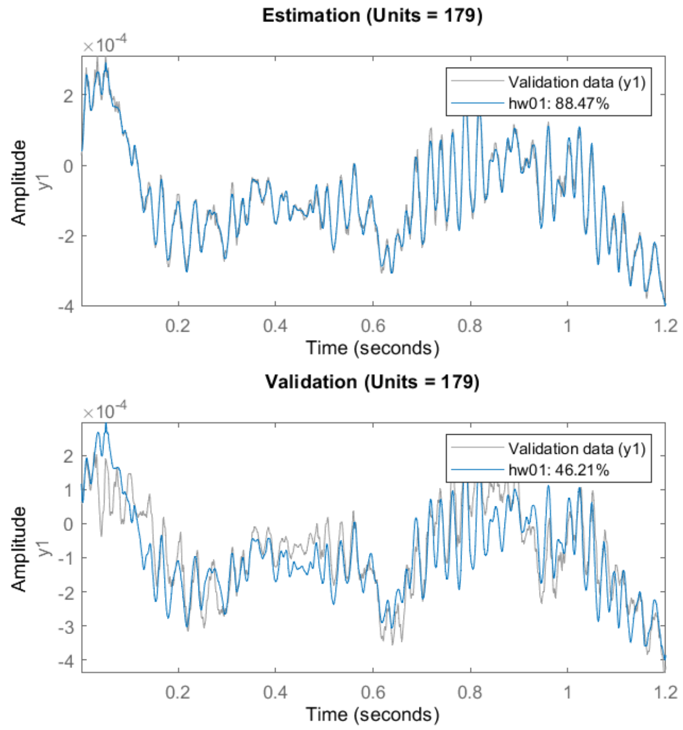


Figure 21: Sigmoid Model generated with 179 units (datapoints 100000-101200)

The model generated with input and output nonlinearities as a sigmoid network with 179 units follows the trends of both datasets, which suggests that it could be a good case for modelling the nonlinearities, however it does not follow all the trends so there is potential for a better model. This was the best model for the nonlinearity that could be achieved using the nonlinear Hammerstein-Weiner model in MATLAB.

Due to the sigmoid network providing the most promising set of results, more models were generated with a single sigmoid network input nonlinearity block and then an additional set with just a single sigmoid network output nonlinearity block to see if the model fits the data with only one nonlinearity instead of two as previously tested. The data below (see figures 22 and 23) was generated using a smaller dataset of datapoints 200000 to 200200 to improve the computation time.

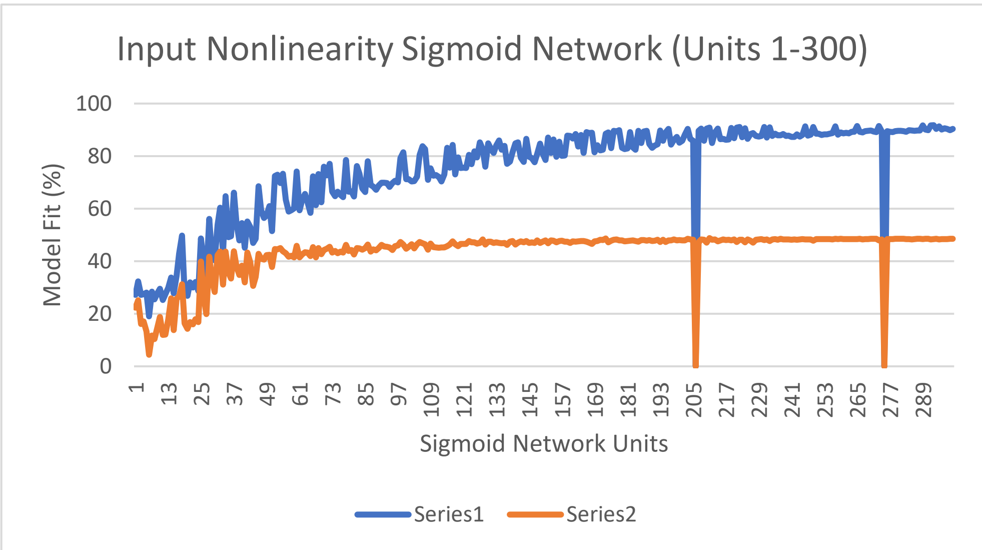


Figure 22: Input Nonlinearity Sigmoid Network Model % fit (Units 1-300)

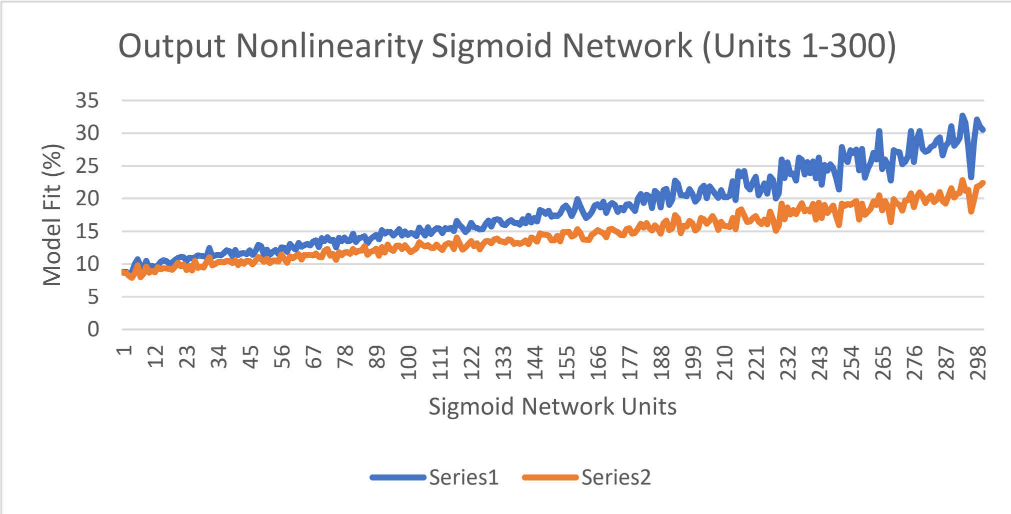


Figure 23: Output Nonlinearity Sigmoid Network Model % fit (Units 1-300)

The single input nonlinearity gives a more consistent trend than two nonlinear blocks, the maximum fit values are very similar for both estimation and validation data. In contrast, the single output nonlinearity does not provide a very good fit for the units tested.

Depending on how many units are chosen either a single input sigmoid network could be a better choice versus the usual input and output sigmoid network blocks.

6.2. One Dimensional Polynomial Network

Another nonlinear model that was tested against the data from the suspension system was generated using a one-dimensional polynomial network. The default setting for this network is one degree of polynomial (see figure 24), however this can be increased. The number of coefficients can also be altered; however, you cannot change both at the same time, one of these parameters must be set to its default value.

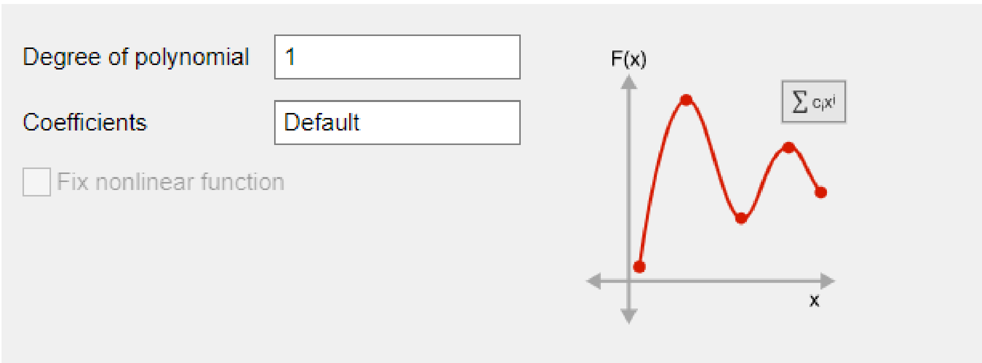


Figure 24: One Dimensional Polynomial Network Parameters

After testing this model against a section of the data, it showed the best fit with the default setting of one degree of polynomial, with two degrees of polynomial there was a significant drop, after that, the fit did not change at all, staying the same as the results obtained from two degrees.

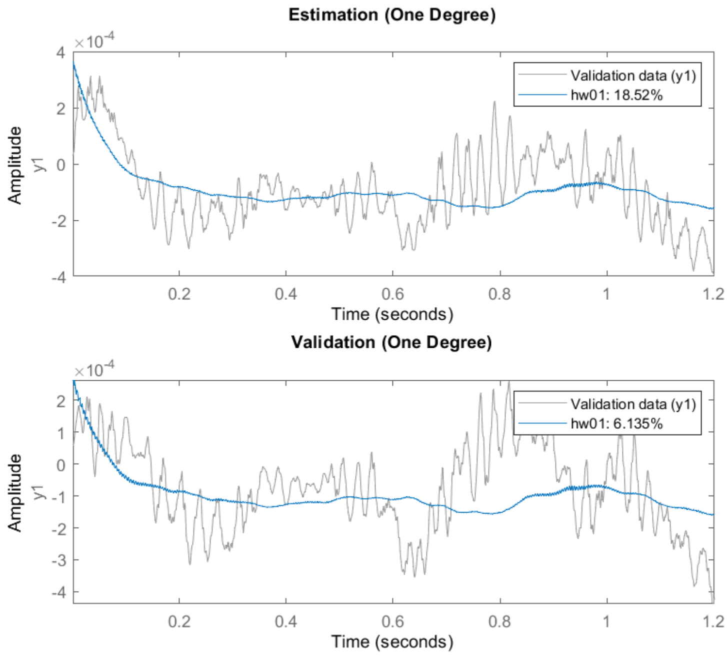


Figure 25: One Dimensional Polynomial Model generated with One Degree (datapoints 200000-201200)

From the results generated, with an input and output polynomial block, a one-dimensional polynomial network does not really pick up on the high frequency trends in the data (see figure 25). With a single input block (see figure 26, the fit against the data is improved slightly, however still not picking up on the higher frequency information. A single output does not provide any benefits versus the single input and changing coefficients does not help improve the fit at all.

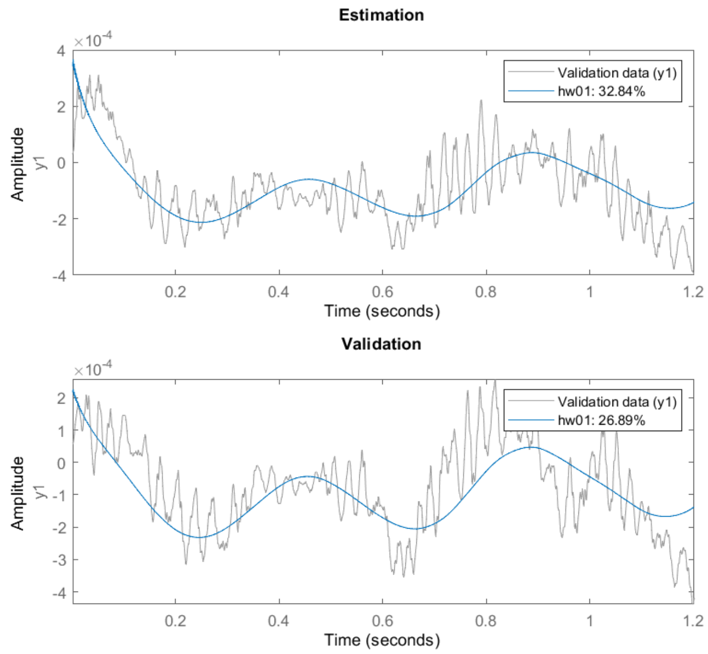


Figure 26: One Dimensional Polynomial Model versus Validation data (Second Degree, Input Block only)

6.3. Piecewise Linear Function

One of the types of nonlinear models that can be generated using the `nlhw` function is the piecewise linear function (see figure 27). The number of breakpoints can be adjusted for this nonlinear model, the default value is 10. After incrementing the number of breakpoints and testing the fit against the estimation and validation data the best fit value achieved was a 41% for the estimation data and 34% for the validation data, which does not show promising results and most likely not taking this function any further with testing (results plotted in figures 26 and 29).

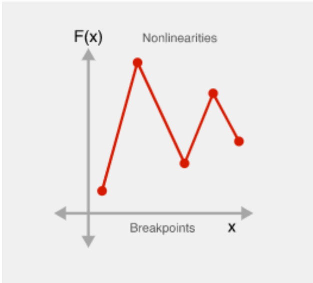


Figure 27: Piecewise Linear Function

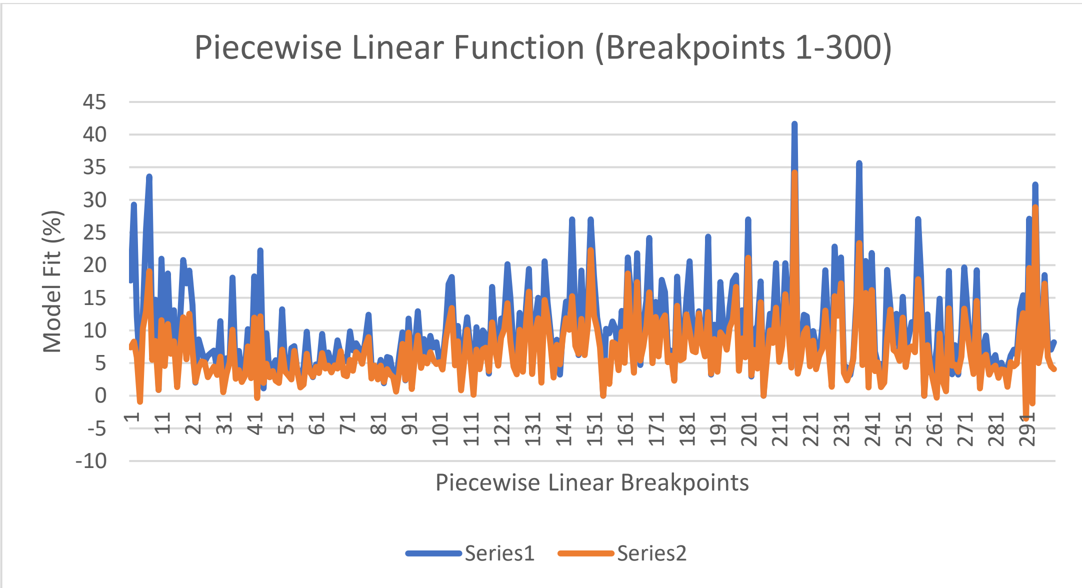


Figure 28: Piecewise Linear Function Model % fit (Breakpoints 1-300)

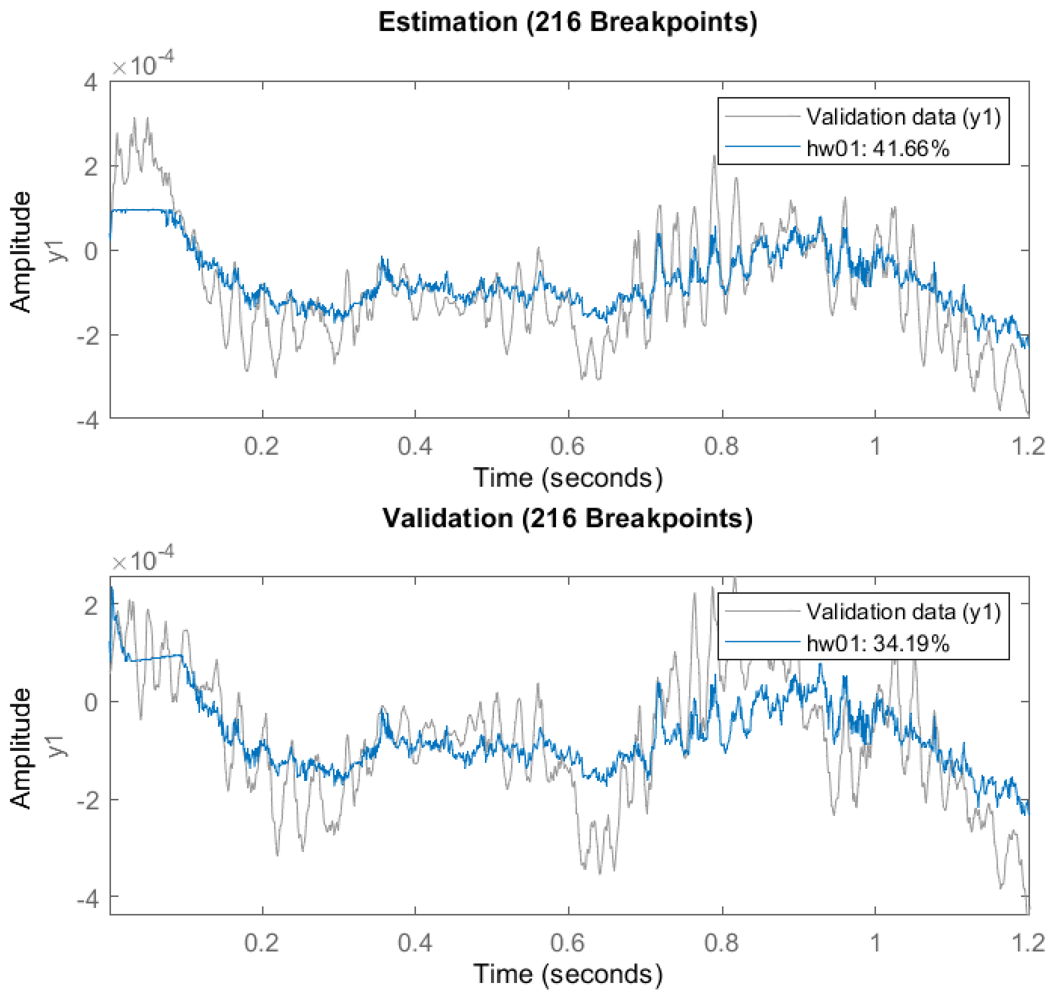


Figure 29: Piecewise Linear Function Model versus Validation data (216 Breakpoints)

6.4. Wavelet Network

Another set of nonlinear models that were generated in MATLAB were created using the wavelet network. The default units for the wavelet network are 10 however this can be altered (see figure 30), a set of models were generated with unit values 1-300 for a cut of datapoints between 200000-201200.

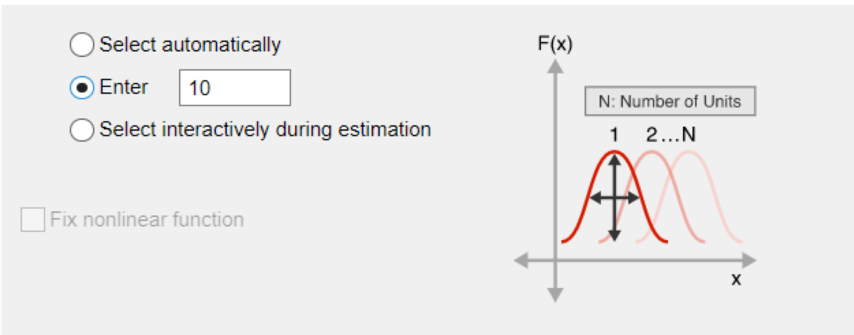


Figure 30: Wavelet Network Parameters

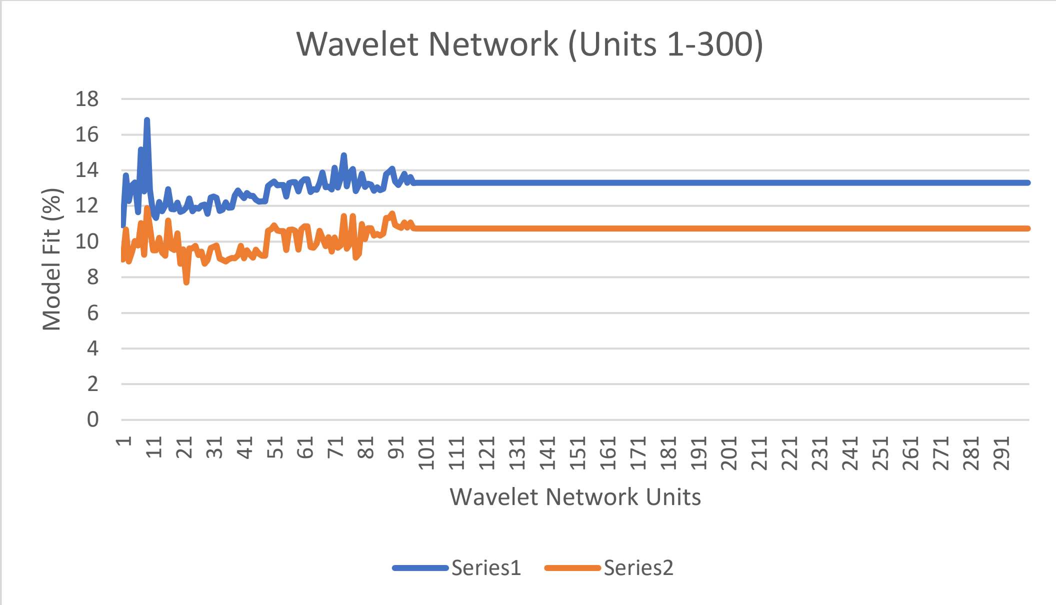


Figure 31: Wavelet Network Model % fit (Units 1-300)

The fit value varies for unit values below 100, after that there is a consistent low fit value, as shown in figure 31. When comparing the unit value with the highest fit value against the plotted data, we can see that the model does pick up the occasional trend, however generally it is not a good model for the data, as can be seen in figure 32.

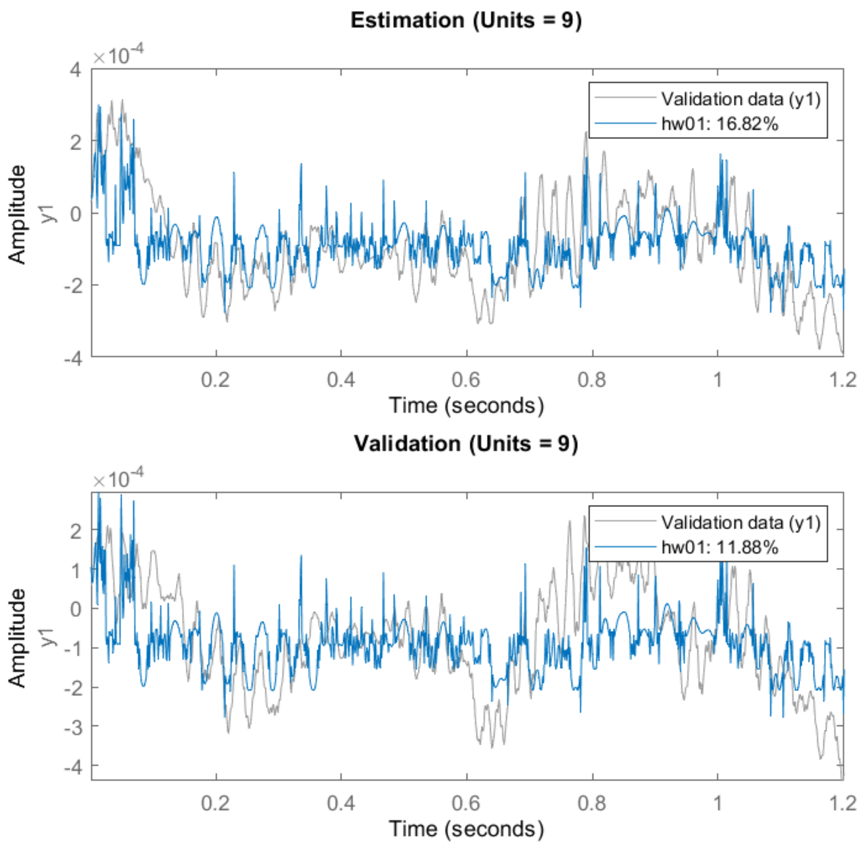


Figure 32: Piecewise Linear Function Model versus Validation data (Units = 9)

6.5. Saturation

One of the other nonlinear models tested from the SysID toolbox is the Saturation nonlinearity. This nonlinear model has two parameters that can be altered – the upper limit and lower limit of each block - so a few different combinations of parameters can be tested. As well as adjusting all limits in equal increments in tests, several more combinations were tested in terms of what limits incremented and which stayed the same. The list of 6 different combinations where the limits change is; the input upper limit, both upper limits, output upper limit, input lower limit, both lower limits and output lower limit. None of these 6 sets of tests produced any results with any suitable fits (see appendix 9D). Incrementing all limits simultaneously produced marginally better results than what was achieved by altering only some of the limits, however there were still no models that followed the data anywhere near as well as the sigmoid networks. The results obtained for the models generated by incrementing all limits simultaneously are shown in the figure 33.

