gbsv Mini-Challenge 1

2025-02-21

In this mini-challenge, a profile of a country (Steckbrief) will be compiled in the form of experiments in foundations in image and signal processing to assess aspects of LO1-LO3. Each student will submit a unique solution with individual data and analysis. This means you will choose images and signals themed suitably for your selected country and the tasks assigned to you. Unless otherwise mentioned, existing libraries may be used. Provide the sources of your data and, if applicable, used code, tools or articles.   
  
Note: Certain tasks are kept open-ended. Set your own frame for the limitation or ask if the boundaries are not clear to you. As a rule of thumb one day should take you around 1.5h +/-30min per day. Appropriate data selection, pinpoint creativity, moderate diversity, and critical thinking are sought rather than extensive submissions.

## Version Individual Rhythm

- Conduct your MC according to your own schedule/rhythm  
- Mandatory check-ins (review meetings): as a rule of thumb this corresponds to one check-in per MC; if things don't go smooth the DS subject matter exper (Fachexpert:in) may request an extra one. Hence organize yourself to check-in early.  
- Register for the review with the DS subject matter expert via the Calendly link in Spaces.

## Version 15-Day Challenge

- Profit from regular feedback  
- Earn 1.5 bonus points per submitted day if you submit at least 12 days  
- Revisions are allowed until day 15 if changes are clearly highlighted in color

## Submission and Grading

- Submission are conducted via Microsoft Teams Assignments in the gbsv Teams  
- Submit HTML Export of your work and link to code and results incl. signals/images. Missing submission files give 0.1 grade penalty points.  
- Optional: submit your self-evaluation of the achieved grading criteria per submission (the self-assessments are not graded; they are a way to help you understand the criteria)  
- See grading criteria and information sheet on definitions related to grading

# 1.1. 1D Signals - Correlation

## Day 1: Auto-Correlation - Defining the Problem & Selecting the Signal

Themed to your country: Define a use case and a problem statement to recognize whether a 1D signal contains recurring patterns. WHAT (use case, problem statement, objectives) do you want to achieve and WHY? Find a suitable 1D signal that contains recurring patterns to analyze auto-correlation. Analyze the recurring patterns within your 1D signal using auto-correlation. In order to demonstrate your results, you may work on a selected part of your original signal. Start a new Notebook.

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### DD01: WHAT: Is the problem to be addressed/solved stated clearly and precisely?

□ No, there is no problem stated or it is imprecise or unclear. (0 point)

□ Yes, the problem was stated clearly and precisely. (0.5 point)

##### DD02: WHAT: Is the use case of the stated problems formulated clearly and precisely?

□ The use case was either not formulated at all or was unclear or imprecise. (0 point)

□ The use case was formulated clearly and precisely. (0.5 point)

##### DD03: WHAT: Were the objectives of the experiments described clearly and precisely?

□ The information on the objectives of the experiments is incomplete or imprecise. (0 point)

□ The objectives of the experiments are clearly and precisely described. (0.5 point)

##### DD04: WHY: Is it explained why the stated problem and the use case are addressed or relevant?

□ There is a lack of explanation as to why the problem and use case are addressed/relevant. (0 point)

□ It explains either why the problem or use case is addressed/relevant, but not both. (0.25 point)

□ It explains why both the problem and use case are addressed/relevant. (0.5 point)

##### DD05: Are the selected images/signals suitable for the assigned tasks?

□ No, the images/signals are not specially chosen to answer the assigned tasks. (0 point)

□ The images/signals chosen are suitable to demonstrate the assigned tasks. (1 point)

□ The images/signals chosen are particularly apt to demonstrate the assigned tasks. (3 points)

##### DD06: Were data sources referenced?

□ No (0 point)

□ Yes (0.5 point)

##### DD07: Was added value provided related to background information on the use case or problem statement?

□ Additonal background information is missing. (0 point)

□ Additional background information was provided. (1 point)

##### DD08: Was "own" data used? E.g. from a company, from holidays, a hobby, etc.

□ No, only public data was used. (0 point)

□ Own data was used. (1 point)

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

##### TC1.1c: Could the repetitive pattern be demonstrated via auto-correlation?

□ No (0 point)

□ Yes (3 points)

## Day 2: Auto-Correlation - Analyzing Results

Can the periodicity of your pattern be recognized via auto-correlogram? Visualize or quantify the results appropriately. Observe, interpret, and discuss your auto-correlation results including parameter choices in 1-3 sentences each.

