Introduction:  
  
Operating profitably in the current market, requires the capability to adapt to increasingly individualized customer demands, strict adherence to deadlines, and expected quality requirements. Failure to provide the requested services on time or with unacceptable quality deficit will result in a loss of business and lead to being squeezed out of the market.  
In the current state of “Industrie 4.0” and Big-Data, multiple opportunities arise to improve speed and accuracy in the production environment. Adaptive process scheduling, for example, can lead to optimal usage of machinery and adherence to the production schedule. Both of those effects will benefit the costumer, as the product will be manufactured faster and cheaper. When it comes to creating a product for the customer, the production part is only one of the aspects, where the new application possibilities of data-driven algorithms can support the manufacturer. Data-driven algorithms can support the designer to conceptualize more effective mechanisms or help the machinist to react to changing machining parameters, like wear and tear on cutting tools.  
Quality control is one of the sections of the production chain where those algorithms can support the identification of rejects or suggest improvements for the production process. The significant advancements in computer science, especially in Machine Learning (ML), can be adapted and transformed to the specific needs of the quality control department, to achieve higher precision rate and efficiency in identifying faults in the final product, than could be done with human labor.  
Machine learning contains those algorithms that are capable of solving tasks without explicitly being programmed to do so. They are based on pattern recognition and their performance improves as more data is available. This property proves them advantageous as more and more data is available from the increasingly digitized production environment. One of the commonly used algorithms in ML are Neural Networks (NNs), which find use in Supervised Learning, Unsupervised Learning and Reinforcement Learning. The main advantage of NNs is that they can be deployed in a multitude of ways, specifically optimized for their intended use cases.  
This report will provide an exemplary use-case for classifying welds in the domain of laser beam welding. This process can easily be applied to any other classification problem just by adapting a few variables. From a given set of data, multiple preprocessing and feature extraction steps are performed. This procedure follows the general KDD-process (Knowledge Discovery in Databases).  
The found features serve as decision bases for the algorithms to classify the welds as “OK” and “not OK”.

Business case:  
  
In more traditional welding operations, an electric arc is used to bind 2 metallic pieces by selectively melting the material on the two parts and letting it solidify afterwards. One of the disadvantages is that heat-spread during the welding process. Especially with highly conductive materials like copper. This is due to the relatively low power density in electronic arcs. To safely combine 2 materials, it can require a prolonged arc presence, that will heat up the entire parts. When it comes to welding overlapped sheets of material, it can happen that the upper sheet is already molten while the underlying material, due to its high thermal conductivity, is not. Additionally, it requires to have an electric circuit over the two parts to form the arc and start the welding process. This is a disadvantage when it comes to high volume welding operations as it has to be made sure that all connections are stable, and all current is flowing as intended every single time.

The production of battery packs is one of the areas where these disadvantages of arc welding make it very difficult to have a safe and efficient welding process. The welding of the copper conductors to the batteries would require a prolonged heat input that would damage the battery-cells. Additionally, it is not beneficial to expose the batteries to high electrical currents of voltages.

Laser-Beam welding (LBW) is one method that can work with these specific boundary conditions.

The power delivery is very high and leads to an almost instantaneous welding of both materials without conducting a lot of heat to the whole part. Besides that, no electric current is required, which is beneficial for welding battery conductors. By refocusing the beam to the desired position, a high rate of welds per minute can be achieved. As a high weld rate is expected, LBW is one of the favorite methods in battery production.

For validating the welding connection, sensors can record data during the welding process, which can serve as a basis to classify if the desired quality was achieved. The following sections explain how a set of data has to be analyzed and transformed to be used in the prediction process.