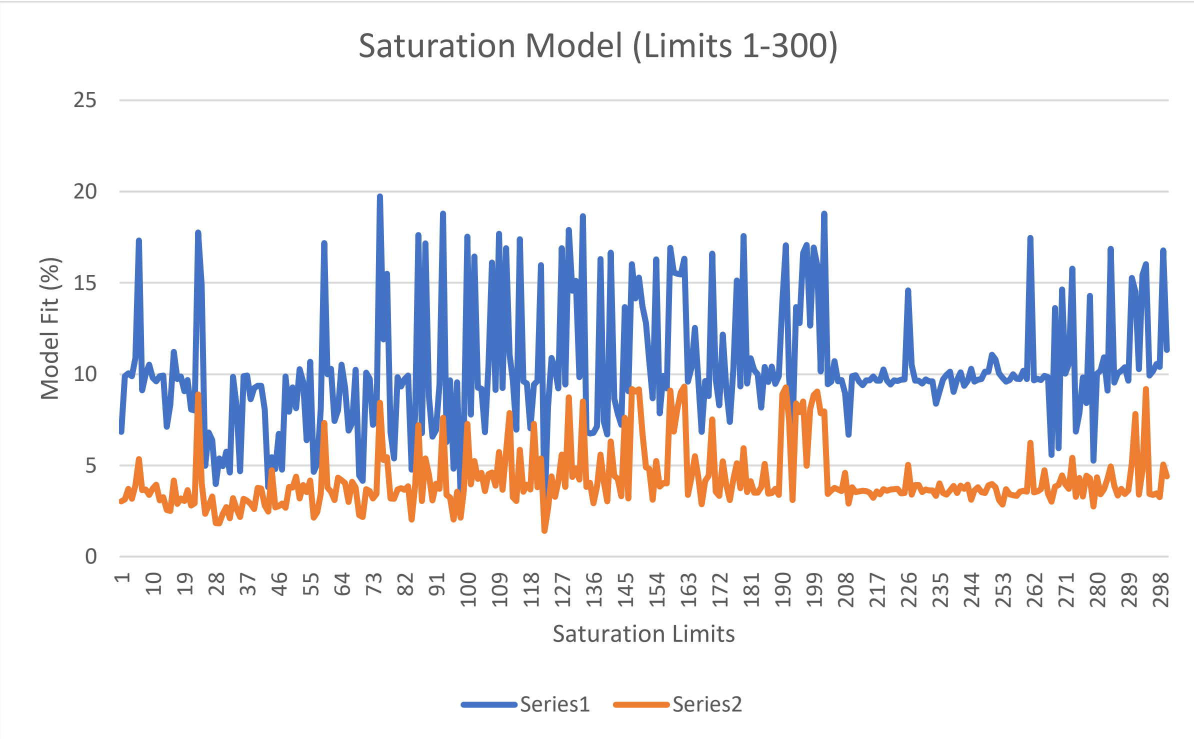


Figure 33: Saturation Model % fit (Limits 1-300)

6.6. Deadzone

Another one of the less successful sets of nonlinear models trialled were the ones generated with input and output deadzone nonlinearity blocks. The deadzone nonlinearity has the option to adjust the upper and lower limits, which, if not changed will resort to their default value (see figure 34).

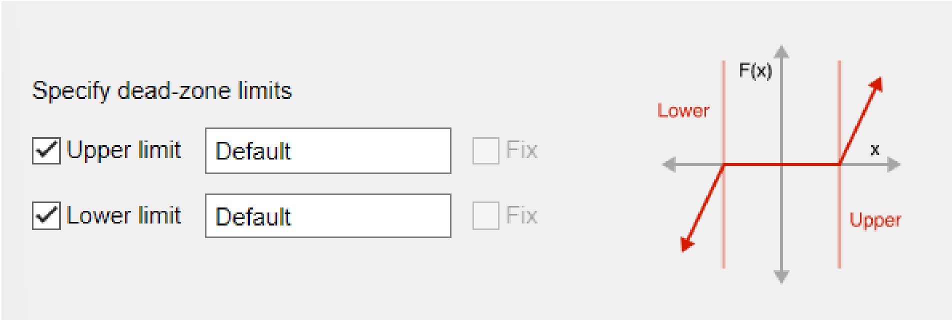


Figure 34: Deadzone Model Parameters

Several combinations of different limit values were trialled, much like the saturation nonlinearity above, changing the following for six different combinations; input upper limit, both upper limits, output upper limit, input lower limit, both lower limits and outer lower limit. With all these combinations there were no promising fits and all combinations not changing after incrementing past a limit value of 2. In addition, these models had a fit value below 16%. Incrementing all limit values at the same time didn't provide much better results either with the best model fit at 19.73% (see figure 35).

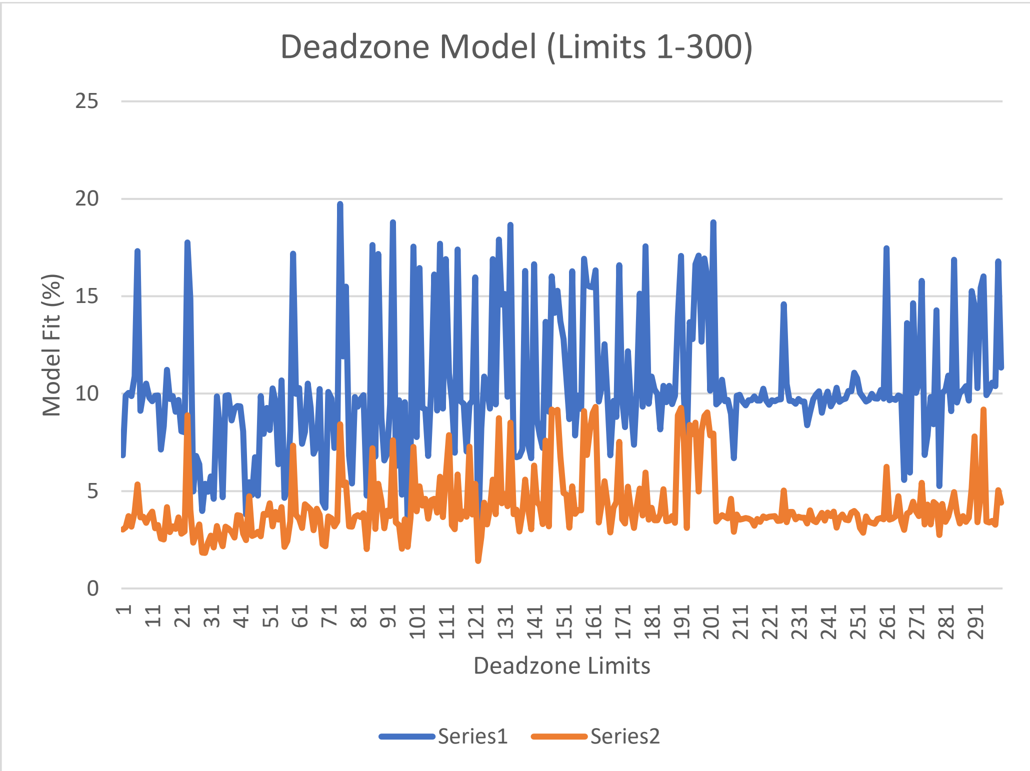


Figure 35: Deadzone Model % fit (Limits 1-300)

As shown in the figure below, a deadzone nonlinearity model does not fit the experimental data well and is not worth investigating any further.

6.7 Combining Nonlinear Models

After finding that the two best nonlinear models were sigmoid network and one-dimensional polynomial network, several tests were done to see if combining different nonlinear models would improve the fit, compared to just using one model in the N-L-N model. To trial this idea, the best fitting one-dimensional polynomial network block (second degree) was taken along with a sigmoid network block with incrementing units. These blocks were combined in two combinations, the first being the sigmoid network as the input block and the one-dimensional polynomial block as the output (see figure 36). The second combination was then the opposite of this, having the one-dimensional polynomial block as the input and sigmoid network block as the output (see figure 37).

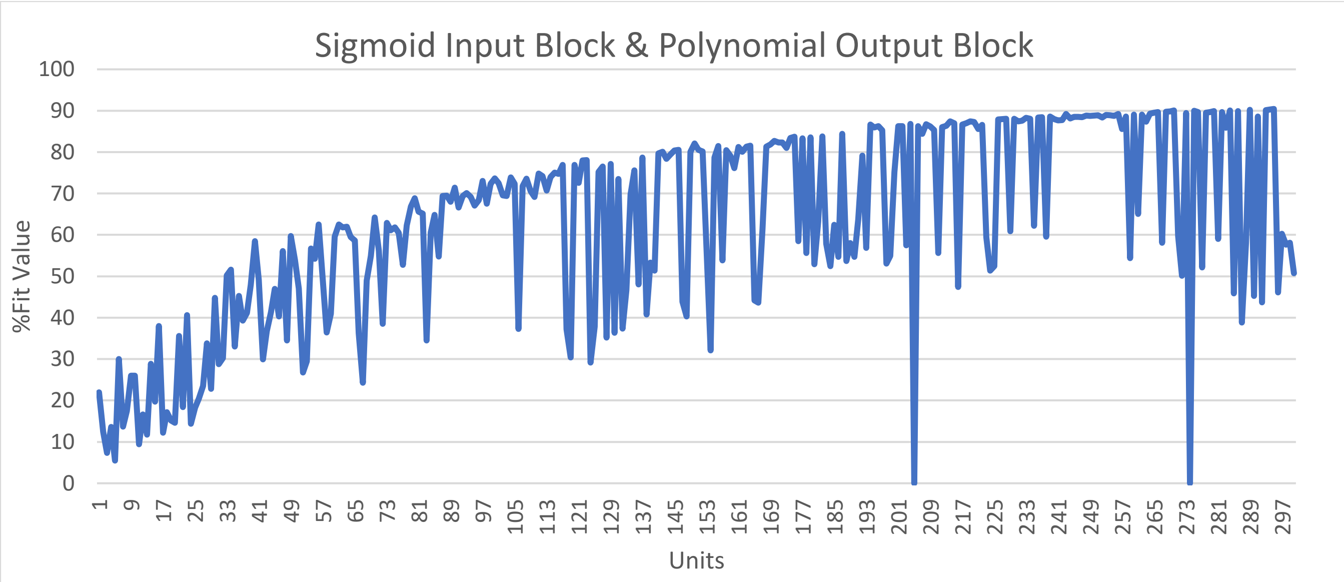


Figure 36: Sigmoid Network Input Block with Second Degree Polynomial Output Block Fit results (Units 1-300)

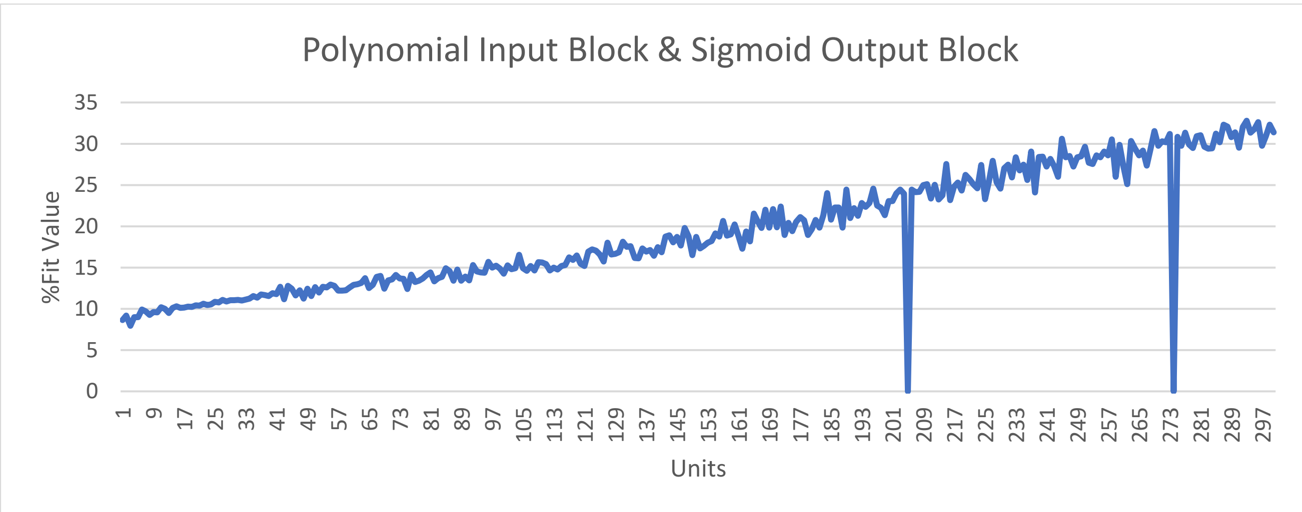


Figure 37: Second Degree Polynomial Input Block with Sigmoid Network Output Block Fit results (Units 1-300)

Out of these two models, the model with the input sigmoid network block performed a lot better than the one generated with a sigmoid network block as the output. These models produce a very similar fit value to the models generated with only a single sigmoid block. This could suggest that the polynomial block in these models is having very little effect on the generation of the model. Despite having reasonable estimated fit data, particularly in the first model, it was decided not to take the approach of combining different nonlinearities any further as the validation fit values produced were extremely low. The validation fit values ranged from 2.79% to -1×10^{13} %, which is some of the lowest fit values generated across the whole project.

6.8 Overall findings

The models generated with the sigmoid network provided the closest fit to the small cut of experimental data out of all the nonlinear blocks tested. To see how well this model would fit across a wide spread of datapoints, a sigmoid network model with two blocks, 500 units for each block, was generated. The datapoints spanned across a whole period (200,000 to 300,000 datapoints). The fit of this model can be seen in figure 38.

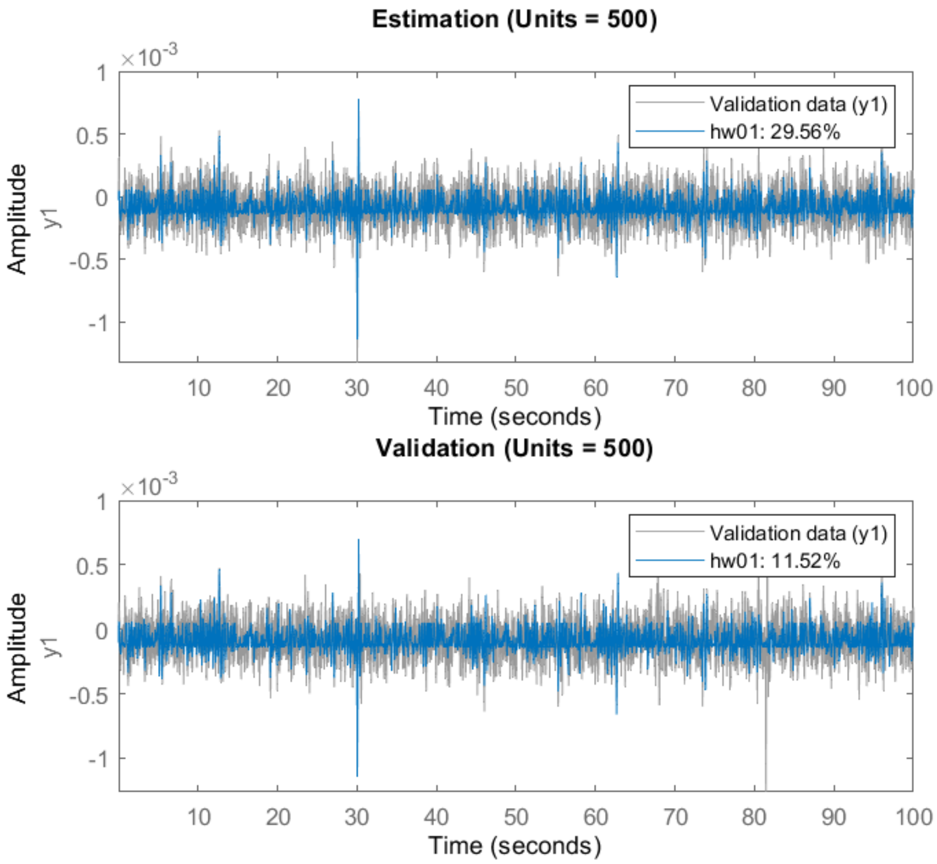


Figure 38: Sigmoid Network generated with a wide spread of datapoints

Whilst the numerical fit value is quite low when you compare this to some of the previous results generated with sigmoid networks, a much larger dataset has been used so this is to be expected. Even though the numerical fit value is low, the model still picks up most of the trends of the experimental data. The experimental data has higher frequency components that the model is failing to pick up, this could be because there is an extra component that was not initially considered in the original hypothesis.

7.Conclusion

The objective of this project was to identify the nonlinearities presence in the active suspension system as demonstrated in Kioutsoukis et al. (2022) and similar prior studies, e.g. Fayyad (2012) and Minlanese et al. (2004). Six different nonlinear blocks were used to generate many models which were then compared against the experimental data collected in Kioutsoukis et al. (2022). The initial hypothesis was that the experimental data comprised of a linear component, a nonlinear component and some noise component.

Upon analysing the results, particularly those pertaining to the model generated with sigmoid network blocks, combined with a moving average filter, a model was developed that replicated some of the trends observed in the original experimental data. However, direct comparison of this model with the experimental data revealed an inability to capture certain high-frequency components that the experimental data had. This discrepancy would suggest that an amendment needs to be taken to the original hypothesis, in addition to the linear, nonlinear and noise component, there is an additional high frequency component that has not yet been identified.

The other five nonlinear blocks did not produce very accurate models compared with a sigmoid network. The average moving filter used to reduce the noise did work to some level of success, improving the fit of the model against the data. However, some of the unidentified high frequency component could be attributed to this noise, meaning that the average moving filter did not filter out enough noise. Without knowing the possible fourth unknown component, it is impossible to verify this.

Although the project did not fully achieve its objectives, the work detailed in this report does provide a good foundation for future work and has made some progress in understanding what the experimental data collected in Kioutsoukis et al. (2022) is made up of. Unfortunately, the problem was more complex than initially expected meaning that it could not be completed in the time frame allocated to this project.

7.1. Future Works

Further work on this project could involve testing additional identification methods, such as Sparse Identification of Nonlinear Dynamics (SINDy). SINDy employs a data-driven framework that yields interpretable models that avoid overfitting (Fasel et al., 2021). One key advantage of using SINDy is that it has ‘a robustness to noise with less training data’ (Kaheman et al., 2022), the noise and high frequency components being something the N-L-N Hammerstein-Weiner model struggled with. This capability may enable SINDy to circumvent these issues. In addition, the ability to produce accurate results with less training data is also a benefit as it will improve computation time for generating models.

Another modelling technique that did not receive attention in this study is a Nonlinear ARX Model (NARX Models). NARX models are better suited to modelling dynamic nonlinearities, compared to Hammerstein-Weiner models which can only model static nonlinearities. NARX models are available in the MATLAB SysID toolbox. This means they can be tested in a similar manner to which the Hammerstein-Weiner models were tested in this project. In addition to this, NARX models have not received much attention in literature (Zhu, 2002), meaning there is potential to try methods which have not yet been investigated fully.

Currently all the analysis done in the MATLAB script has used validation data, which is periodic to the estimation data, however when using validation data that is not periodic, the fit value would be very poor (negative in a lot of cases). In the future, more analysis will need to be done on this as it is important to achieve a strong fit value not only with periodic validation data but also validation data that is not periodic.

8.References

Ahmadian, M. (2001) ‘Active control of vehicle vibration’, *Encyclopedia of Vibration*, pp. 37–45. doi:10.1006/rwvb.2001.0193.

Bai, E.-W. (2002) ‘A blind approach to the Hammerstein–wiener model identification’, *Automatica*, 38(6), pp. 967–979. doi:10.1016/s0005-1098(01)00292-8.

Chamseddine, A., Noura, H. and Raharijaona, T. (2007) ‘Full vehicle active suspension: Sensor fault diagnosis and fault tolerance’, *Fault Detection, Supervision and Safety of Technical Processes 2006*, pp. 468–473. doi:10.1016/b978-008044485-7/50079-8.

Deng, G. and Cahill, L.W. (1993) ‘An adaptive gaussian filter for noise reduction and edge detection’, *1993 IEEE Conference Record Nuclear Science Symposium and Medical Imaging Conference* [Preprint]. doi:10.1109/nssmic.1993.373563.

Desai, R., Guha, A. and Seshu, P. (2021) ‘A comparison of quarter, half and full car models for predicting vibration attenuation of an occupant in a vehicle’, *Journal of Vibration Engineering & Technologies*, 9(5), pp. 983–1001. doi:10.1007/s42417-020-00278-3.

El-Beheiry, E.M. (2000) ‘Bilinear control theory of Smart Damping Systems’, Current Advances in Mechanical Design and Production VII, pp. 113–122. doi:10.1016/b978-008043711-8/50012-x.

Fasel, U. et al. (2021) ‘SINDy with control: A tutorial’, 2021 60th IEEE Conference on Decision and Control (CDC) [Preprint]. doi:10.1109/cdc45484.2021.9683120.

Fayyad, S.M. (2012) ‘Constructing Control System for Active Suspension System’, *Contemporary Engineering Sciences*, 5(4), pp. 189–200.

Giua, A. *et al.* (2004) ‘Design of a predictive semiactive suspension system’, *Vehicle System Dynamics*, 41(4), pp. 277–300. doi:10.1080/00423110412331315169.

Goga, V. and Kľúčik, M. (2012) ‘Optimization of vehicle suspension parameters with use of evolutionary computation’, *Procedia Engineering*, 48, pp. 174–179. doi:10.1016/j.proeng.2012.09.502.

Golestan, S. *et al.* (2014) 'Moving average filter based phase-locked loops: Performance Analysis and Design Guidelines', *IEEE Transactions on Power Electronics*, 29(6), pp. 2750–2763. doi:10.1109/tpel.2013.2273461.

Hammar, K., Djamah, T. and Bettayeb, M. (2019) 'Nonlinear system identification using fractional hammerstein–wiener models', *Nonlinear Dynamics*, 98(3), pp. 2327–2338. doi:10.1007/s11071-019-05331-9.

Jibril, M., Tadese, M. and Alemayehu, E. (2020) *Design and simulation of voltage amplidyne system using robust control technique* [Preprint]. doi:10.20944/preprints202006.0241.v1.

Jiregna, I.T. and Sirata, G. (2020) 'A review of the Vehicle Suspension System', *Journal of Mechanical and Energy Engineering*, 4(2), pp. 109–114. doi:10.30464/jmee.2020.4.2.109.

Kaheman, K., Brunton, S.L. and Nathan Kutz, J. (2022) 'Automatic differentiation to simultaneously identify nonlinear dynamics and extract noise probability distributions from data', Machine Learning: Science and Technology, 3(1), p. 015031. doi:10.1088/2632-2153/ac567a.

Khajavi, M. *et al.* (2007) 'Improvement of ride and handling performance applying controlled fuzzy logic for an integrated suspension system of active and semi-active', *International Conference on Mechanical and Electrical Technology, 3rd, (ICMET-London 2011), Volumes 1–3*, pp. 2161–2169. doi:10.1115/1.859810.paper344.

Kioutsoukis, I., Foo, M. and Tan, A.H. (2022) 'Application of multi-input uncorrelated periodic signals for identification of active suspension system', *IFAC-PapersOnLine*, 55(1), pp. 229–234. doi:10.1016/j.ifacol.2022.04.038.

Kumar, S., Medhavi, A. and Kumar, R. (2020) 'Active and passive suspension system performance under Random road profile excitations', *The International Journal of Acoustics and Vibration*, 25(4), pp. 532–541. doi:10.20855/ijav.2020.25.41702.

Lin, J. and Lian, R.-J. (2011) 'Intelligent control of active suspension systems', IEEE Transactions on Industrial Electronics, 58(2), pp. 618–628. doi:10.1109/tie.2010.2046581.

Majjad, R. (1997) ‘Estimation of suspension parameters’, *Proceedings of the 1997 IEEE International Conference on Control Applications* [Preprint]. doi:10.1109/cca.1997.627709.

Milanese, M. and Novara, C. (2004) ‘Set membership identification of Nonlinear Systems’, *Automatica*, 40(6), pp. 957–975. doi:10.1016/j.automatica.2004.02.002.

Mathworks (2023a) *Iddata, Input-output data and its properties for system identification in the time or frequency domain - MATLAB - MathWorks United Kingdom*. Available at: https://uk.mathworks.com/help/ident/ref/iddata.html (Accessed: 03 March 2024).

Mathworks (2023b) *NLHW, Estimate Hammerstein-Wiener model - MATLAB nlhw - MathWorks United Kingdom*. Available at: https://uk.mathworks.com/help/ident/ref/nlhw.html (Accessed: 03 March 2024).

Moving average filters (no date) Analog.com. Available at: https://www.analog.com/media/en/technical-documentation/dsp-book/dsp_book_ch15.pdf (Accessed: 20 February 2024).

Narendra, K. and Gallman, P. (1966) ‘An iterative method for the identification of nonlinear systems using a Hammerstein model’, *IEEE Transactions on Automatic Control*, 11(3), pp. 546–550. doi:10.1109/tac.1966.1098387.

Quanser (2023) ‘*Active suspension*’. Available at: https://www.quanser.com/products/active-suspension/ (Accessed: 09 March 2024).

Sam, Y.Md., Osman, J.H.S. and Ghani, M.R.A. (2004) ‘A class of proportional-integral sliding mode control with application to active suspension system’, *Systems & Control Letters*, 51(3–4), pp. 217–223. doi:10.1016/j.sysconle.2003.08.007.

Sasai, T. *et al.* (2020) ‘Wiener-Hammerstein model and its learning for nonlinear digital pre-distortion of optical transmitters’, *Optics Express*, 28(21), p. 30952. doi:10.1364/oe.400605.

Sharp, R.S. and Crolla, D.A. (1987) ‘Road vehicle suspension system design - A Review’, *Vehicle System Dynamics*, 16(3), pp. 167–192. doi:10.1080/00423118708968877.

Solis, A. et al. (2007) ‘Accelerated multiple-pass moving average: A Novel Algorithm for Baseline Estimation in CE and its application to Baseline Correction on Real-time bases’, ELECTROPHORESIS, 28(8), pp. 1181–1188. doi:10.1002/elps.200600538.