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

##### TC04: Were the data or experiments quantitatively analyzed using code? E.g., using KPIs or curves.

□ No, calculated KPIs are missing. (0 point)

□ The calculated metrics are generic and not tailored to the use case. (1 point)

□ The calculated KPIs are selected and calculated to suit the use case. (3 points)

##### TC05: Were advanced methods used for the quantitative analysis?

□ No, standard quantitative methods were used. (0 point)

□ Yes, at least one advanced quantitative methods applied. (3 points)

##### TC1.1d: Was the periodicity of the pattern in the signal calculated?

□ No (0 point)

□ Yes (3 points)

##### AC01: Have observations of the results been written in a clear and precise way?

□ Observations are either missing or are unclear or imprecise. (0 point)

□ Clear and precise observations (e.g. a few bullet points or a few sentences) complement the results. (0.5 point)

##### AC02: Are the observations of the results use case oriented?

□ Observations are generic or missing. (0 point)

□ The noted observations are specifically targeted to the use case or problem statement. (0.5 point)

##### AC03: Have interpretations of the results been written in a clear and precise way?

□ Interpretations are either missing or are unclear or imprecise. (0 point)

□ Clear and precise interpretations (e.g. a few sentences) complement the results. (0.5 point)

##### AC04: Are the interpretations of the results use case oriented?

□ Interpretations are generic or missing. (0 point)

□ The found interpretations are specifically targeted to the use case or problem statement. (0.5 point)

##### AC05: Has a discussion of the results been written in a clear and precise way?

□ The discussion is either missing or is unclear or imprecise. (0 point)

□ A clear and precise discussion completes the results. (0.5 point)

##### AC06: Is the discussion use case oriented?

□ The discussion is generic or missing. (0 point)

□ The discussion are specifically targeted to the use case or problem statement. (0.5 point)

##### AC07: Does the discussion raise interesting aspects?

□ The discussion is rather a protocol of WHAT has been done HOW in what order. (0 point)

□ The discussion critically questions the results or elaborates on specific good/bad results or raises benefits or disadvantages of the applied methods. (0.5 point)

##### AC09: Was there a reasoning WHY WHICH parameters were chosen?

□ No, the reasons for the choice of parameters are missing. (0 point)

□ There are reasons for the choice of parameters. (0.5 point)

□ The choice of parameters is excellently reasoned and targeted towards the use case. (1 point)

##### AC12: Are there any visualizations that show the experiments carried out particularly well/accurately?

□ The visualizations are standard or not available. (0 point)

□ There are some particularly successful visualizations that demonstrate the experiments. (1 point)

##### AC14: Have the axes of the visualizations been labeled? (is graded once at end of one task for all days)

□ Some axis labels are missing (0 point)

□ The axis labels are complete for all variables (1 point)

## Day 3: Cross-Correlation - Defining a Use Case for Signal Detection

Define a problem statement and use case where it could be useful to detect a piece of your signal in the full signal (may be the same as before or a new one). Cut an interesting piece of your signal. Explain WHY you chose this piece? WHAT objective do you want to pursue by cutting this piece? Do you expect this piece to be found once or multiple times? WHY is it relevant for your problem statement/use case? Explain in a few sentences.

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### DD01: WHAT: Is the problem to be addressed/solved stated clearly and precisely?

