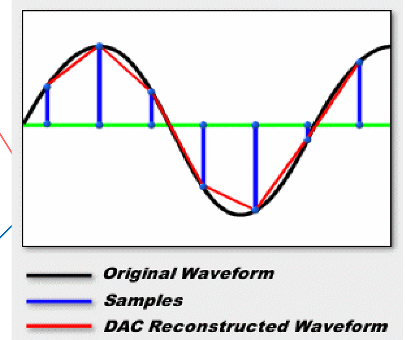
THE AUTONOMOUS POST PRODUCTION OF A PIANO RECORDING

Mike Fisher, Music Technology Research Group, School of Computing and Engineering, **michael.fisher@hud.ac.uk**

Supervisor: Dr. Ian S. Gibson

University of Huddersfield

This investigation aims to determine if the **basic post production** techniques typically applied to a **piano recording** can be done so entirely **autonomously by software**, in the form on a **VST Plugin**. Using **spectral analysis** the software will compare the incoming audio to a **predetermined ideal** and apply **compression and equalisation** accordingly, then alter the parameters of the effects in **real time** in order to maintain a relatively **constant tone and volume**. In the context of a **popular music production** this will be extremely useful during the **mixing process**, as it will automatically control the **large dynamic and frequency range** of the piano.

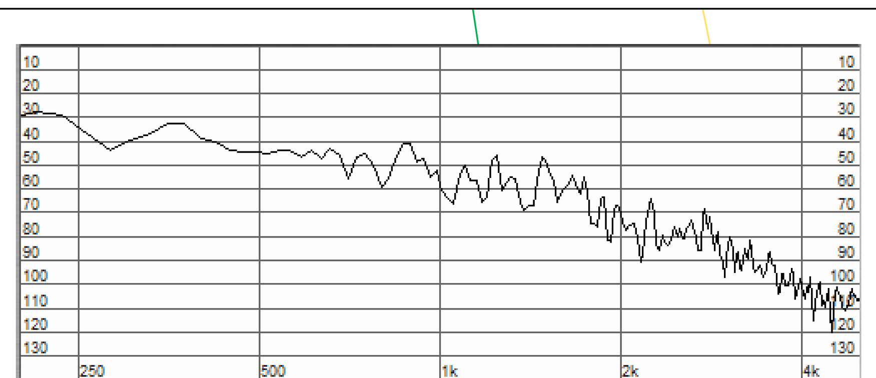


- The tonal qualities of a **time domain** digital signal are determined via **frequency domain analysis.**
- **Conversion** between the time and frequency **domains** is achieved with the **Fourier Transformation.**
- **The Discrete Fourier Transform (DFT)** calculates the Fourier Transform of a **discrete signal.**

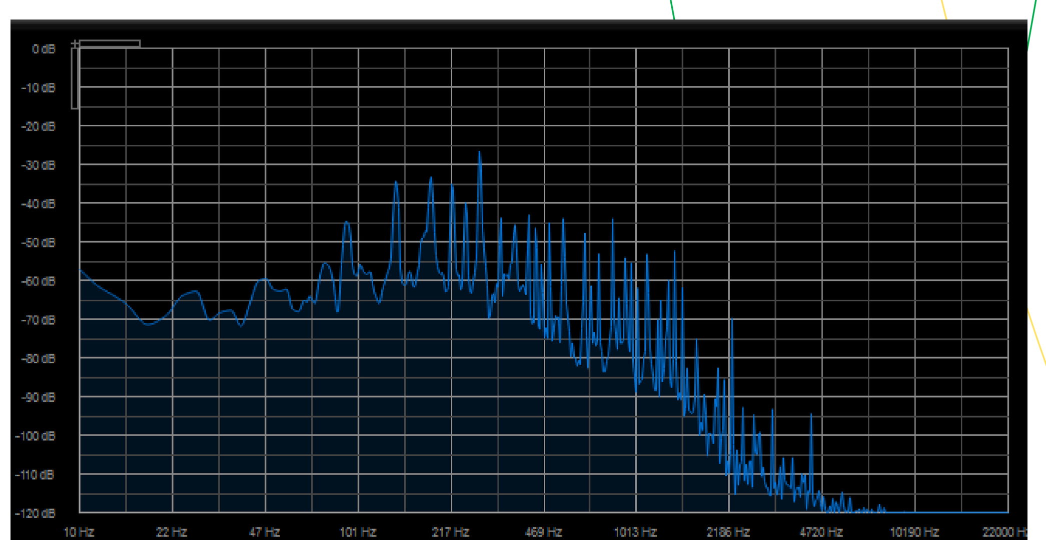
$$X_k = \sum_{n=0}^{N-1} x_n e^{-\frac{2\pi j}{N}kn} \qquad k = 0, \ldots, N-1$$

- **The Fast Fourier Transform (FFT)** is an **algorithm for efficient computation** of the DFT.