Soong, M.F., Ramli, R. and Saifizul, A. (2017) ‘Between simplicity and accuracy: Effect of adding modeling details on quarter vehicle model accuracy’, *PLOS ONE*, 12(6). doi:10.1371/journal.pone.0179485.

Sun, L. *et al.* (2022) ‘A robust Hammerstein-wiener model identification method for highly nonlinear systems’, *Processes*, 10(12), p. 2664. doi:10.3390/pr10122664.

System identification toolbox (2023) Mathworks Inc. Available at: https://uk.mathworks.com/products/sysid.html (Accessed: 15 October 2023)

Tan, A.H., Foo, M. and Ong, D.S. (2022) ‘Road classification using built-in self-scaling method of Bayesian regression’, *Journal of Sound and Vibration*, 516, p. 116523. doi:10.1016/j.jsv.2021.116523.

Wills, A. *et al.* (2013) ‘Identification of Hammerstein–Wiener Models’, *Automatica*, 49(1), pp. 70–81. doi:10.1016/j.automatica.2012.09.018.

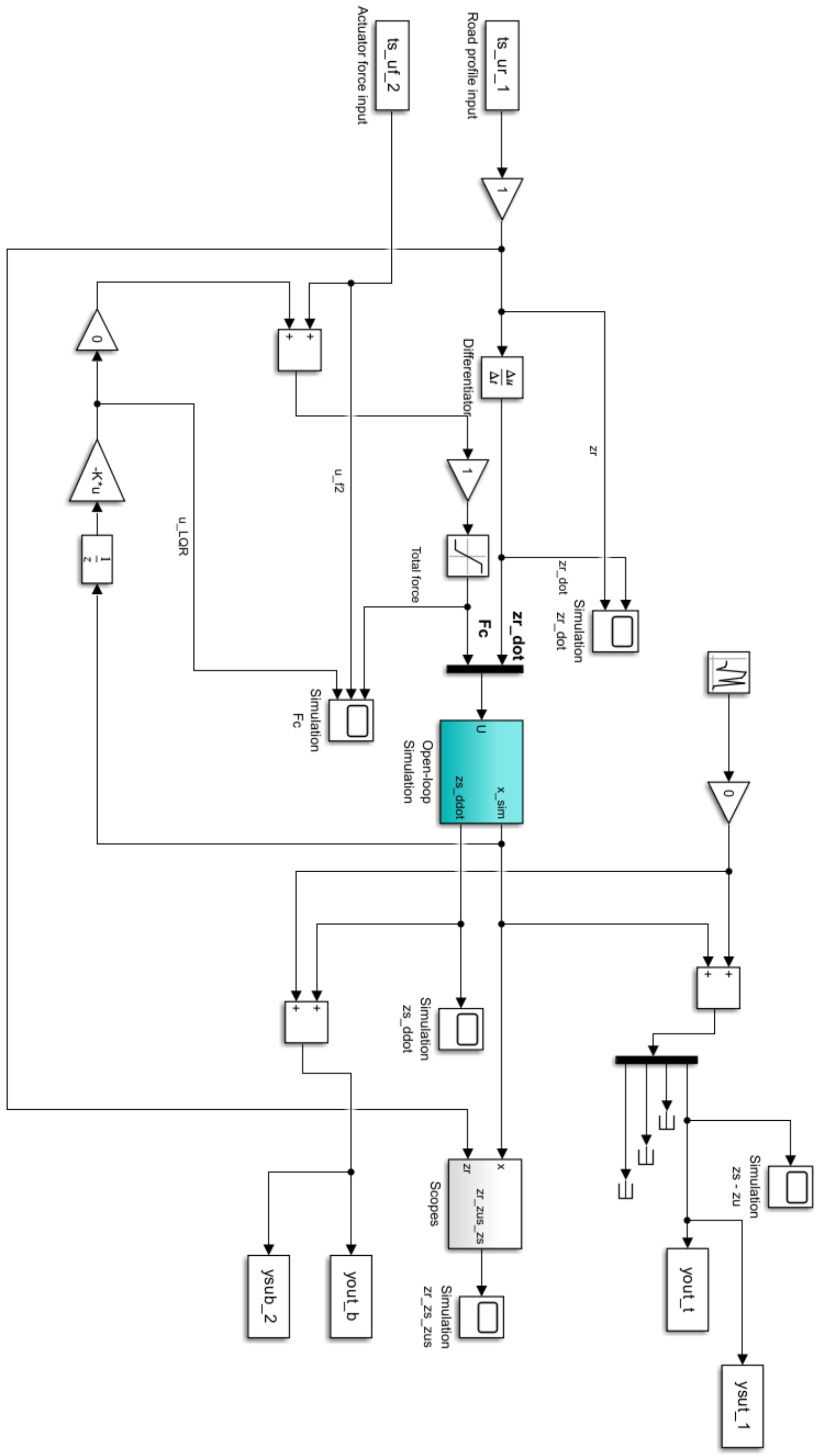
Quarter car suspension model transfer function (no date) x-engineer.org. Available at: https://x-engineer.org/quarter-car-suspension-transfer-function/ (Accessed: 10 March 2024).

Yoshimura, T. *et al.* (2001) ‘Construction of an active suspension system of a quarter car model using the concept of sliding mode control’, *Journal of Sound and Vibration*, 239(2), pp. 187–199. doi:10.1006/jsvi.2000.3117.

Zhu, Y. (2002) ‘Estimation of an N–L–N hammerstein–wiener model’, *Automatica*, 38(9), pp. 1607–1614. doi:10.1016/s0005-1098(02)00062-6.

9. Appendices

9.A. Simulink Model



9.B. Toolbox GUI Test Spreadsheet

	Input NL	Linear Block	Output NL		fit
input(u)	sigmoid (10 units)	1.2.1	sigmoid (10 units)	output(y)	58.14
	sigmoid (10 units)	2.3.1	sigmoid (10 units)		59.56
	sigmoid (20 units)	1.2.1	signoid (20 units)		3.948
	sigmoid (10 units)	2.4.1	sigmoid (10 units)		34.68
	sigmoid (10 units)	3.4.1	sigmoid (10 units)		45.32
	sigmoid (10 units)	1.4.1	sigmoid (10 units)		70.05
	sigmoid (5 units)	1.4.1	sigmoid (5 units)		68.06
	sigmoid (20 units)	1.4.1	sigmoid (20 units)		70.92
	sigmoid (50 units)	1.4.1	sigmoid (50 units)		35.85
	sigmoid (30 units)	1.4.1	sigmoid (30 units)		40.07
	sigmoid (20 units)	2.4.1	sigmoid (20 units)		31.35
	sigmoid (10 units)	2.4.1	sigmoid (10 units)		34.68
	sigmoid (10 units)	1.8.1	sigmoid (10 units)		36.9
	sigmoid (10 units)	2.8.1	sigmoid (10 units)		2.827
	sigmoid (20 units)	1.4.5	sigmoid (20 units)		57.31
	sigmoid (20 units)	1.4.2	sigmoid (20 units)		13.97
	sigmoid (20 units)	1.4.10	sigmoid (20 units)		38.99
	sigmoid (20 units)	4.8.1	sigmoid (20 units)		63
	sigmoid (20 units)	2.8.1	sigmoid (20 units)		9.743
	sigmoid (25 units)	1.4.1	sigmoid (25 units)		51.71
	sigmoid (15 units)	1.4.1	sigmoid (15 units)		79.26
	sigmoid (12 units)	1.4.1	sigmoid (12 units)		74.97
	sigmoid (16 units)	1.4.1	sigmoid (16 units)		70.06
	sigmoid (14 units)	1.4.1	sigmoid (14 units)		70.97
	piecewise (10 breakpoints)	1.4.1	piecewise (10 breakpoints)		64.45
	one-dimensional poly (fourth d	1.4.1	one-dimensional poly (fourth degree)		27.53
	sigmoid (15 units)	1.4.1	piecewise (10 breakpoints)		62.33

units (Sigmoid)	Filtered Fit	Unfiltered Fit	units (Sigmoid)	Filtered Fit	Unfiltered Fit
0	55.24	31.12	49	86.21	89.91
1	5.949	26.54	50	80.37	35.85
2	10.55	39.17	51	79.61	92.42
3	53.9	38.97	52	77.74	90.47
4	19.01	63.51	53	71.82	62.61
5	46.19	68.06	54	91.59	77.19
6	39.38	70.03	55	73.46	57.33
7	64.63	65.69	56	83.87	18.97
8	70.75	49.28	57	92.4	82.12
9	26.51	70.41	58	84.15	16.09
10	65.81	70.05	59	91.65	77.79
11	42.32	73.61	60	89.91	-3.626
12	33.34	74.97	61	93.93	94.12
13	50.42	66.71	62	58.17	80.12
14	51.43	70.97	63	-33.66	32.83
15	59.34	79.26	64	70.31	40.43
16	66.32	70.06	65	65.64	38.91
17	65.81	76.03	66	83.36	94.28
18	67.19	74.53	67	87.38	43.97
19	26.6	69.2	68	66.89	49.14
20	70.39	70.92	69	79.05	6.556
21	71.7	81.47	70	95.85	-16.53
22	67.65	28.26	71	79.52	30.18
23	54.49	35.07	72	80.83	93.12
24	61.05	63.69	73	95.16	94.14
25	72.71	51.71	74	35.37	95.9
26	17.33	85.67	75	72.41	86.62
27	77.75	79.2	76	49.02	96.48
28	62.2	64.43	77	74.25	97.09
29	40.46	82.69	78	95.6	94.84
30	73.53	40.07	79	94.69	95.51
31	76.01	82.09	80	90.71	80.91
32	86.59	27.43	81	88.02	-10.88
33	52.34	69.35	82	87.05	1.073
34	35.94	67.87	83	88.22	86.18
35	75.47	10.06	84	83.93	22.25
36	78.79	80.4	85	46.94	90.5
37	73.83	80.54	86	55.44	53.5
38	79.54	87.04	87	96.42	6.75
39	78.12	87.6	88	81.46	86.18
40	69.27	86.97	89	60.36	91.14
41	86.55	90	90	88	96.34
42	82.69	84.48	91	90.53	50.08
43	87.51	-22.67	92	17.69	98.21
44	60.98	29.8	93	74.66	77.69
45	69.44	30.08	94	96.22	43.89
46	59.78	37.37	95	85.86	97.19
47	74.55	-8.885	96	64.74	87.62
48	91.36	37.2	97	63.06	45.44
			98	89.1	91.92
			99	93.65	18.74
			100	78.85	72.93

9.C. MATLAB Code

init

```
load yout_t_scale.mat
load yout_b_scale.mat
load yt_1_0_50_500.mat
load yb_2_0_50_500.mat
```

Generate NLHW Model with Sigmoid Network

```
close all
unitstart = 0; %parameters can be changed
unitend = 300;
cut1 = 200000;
cut2 = 200000+1200;

resultsize = 1 + unitend - unitstart;
results = [zeros(resultsize,3)];


for i = unitstart : unitend

    results(i,1) = i;

    Units = i;
    Fs = 1000;
    Ts = 1/Fs;

    % Define orders of linear block
    nb = 1;
    nf = 4;
    nk = 1;

    %data processing
    ysim = ysub_2.data';
    yb2 = yb_2(2,:);
    yexp = yb2;
    yexpcut = yexp(cut1:cut2);
    ysimcut = ysim(cut1:cut2);
    ysimcutma = movmean(ysimcut, 25);
    zbody = iddata(yexpcut',ysimcutma',Ts);
    zbody2 = iddata(yexp(cut1+100000:cut2+100000)',movmean(ysim(cut1+100000:cut2+100000),25)',Ts);

    % Estimate Hammerstein-Wiener Model
    hw01 = nlhw(zbody,[1 4 1],idSigmoidNetwork(i),idSigmoidNetwork(i)); %nonlinear blocks can be altered

    figure()
    subplot(2,1,1)
    compare(zbody,hw01)
    title('Estimation (Units = 500)')
    subplot(2,1,2)
    compare(zbody2,hw01);
    title('Validation (Units = 500)')

    %saving results
[x, fit, xx] = compare(zbody,hw01);
[x2, fit2, xx2] = compare(zbody2,hw01);

results(i,2) = fit;
results(i,3) = fit2;

end
```

9.D NLHW Spreadsheet Results

(on next page)

4th Order Sigmoid	200000-201200 validation +100000		100000-100200 validation +100000		100000-101200 validation +100000		100000-100200 validation +80000		200000-200200 NL-L (one NL block)		200000-200200 L-NL (one NL block)	
Unit	Est. Fit	Val. Fit	Est. Fit	Val. Fit	Est. Fit	Val. Fit	Est. Fit	Val. Fit	Est. Fit	Val. Fit	Est. Fit	Val. Fit
1	11.18562	9.704693			4.673613	4.553886	4.673613	2.799906	27.19479	22.35191085	8.801245	8.67529481
2	7.517778	6.722862			4.612794	4.616601	4.612794	2.100022	32.35568	25.15329169	8.808368	8.68178923
3	4.759349	3.311931			5.211038	4.432286	5.211038	1.725716	27.19494	16.16693296	8.531555	8.17779064
4	3.232365	0.92766			2.223529	2.087431	2.223529	0.355645	27.45001	17.12433455	8.714522	7.88884065
5	4.139604	2.912863			0.849574	0.927178	0.849574	0.283605	28.0724	13.30485068	10.01987	8.58999312
6	6.35948	4.13363			8.037431	8.502533	8.037431	-0.38279	19.06002	4.384200699	10.71746	9.82170542
7	6.546593	6.677377			4.804957	4.765183	4.804957	1.386285	28.39295	11.74667004	9.669868	7.98461287
8	1.020819	-2.03476			5.298468	5.520166	5.298468	-0.29213	25.53142	10.39056593	9.212898	8.50569246
9	4.706006	5.149393			0.604779	0.617679	0.604779	0.428676	27.80473	14.74038629	10.5051	9.60859543
10	7.356461	6.631782			7.578578	7.087371	7.578578	-283167	29.57855	18.73323859	9.473097	8.65866956
11	7.251665	7.073967			6.281542	6.218705	6.281542	0.028009	25.22147	11.9525509	9.727158	8.96800441
12	7.095562	4.682368			3.994997	3.019052	3.994997	-152.684	27.41212	12.08737646	9.538169	8.75509153
13	4.469113	2.486133			2.087175	1.668779	2.087175	-2.30075	29.93878	17.85729778	9.734669	9.52773969
14	4.087059	3.330129			8.859037	8.709303	8.859037	0.296393	33.84072	25.84667249	10.33608	9.20306048
15	4.610177	2.253662			3.992746	1.351759	3.992746	-26.0246	27.85463	13.76111231	10.59207	9.35980247
16	9.084804	8.517867			6.120569	5.447646	6.120569	-139507	34.3712	25.80027745	10.42573	9.30962871
17	10.52894	5.760782			11.71405	10.74892	11.71405	-11.4532	42.97245	26.74477676	10.06613	9.26083169
18	8.070843	7.369493			9.271283	9.091901	9.271283	-13.9021	49.81643	31.16498676	10.2647	9.12332303
19	8.089196	5.910526			7.027528	7.195536	7.027528	-200.557	28.06886	16.2968308	10.62347	9.59943771
20	7.893991	7.196149			8.194246	7.827862	8.194246	-4.54454	26.81334	14.26608541	10.92341	10.1960569
21	11.95681	6.892343			7.511476	7.4714	7.511476	-0.16664	31.95923	16.8215839	11.09663	9.67327006
22	13.37441	10.96866			1.346024	1.337529	1.346024	-0.69965	30.01978	16.00291849	11.0279	9.95872762
23	10.52921	7.605862			6.561958	6.610248	6.561958	-1.41357	32.04405	17.93102228	10.5041	9.07365622
24	7.448653	2.421944			9.529725	9.615291	9.529725	-6.01403	28.6301	16.81999784	10.97245	9.72431595
25	11.84487	7.344525			31.24719	31.80427	31.24719	-47384.2	48.69505	39.91140467	10.85725	9.0437002
26	9.688136	8.04029			21.14632	22.57964	21.14632	-4.25658	39.91996	26.25479089	11.03898	10.5008526
27	9.159853	6.981622			6.147724	6.057551	6.147724	-9.56545	33.84689	19.87425261	11.32385	9.42081417
28	11.64055	7.911189			7.606513	7.28447	7.606513	-19680.4	56.14294	41.74244422	11.29525	9.5945846
29	13.78496	10.22799			9.175218	8.399303	9.175218	-9.35801	40.72116	32.78027702	11.16044	9.46000699
30	2.078329	2.172511			3.388028	2.972598	3.388028	-1.63476	40.31182	28.2963651	11.10095	10.2942182
31	8.353549	8.125926			5.012381	5.096542	5.012381	0.952656	53.77839	42.3266797	12.43281	11.0145323
32	0.770034	2.739532			5.076398	4.944076	5.076398	0.048995	60.30165	43.6934502	11.14516	9.80435069
33	10.05012	8.006749			40.13107	39.67193	40.13107	-127894	43.10107	31.07014168	11.3027	10.0084231
34	0.696475	1.718632			40.19178	40.43429	40.19178	-107.99	64.74094	43.68408306	11.35111	10.3155872
35	9.522084	6.99107			6.679378	6.394339	6.679378	-0.31645	49.16547	35.69122484	11.33772	10.2787386
36	11.51985	7.625114			6.140909	5.59712	6.140909	-862.542	49.49853	33.47874111	11.6481	10.2324588
37	14.35345	12.24614			5.212826	5.208424	5.212826	-0.55354	66.05615	43.74123551	12.10284	10.5136081
38	9.710965	6.27106			0.385774	-0.0281	0.385774	-2.02716	54.48868	38.0922432	11.96164	10.4515359
39	12.77676	11.46915			63.00406	55.18424	63.00406	-1142.17	47.97965	34.81816971	11.20742	10.1470055
40	10.74483	6.205537			9.340775	8.90226	9.340775	0.442567	54.46103	38.30682103	12.16757	10.5943917
41	12.26142	10.16829			9.032312	7.945801	9.032312	-2962.93	45.12724	31.94590807	11.38588	9.83083234
42	9.139031	6.375669			8.196122	8.646472	8.196122	-3697.67	55.15175	43.27313887	11.61554	10.4436631
43	15.1942	11.51258			12.59771	12.74046	12.59771	-4.9788	53.10738	39.61966155	11.64266	10.0303398
44	13.11197	10.26719			10.91985	10.72155	10.91985	-201.751	47.00219	30.63294753	11.50394	10.4738374
45	3.673304	4.32021			39.28968	38.28706	39.28968	-88.7643	48.52221	33.98647696	12.11692	10.4641548
46	18.40577	14.44373			3.416349	3.645118	3.416349	-14.3949	68.56512	42.84298583	11.39478	9.93558721
47	5.693022	6.306197			10.92434	11.31239	10.92434	-25.4924	59.35798	40.95336425	11.96804	10.482783
48	6.456178	3.041504			4.846121	5.198571	4.846121	-0.85989	56.49737	40.6619721	12.92756	11.053756
49	-0.68497	0.846811			48.33305	43.03773	48.33305	-45.993	57.46189	42.35268596	12.73629	10.7281896
50	27.17321	16.12458			50.73722	48.89299	50.73722	-41.8784	60.98022	42.44996084	11.31556	10.3614943
51	14.18073	9.366104			62.38333	55.53323	62.38333	-11507	51.47054	37.79401685	12.20124	10.8419236
52	9.391933	9.94513			17.10383	16.83755	17.10383	-107.621	72.39522	44.61031877	11.42488	10.1429394
53	8.873958	2.835454			14.25578	14.56562	14.25578	-1.74404	72.85706	44.46911485	11.87711	10.5595294
54	25.00099	19.43541			20.15425	20.48168	20.15425	-9.69457	69.69235	44.9875711	12.17441	10.5379519
55	8.565843	6.012187			10.96127	10.46694	10.96127	-539.132	73.34067	43.78094577	11.51043	10.4141808
56	-0.64184	1.645072			21.84419	22.2938	21.84419	-9.15299	63.38339	42.99423571	12.54057	11.4549656
57	32.03586	19.21147			22.33543	23.68036	22.33543	-3.58495	58.90337	41.67192058	12.51159	10.7799029
58	5.951194	4.583493			45.75041	38.53345	45.75041	-84.4383	59.4166	42.09919102	11.85715	10.2207515
59	18.80193	10.27596			11.14879	10.67457	11.14879	-28009.1	60.07817	41.4533987	13.08787	11.1521445
60	13.07985	9.458891			67.58872	59.82081	67.58872	-50.3327	74.10957	45.80543869	12.52307	10.8834312
61	14.12808	11.26242			35.24233	34.69732	35.24233	-158907	59.42065	41.44047281	12.20611	11.2178216
62	25.87646	19.72412			8.212297	8.182333	8.212297	-37.6603	63.26976	42.54743114	13.22577	11.5175914
63	23.77376	14.02821			16.27157	16.22418	16.27157	-1297.4	65.62254	43.37445318	12.61699	10.7073984
64	26.18787	15.8168			12.11098	10.31799	12.11098	-262.12	62.42855	43.29949913	12.87659	11.3997916
65	13.99645	9.248577			22.38543	22.29547	22.38543	-753.759	58.43998	41.91312742	13.097	11.3899883
66	12.67583	8.821057			18.22376	18.23302	18.22376	-5172.27	72.32689	45.35607823	12.84087	11.3846664
67	20.04433	16.02759			55.07874	50.72546	55.07874	-57.2821	61.28735	41.46227879	13.4315	11.3444406
68	14.88286	9.971303			49.68856	44.91748	49.68856	-5383.34	73.10074	44.96680692	13.6159	11.59261
69	11.88426	9.588124			13.93787	14.39477	13.93787	-4.89035	62.48733	42.63283763	12.59387	11.1470093
70	14.89003	11.00897			69.61471	62.24849	69.61471	-548.168	75.9911	44.24748489	13.96403	11.0036938
71	29.60868	20.28902			15.15929	15.31274	15.15929	-2506.02	72.68686	44.78437479	13.52824	12.0490511
72	17.63107	12.5925			9.303578	8.25216	9.303578	-944.351	77.00664	45.52598049	14.09078	12.3130795
73	38.35381	23.03759			12.71576	12.49604	12.71576	-6067.86	66.45936	43.34286202	13.58367	11.2556778
74	26.93441	18.34776			41.19835	40.83369	41.19835	-6.80993	64.71325	43.87623053	13.71657	11.5371523
75	26.5167	17.08506			56.44483	49.75735	56.44483	-276.146	66.5159	43.03249555	12.56243	10.6474911
76	23.47698	18.48601			22.71959	20.44425	22.71959	-83.7509	65.17865	43.64332899	13.9886	11.8311138