□ No, there is no problem stated or it is imprecise or unclear. (0 point)

□ Yes, the problem was stated clearly and precisely. (0.5 point)

##### DD02: WHAT: Is the use case of the stated problems formulated clearly and precisely?

□ The use case was either not formulated at all or was unclear or imprecise. (0 point)

□ The use case was formulated clearly and precisely. (0.5 point)

##### DD03: WHAT: Were the objectives of the experiments described clearly and precisely?

□ The information on the objectives of the experiments is incomplete or imprecise. (0 point)

□ The objectives of the experiments are clearly and precisely described. (0.5 point)

##### DD04: WHY: Is it explained why the stated problem and the use case are addressed or relevant?

□ There is a lack of explanation as to why the problem and use case are addressed/relevant. (0 point)

□ It explains either why the problem or use case is addressed/relevant, but not both. (0.25 point)

□ It explains why both the problem and use case are addressed/relevant. (0.5 point)

##### DD05: Are the selected images/signals suitable for the assigned tasks?

□ No, the images/signals are not specially chosen to answer the assigned tasks. (0 point)

□ The images/signals chosen are suitable to demonstrate the assigned tasks. (1 point)

□ The images/signals chosen are particularly apt to demonstrate the assigned tasks. (3 points)

##### DD06: Were data sources referenced?

□ No (0 point)

□ Yes (0.5 point)

##### DD07: Was added value provided related to background information on the use case or problem statement?

□ Additonal background information is missing. (0 point)

□ Additional background information was provided. (1 point)

##### DD08: Was "own" data used? E.g. from a company, from holidays, a hobby, etc.

□ No, only public data was used. (0 point)

□ Own data was used. (1 point)

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

## Day 4: Cross-Correlation - Finding the Cut Piece

Try to find the cut piece via cross-correlation in the signal. In order to demonstrate your results, you may work on a selected part of your original signal. Visualize or quantify the results appropriately. How do you recognize that the position fits? Observe, interpret, and discuss in 2-3 sentences each.

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

##### TC04: Were the data or experiments quantitatively analyzed using code? E.g., using KPIs or curves.

□ No, calculated KPIs are missing. (0 point)

□ The calculated metrics are generic and not tailored to the use case. (1 point)

□ The calculated KPIs are selected and calculated to suit the use case. (3 points)

##### TC05: Were advanced methods used for the quantitative analysis?

□ No, standard quantitative methods were used. (0 point)

□ Yes, at least one advanced quantitative methods applied. (3 points)

##### TC1.1e: Was the extracted piece of data found via cross-correlation?

□ No (0 point)

□ Yes (3 points)

##### AC01: Have observations of the results been written in a clear and precise way?

□ Observations are either missing or are unclear or imprecise. (0 point)

□ Clear and precise observations (e.g. a few bullet points or a few sentences) complement the results. (0.5 point)

##### AC02: Are the observations of the results use case oriented?

□ Observations are generic or missing. (0 point)

□ The noted observations are specifically targeted to the use case or problem statement. (0.5 point)

##### AC03: Have interpretations of the results been written in a clear and precise way?

□ Interpretations are either missing or are unclear or imprecise. (0 point)

□ Clear and precise interpretations (e.g. a few sentences) complement the results. (0.5 point)

##### AC04: Are the interpretations of the results use case oriented?

□ Interpretations are generic or missing. (0 point)

□ The found interpretations are specifically targeted to the use case or problem statement. (0.5 point)

##### AC05: Has a discussion of the results been written in a clear and precise way?

□ The discussion is either missing or is unclear or imprecise. (0 point)

□ A clear and precise discussion completes the results. (0.5 point)

##### AC06: Is the discussion use case oriented?

□ The discussion is generic or missing. (0 point)

□ The discussion are specifically targeted to the use case or problem statement. (0.5 point)

##### AC07: Does the discussion raise interesting aspects?

□ The discussion is rather a protocol of WHAT has been done HOW in what order. (0 point)

□ The discussion critically questions the results or elaborates on specific good/bad results or raises benefits or disadvantages of the applied methods. (0.5 point)

##### AC09: Was there a reasoning WHY WHICH parameters were chosen?

□ No, the reasons for the choice of parameters are missing. (0 point)

□ There are reasons for the choice of parameters. (0.5 point)

□ The choice of parameters is excellently reasoned and targeted towards the use case. (1 point)

##### AC12: Are there any visualizations that show the experiments carried out particularly well/accurately?

□ The visualizations are standard or not available. (0 point)

□ There are some particularly successful visualizations that demonstrate the experiments. (1 point)

##### AC14: Have the axes of the visualizations been labeled? (is graded once at end of one task for all days)

□ Some axis labels are missing (0 point)

□ The axis labels are complete for all variables (1 point)

## Day 5: Cross-Correlation - Applying Changes to the Signal

What types of changes could you apply to your signal to test whether the cut piece can still be found? Name the 1-2 most important changes that fit your use case. Explain in 1-2 sentences why exactly these changes are relevant. Change your cut piece accordingly with 1-2 transformations.