Spectral Analysis

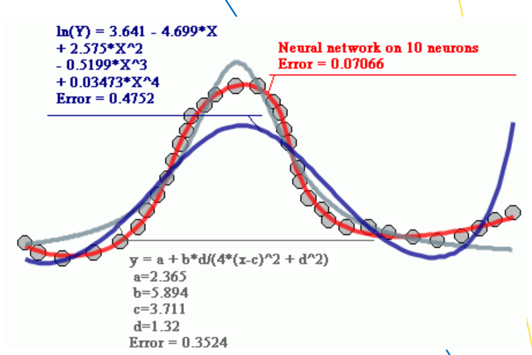


- Observing the **frequency content** of a signal in this way is called **Spectral Analysis**, and shows the **amplitude of component sine waves** in the signal.

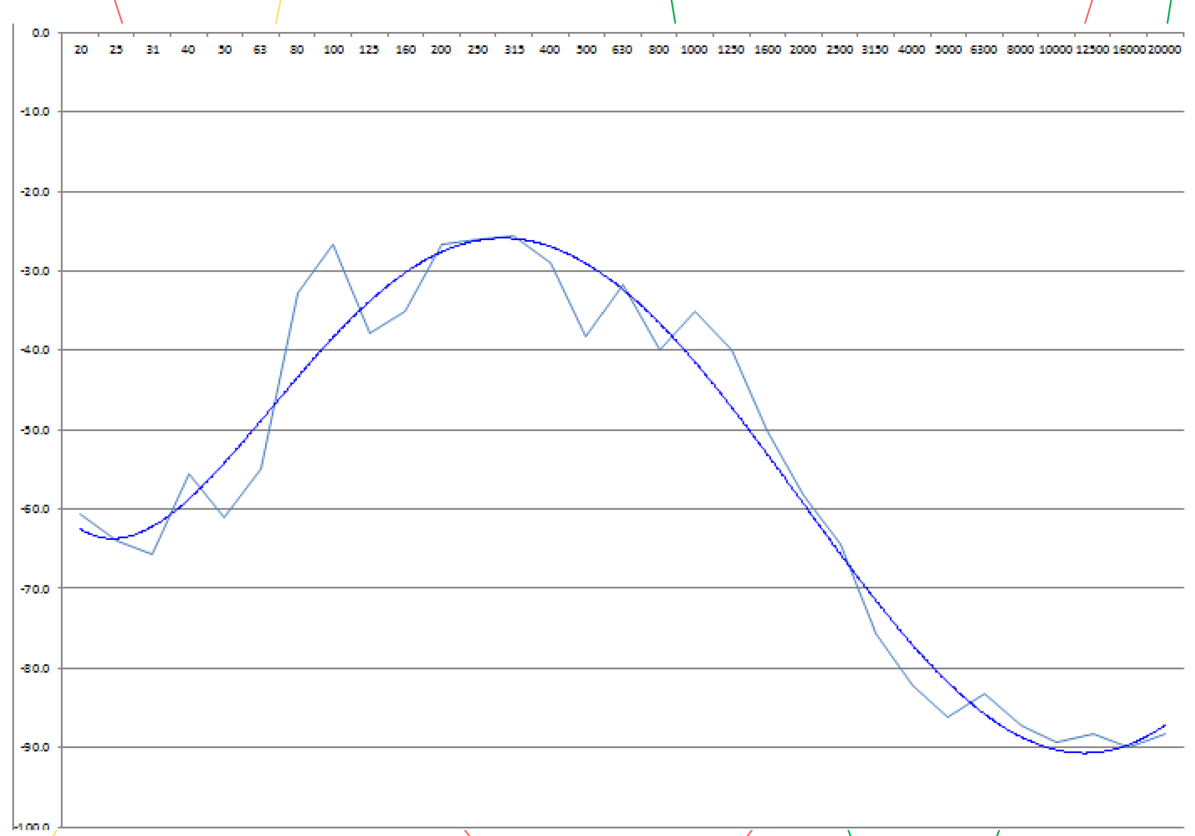


Regression

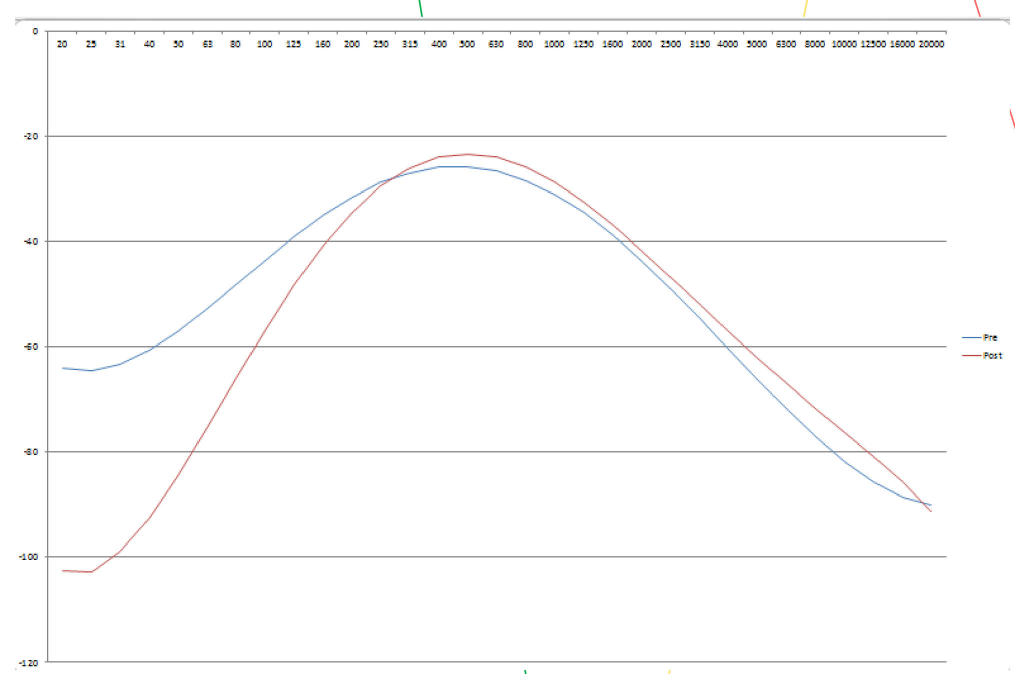
- An **overall shape** can be observed in the traces of **most pianos and recordings**. This is in fact a common trace shape for a large variety of musical instruments.
- The **slight differences** in that shape determine the **tonal qualities** of a sound by showing the **spread of amplitudes** across the spectrum.
- The results also show that the trace is very **jagged.** A combination of its jagged shape and **flickering movement** make it very difficult to observe how the trace **changes over time**, and also to **determine its shape.**



- A **smooth trace** can be made with **non-linear regression**—a 5th order polynomial is derived with acts as a **trend line** of the data.
- This is achieved with software via the **Gauss-Newton algorithm.**

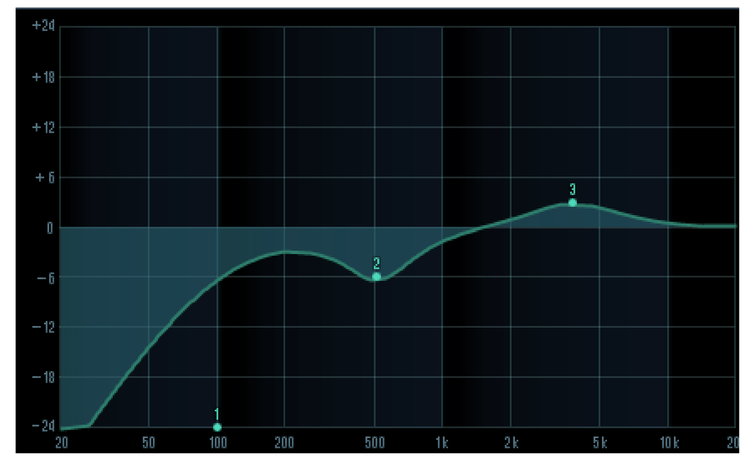


- The tonal qualities of a signal are by definition **qualitative** and therefore can only be assessed **relatively.**
- To do this an **"ideal" trace** is created by having an **experienced mixing engineer** apply the **corrective post production** that is to be carried out by the plugin on **various piano recordings** and establishing an **average.**
- **Three** ideal traces are used; one for each of the most **common types** of piano – **upright, studio grand and grand.**



- The ideal trace represents the **decisions of the mixing engineer** which can be used as a **reference** to which the input is then **compared**, leaving the software to determine what needs to be done to have the **input and ideal** traces be as **similar as possible.**
- The software does this by **literally comparing** the two traces to **find areas** which are more than a **pre-set distance apart**, and using **compression and equalisation** to correct them.

Comparison



- Besides the combination of **signal analysis and effects processing**, the **merging of compression and equalisation** (EQ) is the **main unique quality** of the plugin.
- Compression-like **envelope following techniques** are used to control the **gain of parametric filters.**
- This results in a capability to perform **both compression and compansion**, as the filter gain can be positive or negative.

Processing

- **Filter gain** is determined by the difference in the **Y-axis** between input and ideal trace.
- **Filter centre frequency and Q** factor is determined by differences in the **X-axis** between traces.

- **A high pass filter** will also be implemented, who's cut-off frequency is determined by the first point where the **traces cross.**
- These processes will result in a **piano tone** extremely **difficult to create with existing products.**