77	12.72121	7.073769			12.86623	12.78695	12.86623	-1683.95	64.36104	43.33359996	13.53046	11.3510142
78	79.07325	46.73977			27.74885	27.72955	27.74885	-50.7579	78.56486	46.16328472	14.0571	11.7525424
79	29.12801	20.62749			12.20055	11.63455	12.20055	-51.3079	66.43658	43.95787294	13.51249	11.815189
80	39.21182	28.29037			68.54974	59.71986	68.54974	-126856	66.55634	44.2774087	13.59042	11.5660108
81	38.1588	22.09056			20.30341	19.62262	20.30341	-8.51448	64.67408	42.57662774	14.65576	12.3101986
82	25.11127	17.25683			36.00237	32.19595	36.00237	-875.822	76.26764	45.02686189	13.38745	11.7721191
83	37.39391	21.3816			45.04609	45.76664	45.04609	-52.9513	73.25221	44.89560809	13.96931	12.0439444
84	41.10863	25.50421			-12.8489	-15.9877	-12.8489	-2438.34	67.69869	44.39483593	14.05911	12.0680633
85	41.98872	32.17217			13.98015	13.3788	13.98015	-1230.08	66.28902	45.03869751	14.23428	12.7189085
86	30.79873	15.28111			23.63334	22.63328	23.63334	-402.366	78.00793	46.34856084	13.20063	11.4271157
87	56.30561	34.64332			4.369836	2.965465	4.369836	-2812.56	69.0416	43.63224918	13.81079	11.8370981
88	42.90087	23.29207			52.09558	47.8078	52.09558	-103991	68.41358	44.46703098	14.15499	11.9923436
89	82.2882	46.92563			23.70726	22.22993	23.70726	-15762.5	67.22624	44.12177811	14.43503	12.3286524
90	66.90931	37.57745			14.40029	13.44114	14.40029	-1688	68.78406	45.00839812	13.77586	11.2742611
91	28.59099	16.08243			53.82509	47.32843	53.82509	-110317	69.88906	46.17038057	15.19209	12.5795224
92	36.41211	22.14961			15.91116	16.58981	15.91116	-776.65	69.85532	45.66050245	14.65545	11.7831329
93	30.89224	19.36206			32.98626	31.29333	32.98626	-631.013	69.72621	45.45026985	14.95049	12.9702731
94	34.64833	22.41779			20.34729	19.6954	20.34729	-3.16989	68.22988	45.2509677	14.87921	12.2359166
95	38.01647	21.51032			4.374659	2.770913	4.374659	-7.66928	69.80468	44.24871323	14.36048	12.0245955
96	77.48959	44.13082			34.9304	32.90126	34.9304	-982.185	70.59813	45.78324086	14.79891	12.8008042
97	32.43866	19.96298			16.62204	15.27292	16.62204	-8502.04	69.97538	46.02685671	15.32448	12.8353059
98	35.96414	25.09412			16.86831	15.02586	16.86831	-7265.41	79.23298	47.27728989	14.33377	12.3018513
99	38.36669	24.37038			24.60496	24.27704	24.60496	-19958.2	81.39964	46.37093656	15.00129	12.8849895
100	40.8103	26.24749	48.23156	43.73456	48.23156	43.73456	48.23156	-98352.5	71.1875	44.70443668	14.42859	12.3294077
101	52.53371	32.03384	74.36403	64.66812	74.36403	64.66812	74.36403	-55950.5	71.19366	45.4786776	14.73391	11.8305317
102	85.32756	47.90149	60.64709	56.43211	60.64709	56.43211	60.64709	-25.2031	70.33429	46.49606024	14.62267	12.0793712
103	28.52282	18.63149	36.84109	37.23656	36.84109	37.23656	36.84109	-5.90759	70.51351	44.91906118	14.24526	12.4166449
104	47.15623	27.71734	30.11218	27.71548	30.11218	27.71548	30.11218	-26889	72.1384	46.41612009	15.59608	13.3255968
105	63.34661	40.35277	52.84147	52.06324	52.84147	52.06324	52.84147	-27.859	80.48083	47.30234152	14.98722	12.9188317
106	61.27964	38.82771	66.32802	60.43035	66.32802	60.43035	66.32802	-72.663	83.74726	46.82195817	14.35663	12.6980906
107	86.37081	49.70474	41.16706	39.85993	41.16706	39.85993	41.16706	-13.4011	82.65985	46.51608507	15.61897	12.8692966
108	53.48251	32.37764	71.77186	63.10136	71.77186	63.10136	71.77186	-31411.7	70.97447	44.42258009	14.60372	12.4756787
109	41.48983	27.22056	24.39247	23.06768	24.39247	23.06768	24.39247	-3158.46	75.41499	46.75478479	15.12269	12.4381529
110	41.93395	25.57148	24.05201	22.41153	24.05201	22.41153	24.05201	-44553.5	72.58891	45.40467229	15.47398	13.0014149
111	65.27955	36.06045	62.89742	55.28553	62.89742	55.28553	62.89742	-58.134	72.83586	45.19132254	15.41651	12.4877266
112	32.00954	20.80898	57.33266	54.67352	57.33266	54.67352	57.33266	-141.378	72.0063	45.10638841	14.76121	12.1758022
113	59.42851	41.39497	76.90511	68.02486	76.90511	68.02486	76.90511	-113483	70.36404	45.21678582	15.48272	12.9271568
114	62.52536	38.85529	14.34332	13.24375	14.34332	13.24375	14.34332	-10.1487	73.00386	45.22640658	15.37445	13.1946658
115	86.59849	46.31574	18.72717	17.44492	18.72717	17.44492	18.72717	-246708	83.20355	45.71903627	15.50678	13.1225372
116	65.13457	40.71789	65.24315	58.1754	65.24315	58.1754	65.24315	-39.1126	75.56567	46.37351814	15.04309	12.2791635
117	44.59581	27.54799	64.1482	56.50711	64.1482	56.50711	64.1482	-26.7934	84.24925	47.59430732	16.59207	14.0516858
118	87.45632	48.90295	42.00776	37.96701	42.00776	37.96701	42.00776	-1218.69	72.98487	46.43846809	15.9594	13.1373286
119	47.28061	33.25048	49.84126	43.66626	49.84126	43.66626	49.84126	-387.24	79.5086	45.70548472	15.52743	12.1982525
120	72.1341	45.42849	64.77463	56.82623	64.77463	56.82623	64.77463	-9.86081	75.4306	46.55426809	14.89034	12.5495606
121	73.34293	47.62129	15.23847	14.77463	15.23847	14.77463	15.23847	-13244.9	75.55501	46.6153281	15.3112	13.0224791
122	67.54692	45.06234	29.801	28.92747	29.801	28.92747	29.801	-5731.53	75.44912	46.62129801	16.2877	13.5358496
123	78.40699	45.1287	79.1004	68.67924	79.1004	68.67924	79.1004	-100680	80.51168	47.67942583	15.62627	12.7409065
124	75.15931	43.85936	22.67721	20.89501	22.67721	20.89501	22.67721	-27821.1	76.90531	47.22810446	15.50018	13.1771591
125	59.49304	32.93697	58.55182	51.4315	58.55182	51.4315	58.55182	-94.3517	81.84971	47.14349448	15.29552	12.2422993
126	83.41139	47.62177	43.52949	41.00881	43.52949	41.00881	43.52949	-49.0487	79.56139	46.67633716	15.31254	12.9794805
127	18.04163	13.49494	67.87956	60.09878	67.87956	60.09878	67.87956	-43.9829	85.18047	46.93908426	16.13397	13.4902412
128	88.98327	48.61327	38.62455	37.00079	38.62455	37.00079	38.62455	-986.543	82.49592	48.34474539	16.6681	13.5304215
129	69.21991	41.99719	68.4935	60.48205	68.4935	60.48205	68.4935	-9111.23	75.99868	46.40127481	15.71558	13.1537562
130	48.7049	29.83724	17.40806	15.35365	17.40806	15.35365	17.40806	-155.927	84.8096	47.48666499	16.75206	13.7719086
131	80.33248	44.8045	64.89041	58.4653	64.89041	58.4653	64.89041	-26.0783	82.97461	47.39412595	16.83505	13.9150146
132	87.5476	47.73729	30.39995	28.79993	30.39995	28.79993	30.39995	-348.969	81.21153	46.95526832	16.73665	13.5213854
133	58.00544	37.61561	74.90532	66.6795	74.90532	66.6795	74.90532	-82669.4	84.06678	47.14596348	16.08585	13.4447391
134	83.14878	46.25248	50.38302	45.43355	50.38302	45.43355	50.38302	-18.7705	85.99466	46.91997685	15.94973	13.2811825
135	27.47475	17.84071	63.77663	55.22635	63.77663	55.22635	63.77663	-38779.4	82.41789	46.86966951	16.46716	13.7825479
136	87.40019	47.7374	65.90235	58.72457	65.90235	58.72457	65.90235	-137.738	83.90561	46.97628789	16.6828	13.6103666
137	0	0	0	0	0	0	0	0	77.05671	46.2109515	16.3147	13.0617657
138	89.24706	47.32488	53.50928	49.12323	53.50928	49.12323	53.50928	-1235.04	77.8577	47.40835936	16.30368	13.2588703
139	65.68339	36.08869	68.59868	60.59487	68.59868	60.59487	68.59868	-4851.18	81.49504	47.70655269	16.02345	13.056243
140	90.13628	49.17967	65.75982	58.13579	65.75982	58.13579	65.75982	-57.5891	84.81084	46.34670187	16.86727	13.2939381
141	85.51715	46.25463	66.04168	58.81272	66.04168	58.81272	66.04168	-63.0882	85.20293	47.08039072	16.231	13.6073895
142	87.17255	49.05131	20.69087	20.24774	20.69087	20.24774	20.69087	-9322.06	79.37941	47.50400707	17.36825	13.0372878
143	89.81708	47.46502	33.59409	32.36002	33.59409	32.36002	33.59409	-8839.79	77.84058	47.25449463	16.34681	14.0764877
144	74.99839	40.4116	28.00283	24.48302	28.00283	24.48302	28.00283	-8069.53	86.54502	47.69349332	17.02296	13.8420435
145	55.24118	29.79923	64.25483	57.27603	64.25483	57.27603	64.25483	-26.2418	79.70378	46.99907899	16.48234	13.4327355
146	90.01691	49.13228	44.88786	40.94909	44.88786	40.94909	44.88786	-8236.39	79.19708	47.24907402	18.27754	14.6766265
147	89.98058	48.90205	33.13211	31.89768	33.13211	31.89768	33.13211	-38901.1	77.70678	46.93107473	18.0875	14.5213818
148	89.38279	48.94698	69.11776	61.38429	69.11776	61.38429	69.11776	-59.5044	80.8005	47.96304588	17.66596	14.473484
149	89.33313	48.96162	26.30168	25.73676	26.30168	25.73676	26.30168	-39247.5	84.74167	46.98182075	18.14441	14.3491406
150	87.48868	47.28	70.12576	61.7776	70.12576	61.7776	70.12576	-53.7917	80.96847	47.41518931	17.23861	13.6000652
151	89.61166	48.02461	65.51095	57.51125	65.51095	57.51125	65.51095	-52.0382	78.5596	47.88574028	17.4307	13.6148809
152	71.79279	40.00442	52.958	48.835	52.958	48.835	52.958	-44.7147	87.07285	46.78169153	17.33022	14.3172621
153	50.55301	36.73039	36.15788	36.90258	36.15788	36.90258	36.15788	-1862.19	81.23348	47.96039943	17.72063	13.4916365
154	90.61666	47.32617	65.5781	57.86753	65.5781	57.86753	65.5781	-4266.88	86.2725	47.83959998	18.62395	14.8936658
155	48.72681	28.21258	78.18317	68.07247	78.18317	68.07247	78.18317	-40392	79.78904	47.16868669	18.94049	14.8990613

156	86.10544	46.4484	41.37748	37.3856	41.37748	37.3856	41.37748	-43560	85.51515	47.66927399	18.34365	14.9331926
157	87.46103	46.72328	66.10473	58.19765	66.10473	58.19765	66.10473	-42.2125	80.11676	47.79101593	17.31666	14.2220043
158	70.38778	40.90957	38.24266	38.40273	38.24266	38.40273	38.24266	-149.763	80.21365	47.47340671	18.27324	14.4178803
159	89.58721	49.50423	20.47419	19.11177	20.47419	19.11177	20.47419	-3173.05	87.7708	47.44628044	19.91532	15.3293525
160	21.31125	13.47389	69.94939	61.12533	69.94939	61.12533	69.94939	-11959.6	87.6141	46.93725559	18.8432	14.7386044
161	89.84085	48.77443	66.61521	58.85465	66.61521	58.85465	66.61521	-237.458	86.73589	47.51423211	17.87857	13.7758572
162	75.54829	43.52123	66.7156	58.87231	66.7156	58.87231	66.7156	-265.575	88.42797	47.40620272	17.0483	13.7317911
163	86.57838	46.86907	23.93969	21.78598	23.93969	21.78598	23.93969	-986.652	83.6439	47.62041128	17.38097	13.6719353
164	89.10866	48.62197	67.59748	59.95865	67.59748	59.95865	67.59748	-58.9975	88.052	47.72457709	17.94418	14.5067829
165	5.777337	3.891817	68.27863	60.10412	68.27863	60.10412	68.27863	-79.2467	81.25323	47.72774735	18.95298	14.7777915
166	84.19291	45.42318	32.49292	31.67502	32.49292	31.67502	32.49292	-995.421	89.14634	47.40473175	19.14512	15.196231
167	86.41826	46.65023	40.675	36.42122	40.675	36.42122	40.675	-20.9644	88.72458	47.04779761	18.66086	14.9444985
168	83.97883	49.03787	37.10349	33.60089	37.10349	33.60089	37.10349	-17012.2	88.83457	46.62722737	19.51176	14.7602526
169	90.91495	49.67278	23.10366	20.64671	23.10366	20.64671	23.10366	-934.427	81.42138	47.56844682	17.8387	14.1218379
170	90.93033	48.53509	68.05118	61.79971	68.05118	61.79971	68.05118	-250.364	84.11368	47.64312202	18.95424	15.284237
171	83.38896	44.48138	57.30323	52.8395	57.30323	52.8395	57.30323	-238.819	82.13704	48.2222256	19.3199	15.3582735
172	0	0	0	0	0	0	0	0	82.37862	48.10231117	19.03767	15.07809
173	80.41207	45.51855	43.51405	40.76884	43.51405	40.76884	43.51405	-1216.52	88.51327	48.66075351	17.99105	14.8817654
174	85.96261	45.25211	42.44528	40.17354	42.44528	40.17354	42.44528	-1535.95	89.00303	47.17229415	18.62128	14.4487131
175	90.75204	47.09767	23.01554	21.46935	23.01554	21.46935	23.01554	-4996.97	83.01046	47.80103086	18.20224	14.417606
176	90.30022	47.32828	57.89516	51.79837	57.89516	51.79837	57.89516	-64.8158	89.61426	48.20197556	19.09474	15.3185517
177	86.77956	49.21935	46.07173	42.88067	46.07173	42.88067	46.07173	-58534.3	89.32907	48.29736535	19.12998	15.4509282
178	84.2859	49.23417	28.25199	27.86257	28.25199	27.86257	28.25199	-2355.7	89.83203	47.91012842	18.65901	14.6410861
179	88.46851	46.21184	84.43315	72.5038	84.43315	72.5038	84.43315	-4389.82	83.15084	47.97769331	18.11825	14.802552
180	88.83888	46.77735	31.27082	30.04616	31.27082	30.04616	31.27082	-4814.8	82.63521	47.60900906	20.02566	15.4304311
181	79.51804	42.74948	71.32927	62.80532	71.32927	62.80532	71.32927	-1859.15	82.9592	47.74204341	20.71465	16.1405766
182	90.55293	47.09096	71.38451	61.84378	71.38451	61.84378	71.38451	-90478.1	89.15931	47.84092273	19.35206	15.575473
183	35.74475	23.89776	76.67525	67.22855	76.67525	67.22855	76.67525	-10252.9	83.24563	47.88685535	20.62114	16.2773092
184	84.01889	44.53832	79.60798	69.45918	79.60798	69.45918	79.60798	-9971.15	82.48053	47.66927402	20.32234	15.4967721
185	22.8359	16.96316	65.16566	56.83639	65.16566	56.83639	65.16566	-29.7897	89.65223	47.47538072	18.573	15.1530695
186	90.07506	46.88578	20.73497	18.97904	20.73497	18.97904	20.73497	-381.712	84.97184	48.08037883	21.18886	15.9337821
187	85.9077	46.93495	70.19207	61.63369	70.19207	61.63369	70.19207	-32310.9	89.3402	48.09991049	20.73101	15.4619086
188	88.27313	46.02396	68.81522	61.20973	68.81522	61.20973	68.81522	-8.42412	89.66986	47.85648427	18.65667	14.667751
189	91.07984	49.29336	30.28079	28.82184	30.28079	28.82184	30.28079	-30995.7	84.6695	48.03945121	21.2942	16.2578052
190	75.78267	43.35269	65.6332	60.62612	65.6332	60.62612	65.6332	-213.417	83.12167	47.70704204	21.48679	16.6467152
191	90.57563	46.61927	28.80263	27.88351	28.80263	27.88351	28.80263	-1218.99	84.05081	47.83921719	19.0588	15.1812492
192	70.39002	39.3523	69.99404	61.45166	69.99404	61.45166	69.99404	-89.4675	84.44659	48.12575073	19.80308	15.4590927
193	88.70638	48.24527	71.24717	63.50189	71.24717	63.50189	71.24717	-450.425	89.71142	47.36199919	22.77902	17.4909407
194	79.2974	44.75719	29.1774	26.77763	29.1774	26.77763	29.1774	-7749.1	85.86363	48.12746557	22.28188	16.9814746
195	73.79635	40.89952	39.44194	36.87702	39.44194	36.87702	39.44194	-1129.96	88.98308	47.34187594	20.52922	14.7470694
196	90.02191	48.75191	21.32234	20.5685	21.32234	20.5685	21.32234	-10581.7	90.40655	47.96264093	20.50718	15.8421073
197	91.52512	48.94946	70.00545	62.10735	70.00545	62.10735	70.00545	-2372.14	84.33479	47.94141127	20.34351	15.7183318
198	80.75704	45.20556	25.11956	23.78787	25.11956	23.78787	25.11956	-138.854	86.14479	48.24167647	21.44345	16.6171011
199	87.00376	46.97914	41.0032	40.11359	41.0032	40.11359	41.0032	-4020.79	87.28268	47.9841825	20.76263	16.2516941
200	91.44355	48.34566	63.23558	57.17343	63.23558	57.17343	63.23558	-932.649	85.04823	48.08491206	19.52597	15.1483457
201	91.57798	49.28571	72.31395	64.15636	72.31395	64.15636	72.31395	-1051.64	85.83034	47.91728771	20.0182	15.4740277
202	51.51559	27.48111	46.38007	43.02229	46.38007	43.02229	46.38007	-70.0966	88.18754	47.94271156	21.55617	17.0293609
203	81.14333	46.28832	69.99018	61.89254	69.99018	61.89254	69.99018	-55.1293	90.40491	48.58451958	21.96163	16.8241672
204	90.17959	47.82504	62.83136	55.12618	62.83136	55.12618	62.83136	-2894.73	86.51136	48.26046796	20.05045	16.1352154
205	90.68845	47.15283	71.10269	62.17226	71.10269	62.17226	71.10269	-65.0095	85.82485	48.19465018	21.89201	16.6673669
206	0	0	0	0	0	0	0	0	0	0	21.29291	17.3520411
207	89.95735	46.61911	77.59172	66.67591	77.59172	66.67591	77.59172	-75062.5	89.58948	47.24944571	20.67812	16.5731585
208	91.67817	46.75971	55.53022	50.29639	55.53022	50.29639	55.53022	-45.0494	90.50349	48.2487202	20.12938	15.2494317
209	78.41958	42.42281	65.8512	57.80213	65.8512	57.80213	65.8512	-53.6413	85.7857	48.1503812	21.27326	16.4473826
210	91.75529	49.14129	35.29302	32.97293	35.29302	32.97293	35.29302	-70875.5	90.45989	47.02481105	20.21839	15.8073657
211	79.05408	45.59876	32.33913	31.24437	32.33913	31.24437	32.33913	-3767.2	90.79862	48.79653346	20.2301	15.7514263
212	88.53631	48.23739	29.38079	29.28388	29.38079	29.28388	29.38079	-539.777	84.93604	48.16788363	20.4569	15.6493919
213	81.34144	48.19324	41.90529	39.5274	41.90529	39.5274	41.90529	-4274.21	88.99274	48.34992838	22.66699	17.022693
214	78.43413	43.59466	48.13211	44.35444	48.13211	44.35444	48.13211	-128411	90.41371	47.57312083	19.75195	15.3251726
215	89.52778	49.51014	71.1046	63.25953	71.1046	63.25953	71.1046	-54.003	86.40836	47.93394982	24.16952	18.1203822
216	30.29112	23.0947	11.84725	10.9679	11.84725	10.9679	11.84725	-50.5977	86.62212	48.35039222	23.46512	18.3679229
217	91.65666	49.17228	13.15626	13.12102	13.15626	13.12102	13.15626	-4.70799	86.22329	48.10429262	24.22899	17.4115949
218	54.11478	35.18711	33.81764	33.09673	33.81764	33.09673	33.81764	-1524.55	86.27869	48.18855691	21.8543	16.4532907
219	22.15901	14.39457	34.22477	31.31622	34.22477	31.31622	34.22477	-22122	90.7404	47.9870932	21.38184	16.495444
220	91.42894	47.49354	68.07993	61.80341	68.07993	61.80341	68.07993	-2498.6	86.79132	48.26173283	22.51047	17.0490787
221	91.48642	47.63797	34.91082	32.93503	34.91082	32.93503	34.91082	-9626.94	90.83662	47.3584549	23.35064	17.3145911
222	57.53303	42.34087	21.76387	20.72686	21.76387	20.72686	21.76387	-12900.5	91.03681	48.18885152	20.52658	16.5168017

223	92.21424	47.23603	69.74561	61.26924	69.74561	61.26924	69.74561	-45.0809	87.19248	48.20329596	21.33875	16.1109842
224	61.89369	42.66503	71.58612	62.82026	71.58612	62.82026	71.58612	-40.8489	90.54418	47.17552469	22.31637	16.8164817
225	91.84736	46.40948	69.52078	60.94318	69.52078	60.94318	69.52078	-45.5269	86.56601	48.28297662	20.77658	16.0554737
226	74.54473	46.1189	73.20308	64.34779	73.20308	64.34779	73.20308	-53702.5	88.42512	47.85888893	23.40899	18.0020994
227	87.60671	47.26248	27.58809	26.44424	27.58809	26.44424	27.58809	-6937.95	88.82616	47.0172777	22.85341	16.8560167
228	91.88467	47.10149	73.84876	64.87443	73.84876	64.87443	73.84876	-2672.48	87.70847	48.16998386	20.02198	15.0816472
229	22.4585	20.18213	31.02798	30.49995	31.02798	30.49995	31.02798	-79.4542	87.47446	48.24602694	20.81184	15.8500991
230	82.5761	48.22902	71.58925	61.8426	71.58925	61.8426	71.58925	-21900.3	87.66551	48.40793615	25.987	19.2577356
231	46.48015	34.61527	70.79353	62.6403	70.79353	62.6403	70.79353	-55.1517	91.07495	48.01963025	23.12992	16.8233443
232	91.89011	47.45863	72.79702	64.17624	72.79702	64.17624	72.79702	-48.0656	87.03682	48.27290661	25.53664	18.6290363
233	80.38042	48.352	50.59321	46.90757	50.59321	46.90757	50.59321	-517.145	91.00004	47.72444323	23.7313	17.5685474
234	89.5163	49.3493	34.28615	31.59734	34.28615	31.59734	34.28615	-331.193	87.68998	48.33242814	23.84032	18.2560339
235	88.93174	46.16326	27.416	26.7608	27.416	26.7608	27.416	-36.4754	88.49948	48.42522049	22.77664	17.6286819
236	90.99328	49.59909	24.04672	24.38395	24.04672	24.38395	24.04672	-15.2896	87.91156	48.21019184	26.26817	18.5325075
237	86.76204	47.93199	72.08086	63.18757	72.08086	63.18757	72.08086	-77.9697	87.95956	48.48560932	25.94378	19.3016425
238	23.29075	18.12789	79.42638	68.58879	79.42638	68.58879	79.42638	-59.0757	88.41354	48.33621722	23.6965	18.0519893
239	92.26159	47.37492	46.30112	42.78356	46.30112	42.78356	46.30112	-2471.5	87.71147	48.33990004	25.57442	18.3124122
240	93.12275	46.56373	50.23629	49.00901	50.23629	49.00901	50.23629	-13.6477	87.80861	48.33789002	23.90176	18.0318528
241	82.17194	40.57559	70.08947	61.00874	70.08947	61.00874	70.08947	-34.3203	87.31804	48.20218176	25.70969	19.1735949
242	58.81064	39.53423	49.24949	45.98181	49.24949	45.98181	49.24949	-944.41	87.33632	48.26862258	23.10456	16.8143998
243	87.50337	47.79802	23.15585	22.54403	23.15585	22.54403	23.15585	-2343.99	88.2248	48.18367371	26.25912	19.3695849
244	83.34353	48.013	70.90721	62.19512	70.90721	62.19512	70.90721	-46.1166	87.44491	48.25954214	22.13476	17.0166551
245	92.89321	47.97404	64.33683	58.97886	64.33683	58.97886	64.33683	-29.7509	88.06269	48.41514041	25.14387	19.0502321
246	92.16679	47.41501	67.55626	59.23995	67.55626	59.23995	67.55626	-4897.25	91.33337	48.27195475	24.2569	17.8390356
247	89.10831	46.2266	46.32746	42.75449	46.32746	42.75449	46.32746	-2493.53	87.74117	48.29872239	25.26755	18.3766619
248	1.593824	1.534543	29.06929	27.50034	29.06929	27.50034	29.06929	-41.7697	88.14748	48.2448144	24.66453	18.9454141
249	92.61713	46.69179	34.13997	32.2607	34.13997	32.2607	34.13997	-818.122	91.02381	47.76263202	23.19664	17.3338372
250	69.9991	43.59347	49.09973	43.16873	49.09973	43.16873	49.09973	-10549	88.46475	48.369538	21.39122	15.9577437
251	91.89654	48.61071	32.23077	30.82776	32.23077	30.82776	32.23077	-1062.29	88.56045	48.36837708	27.87273	19.2286671
252	66.83315	46.55304	69.1105	61.26597	69.1105	61.26597	69.1105	-650.128	87.98283	48.36221704	26.21402	18.8981747
253	92.04544	48.56197	32.69208	30.84216	32.69208	30.84216	32.69208	-17.4371	88.32308	48.40511154	25.58615	19.1902035
254	92.0897	46.73796	69.68398	63.59543	69.68398	63.59543	69.68398	-16.4388	88.22246	48.46192112	27.39232	19.0237438
255	10.79792	7.749828	31.24774	30.48992	31.24774	30.48992	31.24774	-30578.9	88.48874	48.41399598	26.95463	19.322548
256	92.3779	49.25237	41.45396	39.37306	41.45396	39.37306	41.45396	-949.665	88.81299	48.32112994	27.51213	19.6197617
257	81.41305	46.67035	23.51103	23.04522	23.51103	23.04522	23.51103	-696.128	91.35048	48.47649774	24.33586	16.770688
258	92.02164	46.86738	71.03678	62.97391	71.03678	62.97391	71.03678	-892.288	88.20953	48.42618981	27.61526	19.219235
259	92.05017	48.92917	72.51774	63.62864	72.51774	63.62864	72.51774	-56.5717	89.06375	48.53037237	23.20324	17.5141655
260	81.64265	45.85998	73.60992	64.78775	73.60992	64.78775	73.60992	-70.5494	88.6904	48.42924904	24.5879	17.947628
261	92.37286	47.83382	59.77327	52.00869	59.77327	52.00869	59.77327	-16499.9	88.88331	48.43261984	25.44643	18.4746679
262	91.30718	47.31181	71.41499	63.39533	71.41499	63.39533	71.41499	-519.277	88.66345	48.41292825	27.01382	19.5879637
263	71.46279	44.70669	71.92534	63.78738	71.92534	63.78738	71.92534	-74.053	89.22579	48.40435927	25.97765	19.0219736
264	92.06921	47.12819	50.91038	46.54842	50.91038	46.54842	50.91038	-3008.4	89.26892	48.40955965	30.3191	20.4966147
265	84.51961	49.54823	25.33567	24.05011	25.33567	24.05011	25.33567	-36.5669	91.44809	48.37016619	24.50421	18.2077602
266	92.22361	47.12499	72.39984	63.11787	72.39984	63.11787	72.39984	-55.6868	89.26	48.476981	26.00471	19.6447982
267	92.99785	46.74205	50.26118	45.50978	50.26118	45.50978	50.26118	-742.71	89.06686	48.33198542	25.10108	18.7291121
268	90.88275	47.45277	29.62175	29.82621	29.62175	29.82621	29.62175	-75.9936	89.51172	48.46900223	22.74515	16.4192355
269	92.15264	46.8793	72.77918	63.85968	72.77918	63.85968	72.77918	-48.7912	89.56285	48.46719826	27.39174	19.9372998
270	48.02358	27.19258	73.37203	64.51369	73.37203	64.51369	73.37203	-70.1764	89.75362	48.56320347	27.15902	19.3097226
271	89.07621	49.56324	66.32215	59.41058	66.32215	59.41058	66.32215	-645.799	89.42205	48.52387387	27.10576	19.0440792
272	19.65163	10.27161	73.27568	64.52446	73.27568	64.52446	73.27568	-1105.85	89.10386	48.54730389	25.24374	18.1749924
273	83.98066	45.69304	18.49972	19.10428	18.49972	19.10428	18.49972	-744.953	91.44023	47.97229807	25.6413	19.726661
274	91.1826	46.99287	72.17267	63.21954	72.17267	63.21954	72.17267	-32.0197	89.31652	48.32560407	26.51838	19.7804628
275	0	0			0	0	0	0	0	0	30.33128	20.7949859
276	0	0			0	0	0	0	89.4848	48.41064664	25.5755	18.7002466
277	79.71159	43.383			41.86695	38.4393	41.86695	-3672.5	89.26315	48.453371	29.02112	20.2233231
278	84.71144	46.67337			75.74936	65.72244	75.74936	-419.15	89.09177	48.42810633	30.31974	20.925317
279	90.54755	49.05901			29.54326	28.78577	29.54326	-1116.39	89.46155	48.51324633	27.62433	20.3511333
280	23.49928	19.35964			44.5085	41.29316	44.5085	-2358.84	89.57595	48.53897797	27.17618	19.3527494
281	74.82932	42.99015			44.52043	42.28626	44.52043	-32.6094	89.57903	48.58324515	27.3662	20.0242996
282	49.27748	38.95717			67.503	62.39675	67.503	-2552.34	89.52646	48.54111539	27.94859	20.4627723
283	89.12528	46.93508			75.78384	66.54042	75.78384	-18494.1	89.30475	48.41556147	28.11138	19.4672227
284	51.91215	37.3151			72.80094	63.62047	72.80094	-31.4798	89.81526	48.38870949	28.94173	19.8898666
285	92.47175	48.23877			79.97083	69.52478	79.97083	-28313.4	89.76496	48.26555412	29.35549	20.9953167
286	33.39433	27.08075			22.20537	22.4318	22.20537	-14.8541	89.60256	48.44663736	26.61314	19.6405288
287	87.07165	44.67032			25.00775	25.08565	25.00775	-2145.98	89.75296	48.48653873	28.0797	19.2287933
288	63.59071	46.82983			71.12593	64.02297	71.12593	-705.556	89.78745	48.49191347	28.55252	20.4094647
289	79.60055	46.84446			75.88461	66.68552	75.88461	-2387.72	91.73463	48.35967028	31.07301	21.5669129
290	92.15439	48.40397			34.84843	33.7517	34.84843	-25449	90.12418	48.4841958	28.0974	20.1553501
291	88.93557	46.68814			29.84381	30.3661	29.84381	-11.5064	89.86359	48.47722337	28.63251	20.7452705
292	92.56034	47.00453			66.37541	59.68456	66.37541	-56.1357	91.7251	48.31243213	29.24321	20.8268794
293	63.33869	42.13232			31.225	30.59951	31.225	-32.2376	91.75884	48.45978254	32.68752	22.836046
294	92.09161	47.05186			20.91351	21.32208	20.91351	-389.676	90.2954	48.52804012	31.61701	21.1796932
295	42.80549	30.76559			25.64886	25.55393	25.64886	-4.96935	91.31496	48.30142792	27.91036	21.3299543
296	79.82154	46.92956			77.85862	67.29343	77.85862	-396.33	90.09833	48.4588368	23.24331	18.0038251
297	51.77421	32.15157			35.74587	34.50459	35.74587	-31957.4	90.60872	48.45092428	28.75641	19.8149126
298	17.49762	15.11383			25.88488	23.44621	25.88488	-32.7085	90.40962	48.46495077	32.09108	21.8368646
299	79.92932	45.92507			69.21194	60.15821	69.21194	-35.3832	89.88668	48.54968763	31.08664	21.9547814
300	92.1236	46.48281			34.00352	31.42012	34.00352	-350.669	90.30517	48.57142373	30.51209	22.4221556

