# Linear and Nonlinear Filters

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I. **Introduction** *Both*

1. Motivation: What problems prompts the use of filters? *(Unwanted noise, enhancement of image properties to extract information)*
2. General difference between Linear and Nonlinear Filters

II. **Linear Filters** *Jose*

1. Formal definition of Linear Filter *Mathematical formula/definition of a linear filter*
2. Types of Linear Filters: *Box, Gaussian, Derivative* General Formulas, implementation in code
3. Use Cases *Noise Removal, Edge Detection, Image Sharpening*
4. Convolution and Kernel *Matrix Operation, neighboring pixels, normalization, separable convolution* add implementation and code to show how matrices are used to pass pixels and transform them
5. Optimization of sigma values *How to determine the best sigma values, what factors come into play to determine those values, what makes the best result and metrics of 'best' result*

III. **Nonlinear Filters** *Alexander*

1. Formal Defintion of Nonlinear Filter
2. Types of Nonlinear Filters: *Median Filtering, MinFilter, MaxFilter, MeanShift Filter, CellularAutomaton*
3. Optimal Nonlinear Filtering *Kushner–Stratonovich filtering*
4. Typical use Cases *Noise Removal*

IV. **Testing and Analysis** *Both*

1. Methodology *(Image sets to be used, metrics of analysis to determine quality)*
2. Test scenarios *Noise Removal, Image Sharpening, Edge Detection, Median Filtering, Morphological Filtering*
3. Optimization of parameters based on each types of filter and how the optimization is determined.
4. Results based on test cases *(Graph, Data Table, etc)*
5. Tests limitations *What is and is not possible to be determined based on testing*
6. Results discussion

V. **Conclusion** *Both*

1. Pros and Cons of each Types of Filters *Is one filter objectively better? Do they work better for different scenarios?*
2. Limitations of Filtering
3. Further Analysis to be done *What can supplement Filters for further use cases in image processing*