1D Poly	Input & Output NL		Input NL		Output NL	
Degree	Est. Fit	Val. Fit	Est. Fit	Val. Fit	Est. Fit	Val. Fit
1	18.52415	6.134677	17.58735	6.583075	6.971999	6.895805
2	6.898387	5.793243	32.84304	26.88647	6.818794	7.421879
3	6.520805	5.104862	16.52614	8.770419	4.709876	4.612508
4	6.520807	5.104863	16.52614	8.770419	4.709876	4.612508
5	6.520807	5.104863	16.52614	8.770419	4.709876	4.612508
6	6.520807	5.104863	16.52614	8.770419	4.709876	4.612508
7	6.520807	5.104863	16.52614	8.770419	4.709876	4.612508
8	6.520807	5.104863	16.52614	8.770419	4.709876	4.612508
9	6.520807	5.104863	16.52614	8.770419	4.709876	4.612508
10	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
11	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
12	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
13	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
14	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
15	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
16	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
17	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
18	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
19	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
20	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
21	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
22	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
23	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
24	6.520807	5.104863	16.52614	8.770419	4.783951	4.6471
25	6.520807	5.104863	16.52614	8.770419	4.829312	4.679009
26	6.520807	5.104863	16.52614	8.770419	4.829312	4.679009
27	6.520807	5.104863	16.52614	8.770419	4.829312	4.679009
28	6.520807	5.104863	16.52614	8.770419	4.829312	4.679009
29	6.520807	5.104863	16.52614	8.770419	4.829312	4.679009
30	6.520807	5.104863	16.52614	8.770419	4.829312	4.679009
31	6.520807	5.104863				
32	6.520807	5.104863				
33	6.520807	5.104863				
34	6.520807	5.104863				
35	6.520807	5.104863				
36	6.520807	5.104863				
37	6.520807	5.104863				
38	6.520807	5.104863				
39	6.520807	5.104863				
40	6.520807	5.104863				
41	6.520807	5.104863				
42	6.520807	5.104863				
43	6.520807	5.104863				
44	6.520807	5.104863				
45	6.520807	5.104863				
46	6.520807	5.104863				
47	6.520807	5.104863				
48	6.520807	5.104863				
49	6.520807	5.104863				
50	6.520807	5.104863				
51	6.520807	5.104863				
52	6.520807	5.104863				
53	6.520807	5.104863				
54	6.520807	5.104863				
55	6.520807	5.104863				
56	6.520807	5.104863				
57	6.520807	5.104863				
58	6.520807	5.104863				
59	6.520807	5.104863				
60	6.520807	5.104863				
61	6.520807	5.104863				
62	6.520807	5.104863				
63	6.520807	5.104863				
64	6.520807	5.104863				
65	6.520807	5.104863				
66	6.520807	5.104863				
67	6.520807	5.104863				
68	6.520807	5.104863				
69	6.520807	5.104863				
70	6.520807	5.104863				
71	6.520807	5.104863				
72	6.520807	5.104863				
73	6.520807	5.104863				
74	6.520807	5.104863				
75	6.520807	5.104863				
76	6.520807	5.104863				
77	6.520807	5.104863				
78	6.520807	5.104863				
79	6.520807	5.104863				
80	6.520807	5.104863				
81	6.520807	5.104863				
82	6.520807	5.104863				
83	6.520807	5.104863				
84	6.520807	5.104863				
85	6.520807	5.104863				
86	6.520807	5.104863				
87	6.520807	5.104863				
88	6.520807	5.104863				
89	6.520807	5.104863				
90	6.520807	5.104863				
91	6.520807	5.104863				

	Input NL		Combined NL
Coefficient	Est. Fit	Val. Fit	validation +100000 Unit
1	12.769431	6.322505	
2	12.720532	6.178469	
3	12.663592	6.150773	
4	12.470237	6.234233	
5	12.444627	6.226407	
6	12.589974	6.11915	
7	12.579445	6.114139	
8	12.571535	6.110379	
9	12.565304	6.107417	
10	12.713626	6.390845	
11	12.712202	6.390464	
12	12.908815	6.269607	
13	12.909432	6.269763	
14	12.710293	6.390043	
15	12.70962	6.389872	
16	12.708696	6.389639	
17	12.905899	6.268911	
18	12.905088	6.268725	
19	12.707013	6.38926	
20	12.900974	6.266889	
21	12.900296	6.26674	
22	12.705211	6.388857	
23	12.704562	6.388714	
24	12.89868	6.266395	
25	12.89829	6.266318	
26	12.708061	6.389933	
27	12.707718	6.389848	
28	12.707394	6.389769	
29	12.707074	6.389691	
30	12.706764	6.389617	
31	12.901672	6.267062	
32	12.901383	6.266997	
33	12.901093	6.266932	
34	12.705738	6.389376	
35	12.705478	6.389316	
36	12.90037	6.266774	
37	12.901722	6.267077	
38	12.706318	6.389609	
39	12.901342	6.266992	
40	12.705935	6.389519	
41	12.900969	6.266908	
42	12.705873	6.389514	
43	12.705707	6.389475	
44	12.705543	6.389437	
45	12.900616	6.266831	
46	12.900505	6.266808	
47	12.705106	6.389337	
48	12.704962	6.389305	
49	12.704824	6.389274	
50	12.900022	6.266705	
51	12.899887	6.266676	
52	12.704516	6.389208	
53	12.704394	6.389181	
54	12.899635	6.266622	
55	12.8994	6.266569	
56	12.899362	6.266563	
57	12.703965	6.389089	
58	12.703859	6.389066	
59	12.703755	6.389044	
60	12.703662	6.389024	
61	12.898977	6.266485	
62	12.898882	6.266465	
63	12.899345	6.266559	
64	12.703976	6.389128	
65	12.899326	6.266559	
66	12.703834	6.389098	
67	12.899183	6.266529	
68	12.899125	6.266518	
69	12.703608	6.38905	
70	12.703537	6.389035	
71	12.703465	6.38902	
72	12.898687	6.266421	
73	12.703421	6.389015	
74	12.898777	6.266444	
75	12.703295	6.388989	
76	12.703232	6.388976	
77	12.703182	6.388966	
78	12.89854	6.266394	
79	12.703069	6.388944	
80	12.703016	6.388933	
81	12.898435	6.266374	
82	12.702936	6.388918	
83	12.702887	6.388909	
84	12.898153	6.266311	
85	12.898287	6.266345	
86	12.702759	6.388884	
87	12.898127	6.266309	
88	12.898136	6.266313	
89	12.898138	6.266314	
90	12.898099	6.266306	
91	12.702771	6.388899	

	200000-200200 Sigmoid + 1D (2nd Degree)		200000-200200 1D(2nd Degree) + Sigmoid	
	Est. Fit	Val. Fit	Est. Fit	Val. Fit
1	21.95885	-16.63296716	8.649583	1.015544154
2	12.44965	-0.792015358	9.196015	1.24713268
3	7.324002	-16.07772168	7.939783	2.789558496
4	13.57555	-152517.2781	8.977339	0.201850301
5	5.475423	-8.643683094	8.97936	1.999148758
6	29.99193	-21974.76074	9.921946	0.038030127
7	13.67075	-963339.0846	9.694163	1.363578952
8	17.50491	-1338384.677	9.247475	1.120677384
9	26.0245	-967116.6272	9.613147	1.707148736
10	25.98085	-2201.263018	9.570968	0.378748018
11	9.447307	-20.02122838	10.17485	0.579369642
12	16.62875	-13.48009212	9.985753	-0.793692268
13	11.73176	-10.03677125	9.484022	0.343860143
14	28.81416	-135151.3113	10.11498	0.27269549
15	19.7326	-490157.8864	10.29559	-1.317576341
16	38.0165	-1.00557E+13	10.11035	-0.182014602
17	12.18213	-487.9232801	10.14103	-0.292816046
18	17.15372	-1416.05622	10.27364	-10087.71492
19	15.12876	-745.0939967	10.21173	0.049372525
20	14.6502	-117.3573597	10.43749	-1.616120631
21	35.59171	-27883.85462	10.39916	0.039806089
22	18.39936	-508.9900442	10.63001	-0.745880846
23	40.6018	-1807.187829	10.46067	-0.340714438
24	14.41797	-362.7879864	10.54752	-0.34214497
25	18.24299	-117.7496976	10.84662	-3.204238734
26	20.46814	-37.58394167	10.76027	-0.545239555
27	23.53156	-2761.678252	11.0778	-3.028715091
28	33.78409	-2103.838512	10.90059	-1.5461095
29	22.80187	-45.49216838	11.041	-2.45574493
30	44.77517	-2568.980411	11.04684	-0.296785143
31	28.74166	-3306.309586	11.09139	-0.941624134
32	30.22508	-993.6714001	10.98472	-1.62809057
33	50.23962	-16638.78315	11.11924	-1.019978047
34	51.59078	-9044.578492	11.22751	-4.886832001
35	32.99502	-797.6106506	11.53894	-35424.01601
36	45.22343	-169.1458266	11.33487	-2.069537095
37	39.29451	-1374.040199	11.75674	-14.06680337
38	41.15886	-1994.478389	11.67887	-5.905077008
39	48.00018	-2107.278931	11.53634	-34687.80266
40	58.4714	-1283.066529	11.89427	-1.547950344
41	49.13573	-4940.344605	11.77512	-6.771868487
42	29.96065	-346.2605277	12.65566	-1.551187429
43	36.72365	-184.9610373	11.17424	-0.93991733
44	41.27976	-135.5636591	12.79091	-2.971968857
45	46.95886	-2494.636346	12.42674	-225566.6599
46	40.31654	-182.1195927	11.6116	-1.537050537
47	56.11933	-357.3649999	12.2262	-4.111492795
48	34.53536	-1545.408439	11.24849	-1.384601456
49	59.75055	-373.6514815	12.4425	-2.11035081
50	53.92722	-97.732236	11.53282	-0.409151434
51	47.00497	-385.461878	12.61048	-1.33796355
52	26.79621	-3768.789884	11.98965	-2.750907262
53	29.49835	-222.6995537	12.66286	-4.066050353
54	56.72968	-105.7542913	12.59025	-1.71804762
55	54.22474	-188.8559114	12.94249	-7.338732293
56	62.51472	-6887.330946	12.79435	-6.500370492
57	48.96875	-330.5560453	12.21106	-4.528431082
58	36.47432	-13614.69022	12.18357	-3.953011188
59	40.95621	-1179.463351	12.25736	-4.494811905
60	59.55933	-7734.732891	12.57571	-2.205551339
61	62.5026	-1506.416799	12.90098	-8.709485043
62	61.83619	-22268.78274	12.97775	-5.645177601
63	62.00428	-640.621853	13.13102	-5.4117335
64	59.53469	-132.9599638	13.71899	-3.142328978
65	58.62973	-19218.87736	12.52152	-1.955696649
66	36.31975	-125413586.8	12.90504	-1.841333707
67	24.26401	-3571.915291	13.86147	-2.686764572
68	48.99399	-1153.092679	13.99073	-6.907791174
69	54.95645	-769.487591	12.43014	-3.253380557
70	64.18934	-662.2573268	13.43457	-3.911785544
71	56.19883	-6811.349223	13.56696	-7.060903604
72	38.52057	-605.8060188	14.09445	-6.018236689
73	62.93285	-187.6978716	13.69005	-12.61703519
74	61.10308	-6598.505167	13.65322	-4.102864711
75	61.78339	-687.7879782	12.40297	-4.473036442
76	60.50908	-6243.059231	14.12598	-4.103526093
77	52.74577	-5152.922194	13.26025	-9.918443793
78	62.2493	-4849.591141	13.4137	-12.28773079
79	66.87209	-5330.978715	13.66439	-17.1828658
80	68.85587	-1798.669813	14.09829	-5.561184685
81	65.64818	-1296.371043	14.41796	-15.47439804
82	65.13936	-1144.853599	13.31472	-3.967694376
83	34.51344	-1346.565081	13.72351	-4.239704334
84	60.55961	-1086.455619	13.88088	-4.582294233
85	64.85834	-2718.530113	14.89702	-7.845335386
86	54.79755	-1204.173345	14.58415	-2.727966133
87	69.42419	-996.1875474	13.39742	-5.976218031
88	69.51228	-2941.929594	14.76905	-3.590294131
89	68.02179	-804.2200706	13.39701	-2.544553962
90	71.37732	-1347.687475	13.89375	-2.420023954

92	6.520807	5.104863
93	6.520807	5.104863
94	6.520807	5.104863
95	6.520807	5.104863
96	6.520807	5.104863
97	6.520807	5.104863
98	6.520807	5.104863
99	6.520807	5.104863
100	6.520807	5.104863
101	6.520807	5.104863
102	6.520807	5.104863
103	6.520807	5.104863
104	6.520807	5.104863
105	6.520807	5.104863
106	6.520807	5.104863
107	6.520807	5.104863
108	6.520807	5.104863
109	6.520807	5.104863
110	6.520807	5.104863
111	6.520807	5.104863
112	6.520807	5.104863
113	6.520807	5.104863
114	6.520807	5.104863
115	6.520807	5.104863
116	6.520807	5.104863
117	6.520807	5.104863
118	6.520807	5.104863
119	6.520807	5.104863
120	6.520807	5.104863
121	6.520807	5.104863
122	6.520807	5.104863
123	6.520807	5.104863
124	6.520807	5.104863
125	6.520807	5.104863
126	6.520807	5.104863
127	6.520807	5.104863
128	6.520807	5.104863
129	6.520807	5.104863
130	6.520807	5.104863
131	6.520807	5.104863
132	6.520807	5.104863
133	6.520807	5.104863
134	6.520807	5.104863
135	6.520807	5.104863
136	6.520807	5.104863
137	6.520807	5.104863
138	6.520807	5.104863
139	6.520807	5.104863
140	6.520807	5.104863
141	6.520807	5.104863
142	6.520807	5.104863
143	6.520807	5.104863
144	6.520807	5.104863
145	6.520807	5.104863
146	6.520807	5.104863
147	6.520807	5.104863
148	6.520807	5.104863
149	6.520807	5.104863
150	6.520807	5.104863
151	6.520807	5.104863
152	6.520807	5.104863
153	6.520807	5.104863
154	6.520807	5.104863
155	6.520807	5.104863
156	6.520807	5.104863
157	6.520807	5.104863
158	6.520807	5.104863
159	6.520807	5.104863
160	6.520807	5.104863
161	6.520807	5.104863
162	6.520807	5.104863
163	6.520807	5.104863
164	6.520807	5.104863
165	6.520807	5.104863
166	6.520807	5.104863
167	6.520807	5.104863
168	6.520807	5.104863
169	6.520807	5.104863
170	6.520807	5.104863
171	6.520807	5.104863
172	6.520807	5.104863
173	6.520807	5.104863
174	6.520807	5.104863
175	6.520807	5.104863
176	6.520807	5.104863
177	6.520807	5.104863
178	6.520807	5.104863
179	6.520807	5.104863
180	6.520807	5.104863
181	6.520807	5.104863
182	6.520807	5.104863
183	6.520807	5.104863
184	6.520807	5.104863

92	12.89816	6.266317
93	12.702698	6.388885
94	12.702662	6.388878
95	12.702633	6.388873
96	12.702598	6.388866
97	12.898078	6.266302
98	12.702536	6.388855
99	12.897842	6.266249
100	12.897992	6.266285
101	12.702466	6.388843
102	12.897777	6.266236
103	12.702407	6.388832
104	12.702384	6.388828
105	12.897699	6.266221
106	12.89783	6.266252
107	12.897805	6.266246
108	12.897783	6.266242
109	12.897616	6.266204
110	12.897757	6.266237
111	12.897574	6.266196
112	12.897692	6.266223
113	12.89769	6.266224
114	12.702214	6.388802
115	12.897553	6.266192
116	12.702176	6.388796
117	12.897516	6.266184
118	12.70214	6.38879
119	12.897482	6.266178
120	12.897595	6.266204
121	12.897614	6.266209
122	12.702076	6.388779
123	12.897547	6.266194
124	12.897565	6.266199
125	12.897394	6.26616
126	12.897382	6.266158
127	12.897367	6.266155
128	12.897511	6.266188
129	12.897487	6.266183
130	12.897481	6.266182
131	12.701957	6.388762
132	12.701943	6.388759
133	12.897414	6.266168
134	12.897295	6.266141
135	12.701906	6.388754
136	12.897421	6.26617
137	12.897409	6.266168
138	12.897399	6.266166
139	12.897388	6.266164
140	12.701852	6.388746
141	12.897223	6.266127
142	12.897313	6.266147
143	12.701821	6.388741
144	12.897339	6.266154
145	12.89731	6.266148
146	12.897314	6.266149
147	12.897171	6.266116
148	12.897293	6.266145
149	12.897272	6.26614
150	12.897237	6.266132
151	12.897275	6.266141
152	12.703883	6.389291
153	12.703868	6.389288
154	12.703854	6.389285
155	12.703841	6.389282
156	12.703822	6.389278
157	12.703811	6.389276
158	12.703796	6.389272
159	12.703782	6.38927
160	12.703766	6.389266
161	12.703754	6.389263
162	12.703739	6.38926
163	12.703728	6.389258
164	12.703716	6.389255
165	12.7037	6.389252
166	12.703691	6.38925
167	12.899179	6.266532
168	12.703662	6.389244
169	12.703653	6.389242
170	12.703638	6.389239
171	12.703625	6.389236
172	12.899118	6.266519
173	12.70361	6.389233
174	12.703596	6.38923
175	12.703585	6.389228
176	12.703575	6.389225
177	12.899067	6.266508
178	12.703551	6.38922
179	12.703541	6.389218
180	12.70353	6.389216
181	12.899026	6.2665
182	12.703507	6.389211
183	12.703498	6.389209
184	12.898995	6.266493

91	66.60618	-194.6874323	13.43275	-3.180786613
92	69.41122	-672.7972514	15.30192	-6.262092406
93	70.06135	-13760.47717	14.51905	-2.597538903
94	69.17085	-34040.44266	14.42956	-24.60037491
95	67.07297	-5221.471928	14.35741	-282.3891766
96	68.39455	-6315.322457	15.69177	-35.51505699
97	73.00446	-17349.65167	15.00222	-45.29346161
98	67.54123	-1079.908592	15.20911	-17.51368987
99	72.33048	-19843.16875	14.87995	-6.711174884
100	73.6738	-13463.5717	14.2421	-15.6512531
101	72.45954	-38112.91956	15.24546	-16.23932175
102	69.56803	-13540.93601	14.79209	-4.816204473
103	69.43772	-5435.468924	14.91765	-18.23051978
104	73.88696	-15304.53386	16.54286	-27.36691803
105	72.35875	-9626.770801	14.90724	-24.60901698
106	37.26863	-65076.94651	14.58893	-30.69403584
107	71.79759	-19281.96718	15.19237	-26.55135668
108	73.60544	-1858.742971	14.65728	-3.53008811
109	70.5932	-538.9793234	15.63424	-14.20696686
110	69.13734	-8185.9332	15.63066	-18.66174036
111	74.8006	-49950.30714	15.41518	-3.577480751
112	74.17658	-96540.9626	14.64525	-15.51004523
113	70.73134	-6417.743082	14.98212	-3.844155587
114	73.99356	-28251.69402	14.77873	-16.57898022
115	75.03292	-7140.571402	15.19469	-27.24885291
116	74.76612	-25622.96606	15.30677	-20.93557152
117	76.88668	-7682.844583	16.21615	-30.10794125
118	37.22012	-2786.497668	15.92143	-21.30168208
119	30.41447	-196663.0262	16.46174	-19.61520634
120	76.89444	-10216.07911	15.46507	-12.12761303
121	72.59241	-4668.204822	15.19216	-11.25064166
122	77.97314	-149346.8863	16.91305	-6.257744822
123	78.07781	-76246.81275	17.19606	-17.31500758
124	29.17482	-171512.2008	17.0357	-5.147969861
125	37.80784	-150358.8363	16.56195	-13.14143829
126	75.18953	-238733.9205	15.7353	-12.5644229
127	76.49463	-22873.67517	18.00091	-33.99199569
128	35.17853	-119570.9712	16.58925	-42.42893164
129	77.1275	-18418.54535	16.65947	-39.12165368
130	36.34499	-149310.4864	16.83327	-48.16802664
131	73.53452	-44097.99809	18.12272	-27.01904945
132	37.36121	-154949.4457	17.51511	-28.23261859
133	46.62539	-389541.3405	17.6055	-50.21697553
134	69.81833	-186495.4288	16.1654	-32.72937858
135	75.60747	-58916.06862	16.1253	-4.565873435
136	48.07183	-304531.2762	17.31156	-10.89916611
137	78.68046	-178171.8237	16.94072	-16.54801948
138	40.78474	-69857.82941	17.13031	-7.856151811
139	53.29759	-62504.65	16.41061	-32.68461758
140	51.3892	-377942.0805	17.46824	-21.17929948
141	79.72945	-128438.2146	16.84256	-30.92320035
142	80.1115	-31371.98151	18.73754	-6.638252023
143	78.37118	-178150.7688	18.91498	-13.09442657
144	79.46104	-92358.18379	18.04378	-8.796148568
145	80.39422	-16325.55584	18.69934	-25.01850715
146	80.51221	-12141.38021	17.66811	-26.26624534
147	43.85893	-52140.71736	19.79048	-55.87766438
148	40.32487	-13068.81619	18.80405	-58.76946801
149	80.10651	-1702.164494	16.49847	-4.327902377
150	82.096	-3542.67897	18.70627	-9.126260708
151	80.56531	-14838.95815	17.31596	-4.37571565
152	80.15836	-4917.485824	17.61354	-13.95865581
153	56.98244	-15237.84572	17.99566	-17.88584266
154	32.10377	-38757.27693	18.19066	-9.118995791
155	78.69209	-3048.869038	19.12891	-10.81339252
156	81.47302	-14244.76248	18.7508	-15.34270741
157	53.84071	-38659.51893	20.64027	-22.31488893
158	80.492	-1981.400506	18.88572	-43.16099348
159	79.07318	-9201.776251	19.0224	-43.9713689
160	76.10362	-95136.66966	20.22928	-61.25404347
161	81.20438	-33162.03881	18.84636	-41.96785003
162	80.06898	-1021.483983	17.2966	-74.79442579
163	81.33781	-734.2914072	19.36654	-68.16014829
164	81.55729	-1459.318761	18.16193	-52.08812442
165	44.15563	-4315.114134	21.54891	-25.9883338
166	43.66841	-2555.839452	20.62791	-39.11870198
167	61.37252	-1535.79681	19.79334	-30.39157004
168	81.31117	-710.4112946	21.99211	-11.29453128
169	81.87196	-1003.836535	19.82973	-6.681406398
170	82.70083	-1077.256376	22.09113	-21.54007185
171	82.3149	-1005.771295	19.88286	-5.872551309
172	82.28936	-736.7067092	22.40203	-24.21559253
173	81.02344	-1308.695607	18.95209	-9.183638824
174	83.42338	-1078.886399	20.42764	-39.57449255
175	83.74961	-4445.660248	19.42443	-7.326674809
176	58.45562	-1081.680399	20.53457	-9.615989603
177	83.35575	-2746.165386	21.10041	-8.888559865
178	55.65712	-3449.353538	20.718	-6.682563434
179	83.58514	-3649.705232	18.93562	-19.07668166
180	52.90501	-3904.320188	19.65086	-51.06473558
181	63.18886	-1190.630235	20.78112	-30.25980855
182	83.82774	-2098.316875	19.8501	-8.245099971
183	57.86289	-2711.709868	21.34492	-22.77756312

185	6.520807	5.104863
186	6.520807	5.104863
187	6.520807	5.104863
188	6.520807	5.104863
189	6.520807	5.104863
190	6.520807	5.104863
191	6.520807	5.104863
192	6.520807	5.104863
193	6.520807	5.104863
194	6.520807	5.104863
195	6.520807	5.104863
196	6.520807	5.104863
197	6.520807	5.104863
198	6.520807	5.104863
199	6.520807	5.104863
200	6.520807	5.104863
201	6.520807	5.104863
202	6.520807	5.104863
203	6.520807	5.104863
204	6.520807	5.104863
205	6.520807	5.104863
206	6.520807	5.104863
207	6.520807	5.104863
208	6.520807	5.104863
209	6.520807	5.104863
210	6.520807	5.104863
211	6.520807	5.104863
212	6.520807	5.104863
213	6.520807	5.104863
214	6.520807	5.104863
215	6.520807	5.104863
216	6.520807	5.104863
217	6.520807	5.104863
218	6.520807	5.104863
219	6.520807	5.104863
220	6.520807	5.104863
221	6.520807	5.104863
222	6.520807	5.104863
223	6.520807	5.104863
224	6.520807	5.104863
225	6.520807	5.104863
226	6.520807	5.104863
227	6.520807	5.104863
228	6.520807	5.104863
229	6.520807	5.104863
230	6.520807	5.104863
231	6.520807	5.104863
232	6.520807	5.104863
233	6.520807	5.104863
234	6.520807	5.104863
235	6.520807	5.104863
236	6.520807	5.104863
237	6.520807	5.104863
238	6.520807	5.104863
239	6.520807	5.104863
240	6.520807	5.104863
241	6.520807	5.104863
242	6.520807	5.104863
243	6.520807	5.104863
244	6.520807	5.104863
245	6.520807	5.104863
246	6.520807	5.104863
247	6.520807	5.104863
248	6.520807	5.104863
249	6.520807	5.104863
250	6.520807	5.104863
251	6.520807	5.104863
252	6.520807	5.104863
253	6.520807	5.104863
254	6.520807	5.104863
255	6.520807	5.104863
256	6.520807	5.104863
257	6.520807	5.104863
258	6.520807	5.104863
259	6.520807	5.104863
260	6.520807	5.104863
261	6.520807	5.104863
262	6.520807	5.104863
263	6.520807	5.104863
264	6.520807	5.104863
265	6.520807	5.104863
266	6.520807	5.104863
267	6.520807	5.104863
268	6.520807	5.104863
269	6.520807	5.104863
270	6.520807	5.104863
271	6.520807	5.104863
272	6.520807	5.104863
273	6.520807	5.104863
274	6.520807	5.104863
275	6.520807	5.104863
276	6.520807	5.104863
277	6.520807	5.104863

185	12.898984	6.266491
186	12.703466	6.389202
187	12.703457	6.3892
188	12.703447	6.389198
189	12.899082	6.266516
190	12.703428	6.389194
191	12.899062	6.266512
192	12.703407	6.38919
193	12.898902	6.266474
194	12.703388	6.389186
195	12.70338	6.389184
196	12.899009	6.266501
197	12.898862	6.266466
198	12.898855	6.266464
199	12.898852	6.266464
200	12.899008	6.266501
201	12.703349	6.389179
202	12.703346	6.389178
203	12.703334	6.389176
204	12.898839	6.266461
205	12.70332	6.389173
206	12.703312	6.389171
207	12.703303	6.389169
208	12.703287	6.389166
209	12.703287	6.389166
210	12.703271	6.389162
211	12.703273	6.389163
212	12.703258	6.38916
213	12.703256	6.389159
214	12.898756	6.266444
215	12.703238	6.389155
216	12.898866	6.266471
217	12.70322	6.389152
218	12.703216	6.389151
219	12.89872	6.266436
220	12.898714	6.266435
221	12.898706	6.266433
222	12.703189	6.389145
223	12.898689	6.26643
224	12.898682	6.266428
225	12.898677	6.266427
226	12.898799	6.266457
227	12.703149	6.389137
228	12.703149	6.389137
229	12.703144	6.389136
230	12.898766	6.26645
231	12.898829	6.266465
232	12.898629	6.266417
233	12.703113	6.38913
234	12.89874	6.266444
235	12.7031	6.389127
236	12.7031	6.389127
237	12.703093	6.389126
238	12.8986	6.266411
239	12.703086	6.389124
240	12.898592	6.26641
241	12.703069	6.389121
242	12.703062	6.389119
243	12.703053	6.389118
244	12.703052	6.389117
245	12.898677	6.266431
246	12.898738	6.266446
247	12.703035	6.389114
248	12.898661	6.266428
249	12.703021	6.389111
250	12.703023	6.389112
251	12.703009	6.389109
252	12.898644	6.266424
253	12.898634	6.266422
254	12.898509	6.266393
255	12.70299	6.389105
256	12.898618	6.266419
257	12.898613	6.266418
258	12.898672	6.266432
259	12.702976	6.389102
260	12.898604	6.266416
261	12.702968	6.3891
262	12.898581	6.266411
263	12.898641	6.266426
264	12.702947	6.389096
265	12.898456	6.266382
266	12.898456	6.266382
267	12.898452	6.266381
268	12.898555	6.266406
269	12.898554	6.266406
270	12.898433	6.266377
271	12.702914	6.38909
272	12.702912	6.389089
273	12.898428	6.266376
274	12.898528	6.2664
275	12.898586	6.266414
276	12.898579	6.266413
277	12.898593	6.266416

184	52.42846	-6946.555896	24.02696	-14.04926046
185	62.47179	-621.2677004	20.81939	-14.93502759
186	54.69084	-611.5466807	22.28683	-9.861631858
187	84.40743	-727.4553016	22.26162	-16.04967245
188	53.71075	-1893.783662	19.84116	-11.4004256
189	58.00216	-514.2397697	24.44898	-15.40323609
190	54.68607	-1507.966059	20.99461	-13.71492532
191	63.73254	-1188.844873	22.17916	-28.50555227
192	79.14761	-2537.834618	21.25562	-14.63728651
193	56.8745	-858.4526723	22.81017	-17.14841715
194	86.68903	-1381.02088	22.36746	-30.53041641
195	85.92789	-895.9521613	22.8087	-114.3532704
196	86.26642	-1014.628525	24.57644	-94.88664267
197	85.22861	-1740.476616	22.50457	-45.53092623
198	53.0658	-4379.29166	22.24404	-28.35835965
199	54.94638	-5164.844677	21.35669	-33.91712804
200	75.20302	-2525.159834	23.05631	-31.78198562
201	86.24625	-2120.023582	23.0374	-70.95047341
202	86.28226	-2094.012477	23.98962	-83.82270901
203	57.5011	-1572.998797	24.43728	-100.0441144
204	86.82392	-1178.339202	23.93974	-104.3818212
205	0	0	0	0
206	86.2344	-5343.161261	24.45751	-50.38829401
207	84.45178	-4014.348265	24.15034	-41.33989683
208	86.76383	-1585.621635	24.18024	-20.51027845
209	86.18889	-2507.085904	25.00453	-112.9629758
210	85.32648	-1459.154599	25.12212	-62.55450063
211	55.6482	-12116.07149	23.34728	-20.86410163
212	86.07421	-7759.681448	25.01009	-112.9727629
213	86.35462	-1458.995192	23.25153	-75.73711881
214	87.39658	-3536.189617	23.75333	-29.84373822
215	86.97021	-1395.459793	27.56188	-171.8444882
216	47.40208	-2308.678692	23.17168	-138.3593794
217	86.66446	-814.138783	24.79748	-90.63527902
218	86.96956	-1905.880821	25.30776	-42.25604569
219	87.41776	-984.1555618	24.31741	-20.51572989
220	87.24907	-454.1118899	26.23987	-23.00172896
221	85.59746	-729.715838	25.68227	-43.54073911
222	86.5953	-1295.126408	25.07077	-21.77853858
223	59.38948	-1498.191621	24.6015	-82.88487353
224	51.409	-1491.236081	27.42807	-161.7286074
225	52.42922	-1048.92073	23.27711	-36.93015068
226	87.86261	-977.2151368	25.39877	-153.7345181
227	87.97251	-828.007693	27.92336	-217.3149404
228	88.03629	-844.496854	25.32983	-42.75178695
229	60.86883	-1944.27368	24.56892	-108.726368
230	88.03019	-1230.349037	27.04878	-39.56906972
231	87.41716	-1533.374719	27.46632	-27.05834117
232	87.57218	-1337.825562	25.93062	-68.35453236
233	88.28177	-793.9197341	28.36563	-47.9361286
234	88.07694	-2287.790373	26.78386	-23.85683781
235	62.23706	-871.467698	27.47823	-19.00581641
236	88.39692	-1949.264268	25.60509	-25.36627037
237	88.42426	-1935.270951	29.03976	-47.1064683
238	59.56224	-903.71685	24.09824	-25.63375408
239	88.63047	-2353.959373	28.39931	-71.62698839
240	88.00326	-1161.004668	28.43849	-179.5781958
241	87.66901	-1044.213851	27.22719	-149.1427647
242	87.75577	-1754.289985	28.17163	-58.96745357
243	89.18733	-2883.109805	27.26912	-67.83668622
244	88.10265	-2144.944571	25.98906	-15.61018736
245	88.48464	-909.9826622	30.58588	-26.88414493
246	88.54272	-1668.290932	28.36131	-91.97310818
247	88.45253	-5311.826948	28.50233	-35.60137111
248	88.78855	-2789.466287	27.24362	-72.08101076
249	88.73656	-3142.429658	28.37674	-45.634903
250	88.83617	-1046.60764	28.47033	-108.2248451
251	88.87136	-2225.880856	29.64698	-75.20263139
252	88.35281	-2396.379123	27.7122	-15.21800853
253	89.00341	-2264.93296	27.55424	-69.81004511
254	88.87398	-4590.057447	28.57825	-275.6507178
255	88.71015	-1663.05364	28.37514	-69.32656716
256	89.19398	-2095.406764	29.0504	-205.0581646
257	85.58352	-1275.325295	28.57749	-223.7277497
258	88.57353	-2351.254714	30.5121	-58.72310152
259	54.39953	-4283.364626	26.00967	-26.46712492
260	89.03361	-1877.982685	29.88198	-25.3475553
261	65.0751	-1627.632742	27.29068	-41.27156482
262	89.05111	-963.7109803	25.11697	-64.23525255
263	87.31913	-814.5276219	30.33975	-282.4901458
264	89.32547	-1046.630842	29.42862	-229.6474255
265	89.51175	-798.1434842	28.59153	-123.2431598
266	89.66111	-1790.613413	29.15385	-45.56160146
267	58.08132	-9276.459693	27.34738	-25.68681999
268	89.77017	-804.0901084	29.38589	-42.47710438
269	89.82166	-1249.153014	31.53981	-162.2518006
270	90.07362	-1228.021206	29.76094	-248.5015603
271	59.69122	-1006.628503	30.2856	-241.7389836
272	50.12484	-1229.11399	30.16946	-188.2436288
273	89.47633	-2735.123427	31.18379	-310.0986295
274	0	0	0	0
275	89.97929	-2796.533757	30.84583	-131.6214195
276	89.69824	-2826.485329	29.75005	-76.53374047

278	6.520807	5.104863
279	6.520807	5.104863
280	6.520807	5.104863
281	6.520807	5.104863
282	6.520807	5.104863
283	6.520807	5.104863
284	6.520807	5.104863
285	6.520807	5.104863
286	6.520807	5.104863
287	6.520807	5.104863
288	6.520807	5.104863
289	6.520807	5.104863
290	6.520807	5.104863
291	6.520807	5.104863
292	6.520807	5.104863
293	6.520807	5.104863
294	6.520807	5.104863
295	6.520807	5.104863
296	6.520807	5.104863
297	6.520807	5.104863
298	6.520807	5.104863
299	6.520807	5.104863
300	6.520807	5.104863

278	12.898398	6.26637
279	12.898501	6.266395
280	12.89839	6.266368
281	12.898557	6.266408
282	12.89858	6.266414
283	12.703106	6.389142
284	12.703106	6.389142
285	12.703102	6.389141
286	12.703099	6.38914
287	12.7031	6.38914
288	12.703094	6.389139
289	12.703086	6.389138
290	12.703078	6.389136
291	12.703076	6.389135
292	12.703071	6.389134
293	12.703069	6.389134
294	12.703064	6.389133
295	12.703057	6.389132
296	12.703057	6.389132
297	12.703054	6.389131
298	12.703056	6.389131
299	12.703044	6.389129
300	12.70304	6.389128

277	52.1289	-9816.486804	31.32632	-148.7438403
278	89.55109	-3569.187898	29.90508	-112.9525691
279	89.68287	-1251.44191	29.48026	-98.18419331
280	89.87456	-1211.598162	30.91	-217.2428009
281	59.06974	-2610.539607	31.01598	-93.38567456
282	89.6737	-934.5657595	29.64228	-42.31120273
283	85.87385	-1667.706726	29.39154	-46.97611628
284	90.05445	-2953.557161	29.43132	-143.629183
285	45.85938	-3219.614037	31.23671	-79.92320129
286	89.93818	-1350.583777	30.16021	-37.06617119
287	38.85445	-1340.832605	32.30593	-107.6365225
288	58.1161	-2221.797115	32.06277	-42.53956238
289	90.22461	-1075.959605	30.80994	-23.11439664
290	45.26352	-5724.502865	31.39151	-29.44195175
291	88.56458	-792.0244669	29.53588	-23.32381436
292	43.72701	-2187.938943	32.04616	-76.11804713
293	90.12713	-1783.754362	32.78725	-119.2462968
294	90.32218	-998.4516358	31.34278	-69.41891023
295	90.42898	-724.1423234	31.78053	-42.10977052
296	46.09223	-292.4508339	32.61352	-78.05794907
297	60.306	-2381.334508	29.73576	-49.67685452
298	57.64407	-1662.017293	30.91103	-77.97842827
299	58.10575	-2765.739714	32.3142	-282.3446067

Combined NL	200000-200200		200000-200200		Linear Piecewise Model	200200-201200		Wavelet Network	200200-201200	
validation +100000	Sigmoid + 1D (2nd Degree)		1D(2nd Degree) + Sigmoid		validation +100000	Sigmoid + 1D (2nd Degree)		validation +100000	Sigmoid + 1D (2nd Degree)	
Unit	Est. Fit	Val. Fit	Est. Fit	Val. Fit	Breakpoint	Est. Fit	Val. Fit	Units	Est. Fit	Val. Fit
1	21.95885395	-16.633	8.649583083	1.015544	1	17.64502	7.395817692	1	10.91348015	8.99241578
2	12.44964797	-0.79202	9.196014906	1.247133	2	29.29485	8.26874878	2	13.71093872	10.6823459
3	7.324001792	-16.0777	7.939782702	2.789558	3	12.14479	5.868986727	3	12.28323184	8.88641335
4	13.57555426	-152517	8.977339137	0.20185	4	3.766683	-0.932368438	4	13.16297141	9.41647477
5	5.475423214	-8.64368	8.979360172	1.999149	5	12.60834	10.33059638	5	13.31319822	10.0370416
6	29.99193276	-21974.8	9.921945977	0.03803	6	25.58828	13.00393544	6	11.65080763	9.77942996
7	13.67075245	-963339	9.694162737	1.363579	7	33.60655	19.09645935	7	15.16413379	11.0296204
8	17.50490547	-1338385	9.247474883	1.120677	8	9.674747	5.498973968	8	12.80931715	9.2597012
9	26.02449982	-967117	9.613147369	1.707149	9	14.7105	8.371192516	9	16.82127964	11.882588
10	25.98085018	-2201.26	9.570968412	0.378748	10	0.864071	0.891359201	10	12.90109452	10.817044
11	9.447307015	-20.0212	10.17484703	0.57937	11	20.97792	11.58367111	11	11.58206437	9.50372251
12	16.62874594	-13.4801	9.985753372	-0.79369	12	7.988411	4.558344161	12	11.32128211	9.51441578
13	11.7317587	-10.0368	9.484022148	0.34386	13	18.71797	10.99991856	13	12.21788856	10.2074038
14	28.81416033	-135151	10.11498293	0.272695	14	7.742108	6.442350153	14	11.70833957	9.39146304
15	19.73260307	-490158	10.29558731	-1.31758	15	13.07892	8.323837515	15	12.0160223	9.21305589
16	38.0164981	-1E+13	10.110353	-0.18201	16	1.767495	1.325569695	16	12.94714821	11.1753939
17	12.18213485	-487.923	10.14102675	-0.29282	17	11.227	7.032855609	17	11.82168621	9.624889
18	17.15372084	-1416.06	10.27364115	-10087.7	18	20.80807	12.01575619	18	11.80799233	9.52606774
19	15.12875802	-745.094	10.2117255	0.049373	19	17.23176	5.602693417	19	12.18693872	10.4672906
20	14.65020182	-117.357	10.43749236	-1.61612	20	19.15083	12.53946689	20	11.66424185	8.76556374
21	35.59170605	-27883.9	10.39916268	0.039806	21	13.88322	6.835544775	21	11.74129722	9.57169683
22	18.39936134	-508.99	10.63000875	-0.74588	22	1.990581	2.102944658	22	11.91094932	7.70645136
23	40.60180306	-1807.19	10.46067041	-0.34071	23	8.638773	4.267173496	23	12.41793254	9.61119209
24	14.4179653	-362.788	10.54752176	-0.34214	24	6.880472	5.259222759	24	11.7037383	9.62681818
25	18.24299175	-117.75	10.84662331	-3.20424	25	5.22119	5.126250033	25	11.90356659	9.76876998
26	20.46813629	-37.5839	10.76026597	-0.54524	26	6.127153	2.868276502	26	11.84853545	9.24949372
27	23.53155808	-2761.68	11.07779774	-3.02872	27	6.574232	3.734465975	27	12.02194658	9.4342464
28	33.784093	-2103.84	10.90058969	-1.54611	28	6.912861	4.489665251	28	12.07988969	8.75896586
29	22.80186549	-45.4922	11.04099635	-2.45574	29	4.088095	3.195647716	29	11.56104472	8.95847003
30	44.77516958	-2568.98	11.0468377	-0.29679	30	11.42413	6.003076791	30	12.46825903	9.64022186
31	28.74165759	-3306.31	11.09139182	-0.94162	31	1.302944	0.565506635	31	12.52027415	9.70721459
32	30.22508376	-993.671	10.98472344	-1.62809	32	5.734907	3.267461855	32	12.45873424	9.77488386
33	50.23962389	-16638.8	11.11924231	-1.01998	33	5.493561	5.10409185	33	11.71764125	9.04013581
34	51.59077641	-9044.58	11.22750816	-4.88683	34	18.07404	10.11632972	34	11.78447398	8.97431259
35	32.99501995	-797.611	11.53893689	-35424	35	3.025464	2.592306396	35	12.20458168	8.89049983
36	45.22343097	-169.146	11.33486894	-2.06954	36	6.843496	3.92606365	36	11.89687012	9.01748616
37	39.29450822	-1374.04	11.75673922	-14.0668	37	3.430174	2.102468177	37	11.91304174	9.0764691
38	41.15885587	-1994.88	11.67886682	-5.90508	38	4.335462	3.049721047	38	12.58189879	9.06373242
39	48.00018085	-2107.28	11.53633937	-34687.8	39	10.22301	7.530277964	39	12.87463581	9.23116389
40	58.47139739	-1283.07	11.89426972	-1.54795	40	2.809447	2.681346354	40	12.63957605	9.75464085
41	49.1357304	-4940.34	11.77512248	-6.77187	41	18.30053	11.9851668	41	12.44254252	9.06237346
42	29.96065493	-346.261	12.65565906	-1.55119	42	0.905245	-0.359225397	42	12.72868607	9.5148185
43	36.72364952	-184.961	11.17424028	-0.93992	43	22.26291	12.14265883	43	12.57061472	9.2637877
44	41.27976138	-135.564	12.79090896	-2.97197	44	1.135379	1.957255889	44	12.55436226	9.09305707
45	46.95885925	-2494.64	12.42674463	-225567	45	9.579256	4.918634559	45	12.3429863	9.55294673
46	40.31653625	-182.12	11.61160085	-1.53705	46	2.86219	2.859486343	46	12.23640508	9.31007339
47	56.11932832	-357.365	12.2261983	-4.11149	47	4.721179	3.788736957	47	12.25469363	9.21232699
48	34.53535912	-1545.41	11.24848539	-1.3846	48	5.432922	2.295149043	48	12.25795451	9.210478
49	59.75054844	-373.651	12.44250185	-2.11035	49	2.631538	1.971079961	49	13.12354956	10.6136696
50	53.92722031	-97.7322	11.53281808	-0.40915	50	13.26487	7.074070331	50	13.26675743	10.6904822
51	47.00497156	-385.462	12.61048011	-1.33796	51	4.783931	3.731474458	51	13.37762619	10.9170108
52	26.79621386	-3768.79	11.98965476	-2.75091	52	3.209044	3.153315872	52	13.14960547	10.6225215
53	29.49835325	-222.7	12.66285664	-4.06605	53	7.304754	2.52533877	53	13.17415943	10.5882325
54	56.72967787	-105.754	12.59024656	-1.71805	54	7.626532	6.861295288	54	13.17149233	10.5844356
55	54.2247442	-188.856	12.94248746	-7.33873	55	3.550644	3.643414562	55	12.52253299	9.53331606
56	62.51472367	-6887.33	12.7943464	-6.50037	56	3.378583	1.275769488	56	13.27794081	10.6530577
57	48.96875112	-330.556	12.21106098	-4.52843	57	4.272946	1.699112726	57	13.32873124	10.6797245
58	36.47431713	-13614.7	12.18357014	-3.95301	58	9.818008	6.403874397	58	13.3257583	10.6084351
59	40.95621025	-1179.46	12.25736184	-4.49481	59	4.580466	3.681662985	59	12.81578145	9.54386267
60	59.55932969	-7734.73	12.57570559	-2.20555	60	2.854803	2.941399488	60	13.34053544	10.6925016
61	62.50260341	-1506.42	12.9009809	-8.70949	61	4.809696	4.434927239	61	13.49508244	10.850427
62	61.83618773	-22268.8	12.97774743	-5.64518	62	4.36878	3.508597852	62	13.49525276	10.850443
63	62.0042793	-640.622	13.13101553	-5.41173	63	9.442052	6.521410134	63	12.77676353	9.68456901
64	59.53469242	-132.96	13.71898514	-3.14233	64	4.824911	4.155335996	64	12.94334933	9.65201739
65	58.62973224	-19218.9	12.52151734	-1.9557	65	6.635005	4.620219041	65	12.9064321	9.88873686
66	36.31974943	-1.3E+08	12.90504003	-1.84133	66	4.902333	3.586920567	66	13.27859969	10.6001948
67	24.26400964	-3571.92	13.86147348	-2.68676	67	5.453625	4.679746589	67	13.8808087	10.2090273
68	48.9939938	-1153.09	13.99073252	-6.90779	68	8.492254	4.153367143	68	13.05549524	9.73872891
69	54.95645182	-769.488	12.43014213	-3.25338	69	6.351921	6.820350647	69	13.07435093	10.2518735
70	64.18934164	-662.257	13.4345681	-3.91179	70	5.659751	3.198731978	70	12.92045175	9.43882764
71	56.19883109	-6811.35	13.56696304	-7.0609	71	5.241477	2.973803242	71	14.14827673	10.2228643
72	38.52057452	-605.806	14.09445134	-6.01824	72	9.872692	5.473673902	72	13.0273961	9.64790069
73	62.9328488	-187.698	13.69004925	-12.617	73	6.967373	3.808447987	73	13.55020592	9.77367401
74	61.10308499	-6598.51	13.65322187	-4.10286	74	8.05474	6.669010881	74	14.83442148	11.4270736
75	61.78338959	-687.788	12.40296519	-4.47304	75	7.200923	6.08805891	75	13.10280501	9.60554847
76	60.50908145	-6243.06	14.1259782	-4.10353	76	5.270688	4.884544844	76	13.8676112	9.86795951
77	52.74576968	-5152.92	13.26024898	-9.91844	77	8.59962	7.61745756	77	14.07831645	11.4393146
78	62.2493026	-4849.59	13.41370154	-12.2877	78	12.40236	8.988248013	78	12.84086348	9.1057926
79	66.87209111	-5330.98	13.66438513	-17.1829	79	4.796909	2.655448846	79	13.1920679	9.30490209
80	68.85587214	-1798.67	14.09828938	-5.56118	80	4.003991	4.610958575	80	13.79727511	10.9920472
81	65.64818003	-1296.37	14.41795705	-15.4744	81	3.462537	2.528098642	81	13.05770141	10.1367256
82	65.13936184	-1144.85	13.31472083	-3.96769	82	5.484413	4.604934805	82	13.23610698	10.7566227
83	34.51343563	-1346.57	13.7235122	-4.2397	83	1.926722	2.088329513	83	13.19719653	10.7414378
84	60.55961059	-1086.46	13.88088369	-4.58229	84	5.956437	4.086121796	84	12.84378051	10.3410912
85	64.85834421	-2718.53	14.89702442	-7.84534	85	5.786923	3.271775413	85	13.04576373	10.4201632
86	54.79755445	-1204.17	14.58415129	-2.72797	86	3.189133	2.864894646	86	12.88248375	10.3302861
87	69.42419426	-996.188	13.39741775	-5.97622	87	2.122442	0.617851166	87	12.95236064	10.4506504
88	69.51227763	-2941.93	14.76905232	-3.59029	88	6.223822	3.673680435	88	13.78625155	11.3225853
89	68.02178583	-804.22	13.39700506	-2.54455	89	9.722145	7.957008473	89	13.91384163	11.3193243
90	71.37732096	-1347.69	13.89374585	-2.42002	90	2.366839	2.436061309	90	14.08097463	11.5743114
91	66.60618468	-194.687	13.43275116	-3.18079	91	11.83003	9.6804486	91	13.37632625	10.928533
92	69.41122253	-672.797	15.30192236	-6.26209	92	4.731579	1.0157694	92	13.17694494	10.8315461
93	70.06134879	-13760.5	14.51904884	-2.59754	93	7.178116	5.624824723	93	13.44031802	10.7621754
94	69.17085159	-34040.4	14.42955652	-24.6004	94	12.93855	9.19915091	94	13.80014155	11.0716863
95	67.0729694	-5221.47	14.35740919	-282.389	95	6.395338	4.270177245	95	13.29107669	10.7911183
96	68.39455069	-6315.32	15.69176948	-35.5151	96	8.672139	5.928602965	96	13.6128284	11.0650585
97	73.00446046	-17349.7	15.00221694	-45.2935	97	6.367258	4.962449491	97	13.27786987	10.7545559
98	67.54123475	-1079.91	15.20910885	-17.5137	98	9.150277	6.651623574	98	13.29622761	10.7286089
99	72.33048152	-19843.2	14.87994924	-6.71117	99	7.385728	5.513419232	99	13.29622761	10.7286089
100	73.6737958	-13463.6	14.24210186	-15.6513	100	8.19409	4.880377841	100	13.29622761	10.7286089
101	72.4595366	-38112.9	15.24545748	-16.2393	101	5.250962	5.138688773	101	13.29622761	10.7286089
102	69.56803361	-13540.9	14.79208967	-4.8162	102	5.23516	4.024962671	102	13.29622761	10.7286089
103	69.43771611	-5435.47	14.91765122	-18.2305	103	10.1081	8.520805442	103	13.29622761	10.7286089
104	73.88695558	-15304.5	16.54286253	-27.3669	104	17.11667	11.06243235	104	13.29622761	10.7286089

105	72.35874813	-9626.77	14.90724359	-24.609
106	37.26863435	-65076.9	14.58892831	-30.694
107	71.79759243	-19282	15.19237217	-26.5514
108	73.60543877	-1858.74	14.65727654	-3.53009
109	70.59319969	-538.979	15.63423943	-14.207
110	69.13733962	-8185.93	15.63065608	-18.6617
111	74.80060316	-49950.3	15.41518064	-3.57748
112	74.17658211	-96541	14.6452504	-15.51
113	70.73134153	-6417.74	14.98211751	-3.84416
114	73.99356233	-28251.7	14.77873213	-16.579
115	75.03291712	-7140.57	15.19468721	-27.2489
116	74.76611659	-25623	15.30676971	-20.9356
117	76.88668097	-7682.84	16.21614959	-30.1079
118	37.22012034	-2786.5	15.92142986	-21.3017
119	30.41446912	-196663	16.46174246	-19.6152
120	76.89444236	-10216.1	15.46506891	-12.1276
121	72.59240533	-4668.2	15.19215892	-11.2506
122	77.97314218	-149347	16.91304921	-6.25774
123	78.07781321	-76246.8	17.19606162	-17.315
124	29.17482455	-171512	17.03569729	-5.14797
125	37.80784322	-150359	16.56194579	-13.1414
126	75.189532	-238734	15.73529779	-12.5644
127	76.49462552	-22873.7	18.00090911	-33.992
128	35.17852568	-119571	16.58925208	-42.4289
129	77.12750222	-18418.5	16.65946972	-39.1217
130	36.34499284	-149310	16.83326823	-48.168
131	73.53452411	-44098	18.12271945	-27.019
132	37.36121346	-154949	17.51511181	-28.2326
133	46.62538619	-389541	17.60549817	-50.217
134	69.81833056	-186495	16.16539763	-32.7294
135	75.60747273	-58916.1	16.12529887	-4.56587
136	48.07183378	-304531	17.31156041	-10.8992
137	78.68045746	-178172	16.94071738	-16.548
138	40.78474179	-69857.8	17.13030743	-7.85615
139	53.29759353	-62504.7	16.41061201	-32.6846
140	51.38919903	-377942	17.46824065	-21.1793
141	79.72945206	-128438	16.84256379	-30.9232
142	80.1114952	-31372	18.73753846	-6.63825
143	78.37117682	-178151	18.91498302	-13.0944
144	79.46104421	-92358.2	18.04378418	-8.79615
145	80.39421862	-16325.6	18.69934312	-25.0185
146	80.51220967	-12141.4	17.66811311	-26.2662
147	43.85892723	-52140.7	19.79048198	-55.8777
148	40.32487381	-13068.8	18.80405152	-58.7695
149	80.1065069	-1702.16	16.49847047	-4.3279
150	82.09600299	-3542.68	18.7062736	-9.12626
151	80.56531494	-14839	17.31595769	-4.37572
152	80.15836298	-4917.49	17.61353727	-13.9587
153	56.98244221	-15237.8	17.99565514	-17.8858
154	32.10377011	-38757.3	18.19065603	-9.119
155	78.69209119	-3048.87	19.12890554	-10.8134
156	81.47302149	-14244.8	18.7507976	-15.3427
157	53.84071393	-38659.5	20.64026727	-22.3149
158	80.49199908	-1981.4	18.88572158	-43.161
159	79.07318147	-9201.78	19.02240416	-43.9714
160	76.10361516	-95136.7	20.22927985	-61.254
161	81.20437818	-33162	18.84635963	-41.9679
162	80.06897909	-1021.48	17.29659688	-74.7944
163	81.33781159	-734.291	19.36654345	-68.1601
164	81.55728867	-1459.32	18.16192885	-52.0881
165	44.15562693	-4315.11	21.54890547	-25.9883
166	43.66840765	-2555.84	20.62790885	-39.1187
167	61.37251651	-1535.8	19.79334289	-30.3916
168	81.31116658	-710.411	21.9921097	-11.2945
169	81.8719566	-1003.84	19.82973441	-6.68141
170	82.70083318	-1077.26	22.09113375	-21.5401
171	82.31489855	-1005.77	19.88285592	-5.87255
172	82.2893562	-736.707	22.40203251	-24.2156
173	81.02344394	-1308.7	18.95208793	-9.18364
174	83.42338102	-1078.89	20.42763982	-39.5745
175	83.7496061	-4445.66	19.42443448	-7.32667
176	58.45561635	-1081.68	20.53456738	-9.61599
177	83.35575118	-2746.17	21.10040673	-8.88856
178	55.65712421	-3449.35	20.71799567	-6.68256
179	83.58514069	-3649.71	18.93562153	-19.0767
180	52.90501356	-3904.32	19.65085546	-51.0647
181	63.18885603	-1190.63	20.78111652	-30.2598
182	83.82773867	-2098.32	19.85009595	-8.2451
183	57.86288593	-2711.71	21.34492011	-22.7776
184	52.42846385	-6946.56	24.02695749	-14.0493
185	62.47178811	-621.268	20.81938737	-14.935
186	54.69083738	-611.547	22.28683396	-9.86163
187	84.4074286	-727.465	22.26161707	-16.0497
188	53.7107545	-1893.78	19.8411575	-11.4004
189	58.00216141	-514.24	24.4489807	-15.4032
190	54.68607185	-1507.97	20.99460909	-13.7149
191	63.7325353	-1188.84	22.17915904	-28.5056
192	79.1476099	-2537.83	21.25562164	-14.6373
193	56.87449977	-858.453	22.81016747	-17.1484
194	86.68902834	-1381.02	22.36745828	-30.5304
195	85.92789056	-895.952	22.80870167	-114.353
196	86.26641995	-1014.63	24.57644477	-94.8866
197	85.22861034	-1740.48	22.50456568	-45.5309
198	53.06579525	-4379.29	22.24403941	-28.3584
199	54.94638075	-5164.84	21.3566928	-33.9171
200	75.20302021	-2525.16	23.05630742	-31.782
201	86.24625387	-2120.02	23.03739965	-70.9505
202	86.28225682	-2094.01	23.98962343	-83.8227
203	57.50110365	-1573	24.43728241	-100.044
204	86.82392432	-1178.34	23.93973683	-104.382
205	0	0	0	0
206	86.2344025	-5343.16	24.45751308	-50.3883
207	84.45177962	-4014.35	24.15033777	-41.3399
208	86.7638252	-1585.62	24.18023825	-20.5103
209	86.18888546	-2507.09	25.00453323	-112.963
210	85.32648372	-1459.15	25.12211688	-62.5545
211	55.64819889	-12116.1	23.34727515	-20.8641

105	18.20914	13.4380447
106	7.233733	4.677644563
107	10.69846	8.344469008
108	1.983644	0.83623545
109	8.553246	5.374893173
110	11.99664	10.09408472
111	7.363521	5.791597137
112	2.020582	0.13769527
113	10.51874	7.083178626
114	5.961881	4.070158517
115	10.01945	7.103725906
116	9.383461	7.370530457
117	3.388662	3.761940992
118	16.66341	11.21831941
119	9.267543	7.213069568
120	5.955854	4.63009434
121	11.82397	8.88054569
122	11.95864	10.20415453
123	20.16071	14.15564745
124	15.07723	8.367128596
125	6.968263	4.46644036
126	4.997471	3.277584061
127	12.69883	10.08325094
128	4.708847	3.687476865
129	13.67388	11.10228649
130	19.43653	15.9173941
131	4.579974	3.355184223
132	11.61915	9.80464119
133	15.02313	11.88896951
134	4.005548	2.01441091
135	20.57839	14.65389943
136	14.42481	12.03807061
137	9.569751	7.60476731
138	3.277691	2.784142294
139	8.596287	7.809360759
140	3.223025	4.800129978
141	10.07927	9.07436909
142	14.40228	11.87377355
143	13.34723	10.08549818
144	27.02178	15.27411354
145	11.99247	7.631043736
146	6.221203	6.431543851
147	19.17668	11.75272197
148	7.882656	6.253237576
149	14.32288	10.67923837
150	27.02251	22.30213887
151	18.4281	12.37895019
152	12.00677	10.2757646
153	9.177726	7.429314394
154	0	0
155	10.25386	5.405474887
156	9.553206	1.800484167
157	11.35469	8.177374072
158	10.30923	7.922926705
159	5.854078	3.903481045
160	13.00264	9.831709643
161	5.914393	5.032410474
162	21.20474	18.71118431
163	15.5584	8.986323392
164	6.512429	3.519511263
165	21.83467	17.42768665
166	4.727623	5.378202953
167	10.70385	7.433656012
168	14.62548	10.70994343
169	24.18812	15.85087436
170	5.080813	5.011639278
171	14.37939	12.04979587
172	7.844734	6.010841819
173	17.76956	11.40160243
174	15.8671	12.3153849
175	7.136357	5.164192826
176	6.886242	6.136537051
177	2.547523	2.312274087
178	18.24479	13.78230459
179	7.952569	5.466512584
180	8.352016	5.748161661
181	14.71912	12.46686976
182	20.59923	9.905729137
183	9.174261	6.871758843
184	8.890095	6.668464701
185	12.95416	12.58707234
186	9.670849	8.113696054
187	7.335988	6.032654022
188	24.3551	12.80371653
189	3.258676	3.404366679
190	10.87056	8.691153952
191	6.036366	3.666137297
192	17.40644	9.701243783
193	10.02465	8.998614553
194	7.88037	7.050360082
195	13.50322	10.46052554
196	17.60558	11.6894874
197	18.43856	16.64910055
198	5.714756	3.831595653
199	13.09933	8.776252444
200	8.81959	5.908928761
201	27.00491	21.12835605
202	2.939465	3.138795554
203	9.868355	7.025017788
204	10.75321	4.169911261
205	17.50687	14.29612553
206	0	0
207	7.695192	5.448719113
208	12.55502	10.01568633
209	10.97826	8.088183492
210	20.29007	13.50304555
211	7.305921	5.194585982

105	13.29622761	10.7286089
106	13.29622761	10.7286089
107	13.29622761	10.7286089
108	13.29622761	10.7286089
109	13.29622761	10.7286089
110	13.29622761	10.7286089
111	13.29622761	10.7286089
112	13.29622761	10.7286089
113	13.29622761	10.7286089
114	13.29622761	10.7286089
115	13.29622761	10.7286089
116	13.29622761	10.7286089
117	13.29622761	10.7286089
118	13.29622761	10.7286089
119	13.29622761	10.7286089
120	13.29622761	10.7286089
121	13.29622761	10.7286089
122	13.29622761	10.7286089
123	13.29622761	10.7286089
124	13.29622761	10.7286089
125	13.29622761	10.7286089
126	13.29622761	10.7286089
127	13.29622761	10.7286089
128	13.29622761	10.7286089
129	13.29622761	10.7286089
130	13.29622761	10.7286089
131	13.29622761	10.7286089
132	13.29622761	10.7286089
133	13.29622761	10.7286089
134	13.29622761	10.7286089
135	13.29622761	10.7286089
136	13.29622761	10.7286089
137	13.29622761	10.7286089
138	13.29622761	10.7286089
139	13.29622761	10.7286089
140	13.29622761	10.7286089
141	13.29622761	10.7286089
142	13.29622761	10.7286089
143	13.29622761	10.7286089
144	13.29622761	10.7286089
145	13.29622761	10.7286089
146	13.29622761	10.7286089
147	13.29622761	10.7286089
148	13.29622761	10.7286089
149	13.29622761	10.7286089
150	13.29622761	10.7286089
151	13.29622761	10.7286089
152	13.29622761	10.7286089
153	13.29622761	10.7286089
154	13.29622761	10.7286089
155	13.29622761	10.7286089
156	13.29622761	10.7286089
157	13.29622761	10.7286089
158	13.29622761	10.7286089
159	13.29622761	10.7286089
160	13.29622761	10.7286089
161	13.29622761	10.7286089
162	13.29622761	10.7286089
163	13.29622761	10.7286089
164	13.29622761	10.7286089
165	13.29622761	10.7286089
166	13.29622761	10.7286089
167	13.29622761	10.7286089
168	13.29622761	10.7286089
169	13.29622761	10.7286089
170	13.29622761	10.7286089
171	13.29622761	10.7286089
172	13.29622761	10.7286089
173	13.29622761	10.7286089
174	13.29622761	10.7286089
175	13.29622761	10.7286089
176	13.29622761	10.7286089
177	13.29622761	10.7286089
178	13.29622761	10.7286089
179	13.29622761	10.7286089
180	13.29622761	10.7286089
181	13.29622761	10.7286089
182	13.29622761	10.7286089
183	13.29622761	10.7286089
184	13.29622761	10.7286089
185	13.29622761	10.7286089
186	13.29622761	10.7286089
187	13.29622761	10.7286089
188	13.29622761	10.7286089
189	13.29622761	10.7286089
190	13.29622761	10.7286089
191	13.29622761	10.7286089
192	13.29622761	10.7286089
193	13.29622761	10.7286089
194	13.29622761	10.7286089
195	13.29622761	10.7286089
196	13.29622761	10.7286089
197	13.29622761	10.7286089
198	13.29622761	10.7286089
199	13.29622761	10.7286089
200	13.29622761	10.7286089
201	13.29622761	10.7286089
202	13.29622761	10.7286089
203	13.29622761	10.7286089
204	13.29622761	10.7286089
205	13.29622761	10.7286089
206	13.29622761	10.7286089
207	13.29622761	10.7286089
208	13.29622761	10.7286089
209	13.29622761	10.7286089
210	13.29622761	10.7286089
211	13.29622761	10.7286089

212	86.07420985	-7759.68	25.01008669	-112.973	212	8.4591	7.636538774	212	13.29622761	10.7286089
213	86.35462487	-1459	23.25153182	-75.7371	213	20.32299	15.54906929	213	13.29622761	10.7286089
214	87.39658281	-3536.19	23.75333184	-29.8437	214	14.07176	9.963949876	214	13.29622761	10.7286089
215	86.97020745	-1395.46	27.56187522	-171.844	215	6.359383	4.295626201	215	13.29622761	10.7286089
216	47.40207698	-2308.68	23.17167747	-138.359	216	41.65805	34.18501976	216	13.29622761	10.7286089
217	86.66445581	-814.139	24.79747627	-90.6353	217	3.807369	3.403671951	217	13.29622761	10.7286089
218	86.96955777	-1905.88	25.30776057	-42.256	218	7.285674	5.492380276	218	13.29622761	10.7286089
219	87.417759	-984.156	24.31741498	-20.5157	219	12.41827	9.547292572	219	13.29622761	10.7286089
220	87.24906949	-454.112	26.23987166	-23.0017	220	12.16638	10.32604884	220	13.29622761	10.7286089
221	85.59745737	-729.716	25.6822737	-43.5407	221	6.584325	4.496401012	221	13.29622761	10.7286089
222	86.59530398	-1295.13	25.07077234	-21.7785	222	9.893149	8.428004654	222	13.29622761	10.7286089
223	59.38948268	-1498.19	24.60150172	-82.8849	223	7.532903	4.050815491	223	13.29622761	10.7286089
224	51.40899599	-1491.24	27.42807427	-161.729	224	6.110947	6.118650414	224	13.29622761	10.7286089
225	52.42922458	-1048.92	23.2771064	-36.9302	225	10.85323	7.220199355	225	13.29622761	10.7286089
226	87.86261142	-977.215	25.39877442	-153.735	226	19.24161	13.02556335	226	13.29622761	10.7286089
227	87.97250522	-828.008	27.92335618	-217.315	227	9.643508	7.144021182	227	13.29622761	10.7286089
228	88.03629341	-844.497	25.3298261	-42.7518	228	2.551229	1.375430904	228	13.29622761	10.7286089
229	60.86883448	-1944.27	24.5689156	-108.726	229	22.85511	15.2441289	229	13.29622761	10.7286089
230	88.03018706	-1230.35	27.04878196	-39.5691	230	14.11302	12.23579692	230	13.29622761	10.7286089
231	87.41716482	-1533.37	27.46632451	-27.0583	231	21.20187	17.19008407	231	13.29622761	10.7286089
232	87.57217632	-1337.83	25.93062208	-68.3545	232	4.614433	3.460559685	232	13.29622761	10.7286089
233	88.28176987	-793.92	28.36563485	-47.9361	233	4.341693	2.335123507	233	13.29622761	10.7286089
234	88.07693959	-2287.79	26.78386186	-23.8568	234	3.185395	3.786850248	234	13.29622761	10.7286089
235	62.23705803	-871.468	27.47822957	-19.0058	235	5.725395	5.512089458	235	13.29622761	10.7286089
236	88.39691717	-1949.26	25.6050932	-25.3663	236	14.49712	12.51797973	236	13.29622761	10.7286089
237	88.42425605	-1935.27	29.03975925	-47.1065	237	35.65318	23.40478165	237	13.29622761	10.7286089
238	59.5622397	-903.717	24.098243	-25.6338	238	7.032282	4.697256557	238	13.29622761	10.7286089
239	88.63047252	-2353.96	28.39930801	-71.627	239	20.62477	15.73596396	239	13.29622761	10.7286089
240	88.00326375	-1161	28.43848943	-179.578	240	3.160286	1.260715767	240	13.29622761	10.7286089
241	87.66900825	-1044.21	27.22718808	-149.143	241	21.8663	16.17841	241	13.29622761	10.7286089
242	87.75577135	-1754.29	28.17163282	-58.9675	242	6.746605	3.801912269	242	13.29622761	10.7286089
243	89.18733207	-2883.11	27.26911951	-67.8367	243	4.928211	5.09051074	243	13.29622761	10.7286089
244	88.10264728	-2144.94	25.98905519	-15.6102	244	4.871638	1.328729128	244	13.29622761	10.7286089
245	88.48463957	-909.983	30.5858753	-26.8841	245	2.700022	2.000866583	245	13.29622761	10.7286089
246	88.54271651	-1668.29	28.36130628	-91.9731	246	19.26163	8.823017962	246	13.29622761	10.7286089
247	88.45252763	-5311.83	28.50232758	-35.6014	247	13.68547	13.16760134	247	13.29622761	10.7286089
248	88.78855322	-2789.47	27.24361551	-72.081	248	7.954817	6.99419759	248	13.29622761	10.7286089
249	88.73656314	-3142.43	28.37674162	-45.6349	249	12.56884	6.689953179	249	13.29622761	10.7286089
250	88.83617064	-1046.61	28.47033153	-108.225	250	6.898256	5.346496645	250	13.29622761	10.7286089
251	88.87136317	-2225.88	29.6469803	-75.2026	251	15.13406	11.96252486	251	13.29622761	10.7286089
252	88.35281305	-2396.38	27.71219515	-15.218	252	6.919438	4.436407291	252	13.29622761	10.7286089
253	89.00341424	-2264.93	27.55424111	-69.81	253	9.130347	7.321306589	253	13.29622761	10.7286089
254	88.87398358	-4590.06	28.57825014	-275.651	254	11.25696	7.572679951	254	13.29622761	10.7286089
255	88.71015038	-1663.05	28.37514252	-69.3266	255	10.35928	6.671010367	255	13.29622761	10.7286089
256	89.19397802	-2095.41	29.05040374	-205.058	256	27.04989	17.83352208	256	13.29622761	10.7286089
257	85.58351974	-1275.33	28.57748965	-223.728	257	18.25676	13.21677248	257	13.29622761	10.7286089
258	88.57352774	-2351.25	30.51209522	-58.7231	258	0	0	258	13.29622761	10.7286089
259	54.39953048	-4283.36	26.00966806	-26.4671	259	12.44344	7.747790116	259	13.29622761	10.7286089
260	89.03360878	-1877.98	29.88197893	-25.3476	260	3.556511	4.266483974	260	13.29622761	10.7286089
261	65.07510377	-1627.63	27.29067804	-41.2716	261	3.79353	2.00470325	261	13.29622761	10.7286089
262	89.05110938	-963.711	25.11697067	-64.2353	262	7.234043	-0.293211723	262	13.29622761	10.7286089
263	87.31913046	-814.528	30.33975033	-282.49	263	14.8469	9.539146163	263	13.29622761	10.7286089
264	89.32547378	-1046.63	29.42861567	-229.647	264	2.892754	2.149880263	264	13.29622761	10.7286089
265	89.51175351	-798.143	28.59153075	-123.243	265	2.184282	0.703804896	265	13.29622761	10.7286089
266	89.66111492	-1790.61	29.1538525	-45.5616	266	19.10878	13.3834919	266	13.29622761	10.7286089
267	58.08132014	-9276.46	27.3473753	-25.6868	267	3.303968	4.632293058	267	13.29622761	10.7286089
268	89.77017222	-804.09	29.38588647	-42.4771	268	7.750567	4.782642804	268	13.29622761	10.7286089
269	89.82165933	-1249.15	31.53980852	-162.252	269	3.257176	3.691767243	269	13.29622761	10.7286089
270	90.07362093	-1228.02	29.76094356	-248.502	270	9.686979	5.966299389	270	13.29622761	10.7286089
271	59.69121882	-1006.63	30.28559531	-241.739	271	19.66099	13.34884813	271	13.29622761	10.7286089
272	50.12484104	-1229.11	30.16946476	-188.244	272	13.04523	9.622749653	272	13.29622761	10.7286089
273	89.47632813	-2735.12	31.18379349	-310.099	273	6.336699	5.969304234	273	13.29622761	10.7286089
274	0	0	0	0	274	6.532881	3.353689798	274	13.29622761	10.7286089
275	89.97929182	-2796.53	30.84583194	-131.621	275	19.22658	14.49941413	275	13.29622761	10.7286089
276	89.69823578	-2826.49	29.75005438	-76.5337	276	1.826475	1.140381482	276	13.29622761	10.7286089
277	52.12890038	-9816.49	31.32631975	-148.744	277	7.21025	5.757361643	277	13.29622761	10.7286089
278	89.5510871	-3569.19	29.90508061	-112.953	278	9.201073	6.298390384	278	13.29622761	10.7286089
279	89.68287092	-1251.44	29.4802616	-98.1842	279	4.628834	3.244680153	279	13.29622761	10.7286089
280	89.87455922	-1211.6	30.90999705	-217.243	280	5.315098	4.194936021	280	13.29622761	10.7286089
281	59.06973792	-2610.54	31.01598161	-93.3857	281	6.235495	4.625611199	281	13.29622761	10.7286089
282	89.67369508	-934.566	29.64228481	-42.3112	282	3.487817	2.762027224	282	13.29622761	10.7286089
283	85.87385165	-1667.71	29.39154402	-46.9761	283	5.044195	4.014158325	283	13.29622761	10.7286089
284	90.05445124	-2953.56	29.43132437	-143.629	284	3.520413	3.946474303	284	13.29622761	10.7286089
285	45.8593823	-3219.61	31.23671119	-79.9232	285	4.254846	1.382094242	285	13.29622761	10.7286089
286	89.93818141	-1350.58	30.16021201	-37.0662	286	6.143492	5.165817337	286	13.29622761	10.7286089
287	38.8544497	-1340.83	32.30593329	-107.637	287	7.066617	4.534400844	287	13.29622761	10.7286089
288	58.11609836	-2221.8	32.06276511	-42.5396	288	6.223036	4.891443268	288	13.29622761	10.7286089
289	90.22460568	-1075.96	30.80994352	-23.1144	289	13.24784	10.15511954	289	13.29622761	10.7286089
290	45.2635209	-5724.5	31.39150531	-29.442	290	15.386	12.65197984	290	13.29622761	10.7286089
291	88.5645828	-792.024	29.53587894	-23.3238	291	1.026186	-3.503606359	291	13.29622761	10.7286089
292	43.72700642	-2187.94	32.04616031	-76.118	292	27.11265	19.58195273	292	13.29622761	10.7286089
293	90.12712797	-1783.75	32.78725146	-119.246	293	0.585555	-1.156897579	293	13.29622761	10.7286089
294	90.32217605	-998.452	31.34277943	-69.4189	294	32.34022	28.86634162	294	13.29622761	10.7286089
295	90.42897754	-724.142	31.78053054	-42.1098	295	7.154787	5.002783064	295	13.29622761	10.7286089
296	46.09222858	-292.451	32.61351579	-78.0579	296	9.376	7.748518537	296	13.29622761	10.7286089
297	60.30599987	-2381.33	29.73576348	-49.6769	297	18.47184	17.18076141	297	13.29622761	10.7286089
298	57.64406742	-1662.02	30.91102961	-77.9784	298	8.31229	5.933333985	298	13.29622761	10.7286089
299	58.10575069	-2765.74	32.31420076	-282.345	299	7.05072	4.498499844	299	13.29622761	10.7286089
300	50.75338635	-2305.27	31.39862442	-226.851	300	8.175441	4.076311577	300	13.29622761	10.7286089

Saturation	200200-201200		200200-201200		200200-201200	
validation +100000	Input		Output		Both	
Upper Limit	Est. Fit	Val. Fit	Est. Fit	Val. Fit	Est. Fit	Val. Fit
1	6.834595	3.030762	6.834595	3.030762	6.834595	3.030762
2	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
3	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
4	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
5	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
6	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
7	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
8	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
9	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
10	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
11	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
12	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
13	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
14	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
15	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
16	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
17	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
18	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
19	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463
20	9.61593	3.564461	-3.70299	-2.62463	-3.70299	-2.62463

Saturation	200200-201200		200200-201200		200200-201200	
validation +100000	Input		Output		Both	
Lower Limit	Est. Fit	Val. Fit	Est. Fit	Val. Fit	Est. Fit	Val. Fit
1	6.834595	3.030762	18.52415	6.134677	6.834595	3.030762
2	9.61593	3.564461	6.898387	5.793243	-3.70299	-2.62463
3	9.61593	3.564461	6.520805	5.104862	-3.70299	-2.62463
4	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
5	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
6	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
7	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
8	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
9	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
10	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
11	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
12	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
13	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
14	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
15	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
16	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
17	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
18	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
19	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463
20	9.61593	3.564461	6.520807	5.104863	-3.70299	-2.62463

Deadzone	200200-201200		200200-201200		200200-201200	
validation +100000	Input		Output		Both	
Upper Limit	Est. Fit	Val. Fit	Est. Fit	Val. Fit	Est. Fit	Val. Fit
1	13.95084	7.94392	13.95084	7.94392	13.95084	7.94392
2	14.81842	8.463161	14.96017	8.334507	15.65745	8.775967
3	14.81842	8.463161	14.96017	8.334507	15.65745	8.775967
4	14.81842	8.463161	14.96017	8.334507	15.65745	8.775967
5	14.81842	8.463161	14.96017	8.334507	15.65745	8.775967

Deadzone	200200-201200		200200-201200		200200-201200	
validation +100000	Input		Output		Both	
Lower Limit	Est. Fit	Val. Fit	Est. Fit	Val. Fit	Est. Fit	Val. Fit
1	13.95084	7.94392	13.95084	7.94392	13.95084	7.94392
2	14.81842	8.463161	14.96017	8.334507	15.65745	8.775967
3	14.81842	8.463161	14.96017	8.334507	15.65745	8.775967
4	14.81842	8.463161	14.96017	8.334507	15.65745	8.775967
5	14.81842	8.463161	14.96017	8.334507	15.65745	8.775967

Saturation	200200-201200	
validation +100000	Both Blocks	
Both Limits	Est. Fit	Val. Fit
1	6.834595	3.030762
2	9.886403	3.135293
3	10.04597	3.7065
4	9.879046	3.167037
5	10.88605	3.910362
6	17.32095	5.33922
7	9.123738	3.65091
8	9.999115	3.684447
9	10.51174	3.376019
10	9.790581	3.736549
11	9.606371	3.938789
12	9.895001	3.089269
13	9.913635	3.25714
14	7.124563	2.559884
15	8.329145	2.510818
16	11.22107	4.171932
17	9.720931	2.886534
18	9.876901	3.187912
19	9.066494	3.052999
20	9.671667	3.651643
21	8.063915	2.808796
22	8.013534	2.928868
23	17.75409	8.892371
24	14.84633	4.039992
25	4.984839	2.344355
26	6.803419	2.793991
27	6.378723	3.293305
28	3.969648	1.839429
29	5.37422	1.818517
30	4.959562	2.351412
31	5.746187	2.708223
32	4.600195	2.098503
33	9.849643	3.202278
34	8.240445	2.60362
35	4.680415	2.173018
36	9.88559	3.166357
37	9.922131	3.070985
38	8.620003	2.894768
39	9.234087	2.613585
40	9.356276	3.768287
41	9.353166	3.734263
42	8.063916	2.808793
43	3.803944	2.476986
44	5.457344	4.726015
45	4.801219	2.700619
46	6.733408	2.759969
47	4.771332	2.904549
48	9.877752	2.680594
49	7.932744	3.821015
50	9.268264	3.776556
51	8.138915	4.375724
52	10.2704	3.195109
53	9.57909	3.922706
54	6.372672	3.530265
55	10.67231	4.178733
56	4.647075	2.141249
57	5.073903	2.43127
58	8.086503	3.429003
59	17.18122	7.330208
60	9.996055	3.779145
61	10.29058	3.562938
62	7.427259	3.104893
63	8.036593	4.319638
64	10.51171	4.192129
65	9.272473	4.034139
66	6.913355	2.989756
67	7.312545	4.095954
68	10.24285	3.7809
69	4.444028	2.269772
70	4.144946	2.164136
71	10.08238	3.689233
72	9.740943	3.597664
73	7.22014	3.182386
74	7.408807	3.433799
75	19.73496	8.434971
76	11.90609	5.298939
77	15.48955	5.446333
78	6.819171	3.183447
79	5.38351	3.174887
80	9.828864	3.685641
81	9.325526	3.757101
82	9.726693	3.663875
83	9.921602	3.860824
84	4.76494	2.029435
85	7.791246	3.919937
86	17.62569	7.20176
87	6.762874	3.05612
88	17.16528	5.380354
89	8.760362	4.480978
90	6.567199	3.085463
91	6.916923	3.990525
92	9.44513	3.718353
93	18.78632	7.602875
94	6.280436	3.37798
95	9.665261	3.24594
96	4.811593	2.030704
97	9.557052	3.555231
98	3.263609	2.138308
99	6.76983	3.635448
100	17.53993	7.268637
101	7.776054	3.963168
102	16.44367	5.236875
103	9.258964	4.25394
104	9.2032	4.596823
105	6.809413	3.586546
106	10.46744	4.527273
107	16.11938	4.604913
108	9.140465	3.890222
109	17.68967	5.726785
110	9.232594	3.657763
111	16.90018	5.755505
112	11.06435	7.86511
113	9.677302	3.253376
114	6.964005	3.045874
115	17.38881	5.854395
116	9.608947	3.549437
117	9.48065	3.942234
118	7.034025	3.676522
119	9.439372	7.278032

Deadzone	200200-201200	
validation +100000	Both Blocks	
Both Limits	Est. Fit	Val. Fit
1	13.95084	7.94392
2	13.92477	7.789723
3	-20.3597	-14.3727
4	13.90264	6.914541
5	15.34781	9.508281
6	-20.3597	-14.3727
7	15.38696	9.726153
8	13.542	7.543229
9	15.5238	9.740683
10	15.34201	9.50716
11	15.30137	9.375491
12	-20.3597	-14.3727
13	15.53438	9.789923
14	15.35332	9.749907
15	15.13712	9.724183
16	13.45012	7.387212
17	-20.3597	-14.3727
18	15.55076	9.702835
19	15.427	9.653686
20	15.33822	9.503312
21	15.3017	9.161731
22	15.29259	9.378089
23	14.24003	7.411656
24	-20.3597	-14.3727
25	15.52629	9.806461
26	15.55409	9.762781
27	15.55486	9.601729
28	15.28542	9.802815
29	15.47401	9.492239
30	15.15245	9.710999
31	14.70531	8.562288
32	13.42691	7.33126
33	14.50652	7.308379
34	-20.3597	-14.3727
35	15.57073	9.685443
36	15.60431	9.618632
37	15.61359	9.38823
38	15.43157	9.641682
39	15.48196	9.520764
40	15.33877	9.493909
41	14.863	6.389896
42	15.29202	9.191733
43	15.3716	9.175692
44	15.28235	9.372978
45	15.46386	9.197498
46	14.17102	7.418915
47	14.3064	7.774608
48	-20.3597	-14.3727
49	15.63412	9.690402
50	15.5391	9.788166
51	15.5677	9.749057
52	15.5975	9.702489
53	15.51098	9.788082
54	15.5973	9.520593
55	15.49443	9.634334
56	15.35465	9.7484
57	15.42651	9.638848
58	15.53138	9.354581
59	15.40898	9.474528
60	15.19127	9.675627
61	15.36285	9.200579
62	14.70572	8.562581
63	14.77747	8.446787
64	13.42429	7.309981
65	13.08102	7.604373
66	14.15468	6.413411
67	13.29874	5.249687
68	-20.3597	-14.3727
69	15.60763	9.631862
70	15.63871	9.569323
71	15.66464	9.50109
72	15.68934	9.422152
73	15.47398	9.76559
74	15.65019	9.240985
75	15.4519	9.630602
76	15.36313	9.704048
77	15.31632	9.715745
78	15.48279	9.50702
79	15.28873	9.59066
80	15.26216	9.569627
81	15.41817	9.141482
82	14.68927	6.063925
83	15.3247	9.062903
84	15.29798	9.175996
85	15.31177	9.216266
86	15.40618	9.090637
87	15.32047	9.380064
88	15.20204	9.455382
89	15.29002	9.252561
90	15.487	8.926815
91	14.77818	8.383712
92	14.13578	7.553302
93	12.54775	7.151035
94	14.29124	7.773102
95	-20.3597	-14.3727
96	-20.3597	-14.3727
97	-20.3597	-14.3727
98	15.71689	9.525465
99	15.48194	9.85409
100	15.56983	9.748556
101	15.59645	9.710233
102	15.62357	9.667018
103	15.64883	9.619091
104	15.67411	9.565549
105	15.69834	9.502581
106	15.53889	9.751966
107	15.52409	9.651174
108	15.61548	9.468663
109	15.6839	9.14961
110	15.46446	9.662557
111	15.40369	9.712478
112	15.28802	9.800794
113	15.4426	9.633915
114	15.388	9.67343
115	15.35663	9.690185
116	15.57238	9.179488
117	15.38544	9.450933
118	15.38635	9.497652
119	15.43073	9.157698

120	9.624469	3.802848
121	15.97087	5.379818
122	2.332506	1.409961
123	8.21113	2.626748
124	10.87828	4.405381
125	10.30733	3.284545
126	9.22692	4.093885
127	16.9027	5.582296
128	9.439171	3.810992
129	17.90091	8.736134
130	14.5654	4.368571
131	15.12012	4.843588
132	9.84115	4.224125
133	18.65455	8.505392
134	6.843027	3.816182
135	6.74433	4.045359
136	6.789497	2.928094
137	7.134513	3.839941
138	16.29746	5.58757
139	7.413569	4.133592
140	6.694005	3.037563
141	16.64865	6.306831
142	8.650527	4.429839
143	7.839746	4.257047
144	7.212785	3.308079
145	13.68071	7.5985
146	9.062124	3.187686
147	16.01711	9.19104
148	14.14248	9.048277
149	15.28167	9.171216
150	13.7229	6.774075
151	12.79887	4.896528
152	10.7568	4.820853
153	8.683568	3.124362
154	16.28403	5.244805
155	7.848326	3.83415
156	9.901088	4.021896
157	9.221153	4.015282
158	16.92408	9.100592
159	15.57277	6.857569
160	15.48968	8.075528
161	15.45896	9.004878
162	16.32689	9.31851
163	9.58799	3.381889
164	10.34338	4.332606
165	12.53313	5.498679
166	9.824238	4.410855
167	6.836198	2.872486
168	9.623915	4.148402
169	8.804498	4.434975
170	16.59906	7.524365
171	9.696334	3.548087
172	8.283419	3.330034
173	12.17285	5.229016
174	9.185701	3.910915
175	7.378257	3.099574
176	10.27034	4.241587
177	15.12814	5.119237
178	9.325366	3.750472
179	17.56538	5.943033

120	15.23029	9.635535
121	12.82192	3.455516
122	15.38214	9.084541
123	14.54042	8.647373
124	14.56003	8.757429
125	14.80397	7.974802
126	14.7768	8.380027
127	14.04957	8.069152
128	13.38756	7.282097
129	12.52154	7.242368
130	12.7961	7.229421
131	14.34402	7.713182
132	12.72898	3.899974
133	13.49748	9.08863
134	11.11847	6.974483
135	-20.3597	-14.3727
136	-20.3597	-14.3727
137	15.62117	9.604066
138	15.65018	9.544154
139	15.67576	9.479475
140	15.69772	9.409078
141	15.71575	9.33278
142	15.72984	9.251897
143	15.73889	9.163938
144	15.74292	9.069098
145	15.55409	9.660413
146	14.80176	10.06966
147	14.19267	10.06776
148	14.55599	10.00112
149	14.70153	9.990193
150	14.83958	9.969307
151	14.9691	9.937357
152	15.08387	9.882693
153	14.39481	9.980362
154	14.57489	9.975555
155	14.74285	9.956631
156	14.89738	9.923051
157	15.02472	9.865841
158	15.02321	9.771294
159	14.36437	9.885385
160	14.57054	9.860162
161	14.498	9.793981
162	13.98106	9.78646
163	14.23321	9.791417
164	14.15095	5.115432
165	15.01207	6.797886
166	15.35991	8.977147
167	15.33844	9.068482
168	15.32087	9.130185
169	15.46958	8.830719
170	15.33069	9.178063
171	15.50201	8.939614
172	15.45926	8.887371
173	15.34377	9.210412
174	15.32756	9.362117
175	15.43224	8.940256
176	15.18266	9.478291
177	15.4046	9.050518
178	15.28019	9.252494
179	15.1481	9.558773

180	9.485372	3.534515
181	10.87227	4.141505
182	10.22398	3.497361
183	9.990301	3.50419
184	8.167986	3.809611
185	10.39925	5.085486
186	9.567496	3.456925
187	10.40682	3.490117
188	9.463978	3.711212
189	9.8949	3.376734
190	13.9351	8.895029
191	17.06185	9.266862
192	9.837055	7.477594
193	6.913146	3.104813
194	13.67278	8.390457
195	12.80319	7.926364
196	16.64591	8.503821
197	17.08212	4.982531
198	12.66587	8.08498
199	16.93066	8.858661
200	15.96875	9.038068
201	10.1452	7.85403
202	18.79131	7.954519
203	9.447252	3.426446
204	9.595365	3.620934
205	10.70937	3.76426
206	9.603465	3.682494
207	9.67402	3.597169
208	8.958281	4.598699
209	6.682991	2.905596
210	9.884526	3.79955
211	9.94126	3.533938
212	9.592936	3.570675
213	9.402459	3.613623
214	9.655149	3.589716
215	9.654527	3.503771
216	9.86223	3.222359
217	9.639683	3.574137
218	9.643337	3.411741
219	10.24642	3.703578
220	9.635964	3.608055
221	9.422952	3.680081
222	9.666649	3.69552
223	9.615741	3.712088
224	9.68978	3.46893
225	9.706883	3.489371
226	14.59242	5.020964
227	10.4926	3.395636
228	9.634228	3.923075
229	9.634209	3.923257
230	9.487435	3.546307
231	9.717744	3.678464
232	9.59819	3.627281
233	9.598213	3.627308
234	8.373061	3.334267
235	9.043356	4.01504
236	9.704897	3.489047
237	9.958134	3.402197
238	10.12528	3.625206
239	9.022371	3.871545
240	9.696169	3.48056
241	10.09708	3.893555
242	9.355259	3.719483
243	9.623231	3.935689
244	10.29456	3.123205
245	9.582752	3.624918
246	9.700286	3.801359
247	9.737122	3.532924
248	10.138	3.494761
249	10.12398	3.899601
250	11.06944	3.981217
251	10.79532	3.808347
252	10.04155	3.104617
253	9.805565	2.852444
254	9.594983	3.694802
255	9.66991	3.423566
256	9.9963	3.364569
257	9.754551	3.325223
258	9.736865	3.557785
259	10.19182	3.607057
260	9.737164	3.557622
261	17.45661	6.246669
262	9.658581	3.529412
263	9.750214	3.577402
264	9.684524	3.701141
265	9.898976	4.73457
266	9.83164	3.45986
267	5.576709	3.008274
268	13.61371	3.837946
269	5.944846	3.920488
270	14.63215	4.444944
271	10.03329	3.960001
272	10.54788	3.708076
273	15.78105	5.413944
274	6.84737	3.28048
275	7.853138	4.303832
276	9.816997	3.290761
277	8.422279	4.428347
278	14.28073	4.298717
279	5.262628	2.749153
280	10.03224	4.337528
281	10.17971	3.418788
282	10.92167	3.696298
283	9.100572	4.274907
284	16.86776	4.939887
285	9.53691	3.886789
286	10.03992	3.340596
287	10.18662	3.718036
288	10.37529	3.425214
289	9.645957	3.628066
290	15.26357	5.15434
291	14.50874	7.810087
292	10.28092	3.402904
293	15.43037	4.704159
294	16.01682	9.190826
295	9.922813	3.437519
296	10.16933	3.379195
297	10.55707	3.464961
298	10.38792	3.263641
299	16.7839	5.049968
300	11.33177	4.399829

180	15.46014	8.63127
181	14.72625	8.49166
182	14.78478	8.290648
183	14.85409	8.184629
184	14.16842	7.413358
185	13.51022	6.239446
186	12.51297	7.004451
187	13.44809	7.3459
188	14.27799	7.731986
189	14.65072	8.325675
190	-20.3597	-14.3727
191	-20.3597	-14.3727
192	-20.3597	-14.3727
193	-20.3597	-14.3727
194	-20.3597	-14.3727
195	15.57265	9.744155
196	15.78321	9.241993
197	15.4571	9.887941
198	15.45553	9.876907
199	15.48682	9.848828
200	15.56598	9.746345
201	15.59293	9.709531
202	15.61898	9.669941
203	15.64328	9.626781
204	15.66737	9.580017
205	15.68911	9.529176
206	15.70908	9.47405
207	15.72704	9.414106
208	15.74209	9.349413
209	15.7541	9.279521
210	15.76281	9.204098
211	15.7684	9.122473
212	15.52823	9.756796
213	15.46441	9.715206
214	15.51518	9.654776
215	15.09454	9.936337
216	14.31232	10.02738
217	14.45972	10.03351
218	14.6022	10.03172
219	14.73892	10.02134
220	14.86064	9.991942
221	14.98248	9.9632
222	15.13854	9.894382
223	14.31882	10.01439
224	14.49524	10.01793
225	14.66126	10.00942
226	14.79729	9.980028
227	14.93987	9.947568
228	15.11076	9.871747
229	14.38913	9.997635
230	14.58043	9.991498
231	13.64769	9.895044
232	13.9134	9.940001
233	13.83045	9.857014
234	13.16585	9.724072
235	13.48848	9.801444
236	12.72211	9.623697
237	13.27273	9.782737
238	13.34713	9.743074
239	8.412003	-2.25945
240	12.95285	9.717704
241	15.03971	7.236617
242	12.60655	3.170044
243	11.69384	9.215176
244	11.98875	9.331063
245	14.58451	8.68197
246	14.52352	8.66501
247	14.58064	8.571329
248	14.46706	8.838502
249	14.71206	7.399794
250	14.7575	7.696776
251	14.79308	8.197109
252	14.74008	8.46093
253	14.08219	7.396935
254	14.0268	8.091148
255	14.25237	8.060654
256	13.34842	7.254615
257	13.05686	7.88472
258	12.47164	7.116276
259	11.89171	6.531432
260	12.62756	6.609615
261	14.40768	7.73202
262	14.30812	7.412492
263	14.22678	7.477239
264	13.43312	5.133218
265	14.37564	7.388059
266	4.150081	4.15607
267	12.96942	7.302755
268	12.95338	6.424245
269	-20.3597	-14.3727
270	-20.3597	-14.3727
271	-20.3597	-14.3727
272	-20.3597	-14.3727
273	-20.3597	-14.3727
274	11.14558	9.066346
275	11.22568	9.102907
276	11.30571	9.139073
277	11.38565	9.174829
278	11.46549	9.21016
279	11.54522	9.245049
280	11.62481	9.279476
281	11.70421	9.313423
282	11.78342	9.346777
283	11.86241	9.379575
284	11.94115	9.411853
285	12.01959	9.443556
286	12.09769	9.474661
287	12.17542	9.504889
288	12.25272	9.534809
289	12.32955	9.564261
290	10.54905	8.776573
291	7.81853	7.283328
292	7.958134	7.364797
293	8.097462	7.445676
294	6.122178	6.250644
295	6.286391	6.353083
296	7.86523	7.257456
297	8.021402	7.348373
298	8.177056	7.438226
299	8.330512	7.526899
300	8.48474	7.614408