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### TC1.1f: How suitable are the planned robustness experiments?

□ There are no experiments on robustness described (0 point)

□ There are generic experiments to test robustness described (1 point)

□ The robustness testing experiments described are particularly relevant to use case or problem statement (2 points)

##### TC1.1g: Were the data transformations to test the robustness applied correctly?

□ No, there were errors or no data transformations applied (0 point)

□ 1 appropriate transformations was applied (1 point)

□ 2+ appropriate transformations were applied (2 points)

##### AC05: Has a discussion of the results been written in a clear and precise way?

□ The discussion is either missing or is unclear or imprecise. (0 point)

□ A clear and precise discussion completes the results. (0.5 point)

##### AC06: Is the discussion use case oriented?

□ The discussion is generic or missing. (0 point)

□ The discussion are specifically targeted to the use case or problem statement. (0.5 point)

##### AC07: Does the discussion raise interesting aspects?

□ The discussion is rather a protocol of WHAT has been done HOW in what order. (0 point)

□ The discussion critically questions the results or elaborates on specific good/bad results or raises benefits or disadvantages of the applied methods. (0.5 point)

##### AC08: Was there a reasoning WHY WHICH methods were chosen?

□ No, there is no reasoning for the choice of methods. (0 point)

□ There are reasons for the choice of methods. (0.5 point)

□ The choice of methods is excellently reasoned and targeted towards the use case. (1 point)

##### AC14: Have the axes of the visualizations been labeled? (is graded once at end of one task for all days)

□ Some axis labels are missing (0 point)

□ The axis labels are complete for all variables (1 point)

## Day 6: Cross-Correlation - Testing on the Modified Signal

Check whether the piece can still be found via cross-correlation in the modified 1D signal. Visualize or quantify the results appropriately.

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

##### TC03: Were interesting intermediate steps demonstrated?

□ No. (0 point)

□ Yes. (3 points)

##### TC04: Were the data or experiments quantitatively analyzed using code? E.g., using KPIs or curves.

□ No, calculated KPIs are missing. (0 point)

□ The calculated metrics are generic and not tailored to the use case. (1 point)

□ The calculated KPIs are selected and calculated to suit the use case. (3 points)

##### TC05: Were advanced methods used for the quantitative analysis?

□ No, standard quantitative methods were used. (0 point)

□ Yes, at least one advanced quantitative methods applied. (3 points)

##### TC1.1h: How suitable were the robustness experiments of the cross-correlation?

□ There were no experiments conducted on robustness (0 point)

□ There are generic experiments conducted to test robustness (1 point)

□ The robustness testing experiments conducted are particularly relevant to use case or problem statement (3 points)

##### TC1.1i: Were advanced procedures used to test the robustness of the cross-correlation?

□ No (0 point)

□ Yes, at least one procedure was advanced. (3 points)

##### TC1.1k: Was it demonstrated what to what degree transformations are tolerated?

□ No (0 point)

□ It was demonstrated to what degree the transformations are tolerated or not. (3 points)

##### AC14: Have the axes of the visualizations been labeled? (is graded once at end of one task for all days)

□ Some axis labels are missing (0 point)

□ The axis labels are complete for all variables (1 point)

## Day 7: Cross-Correlation - Discussion and Interpretation

Discuss your choice of methods and parameters in 1-2 sentences each. Observe, interpret, and discuss your results in 2-3 sentences each in relation to your problem statement/use case. What types of changes are tolerated? Which ones are not?

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

##### AC01: Have observations of the results been written in a clear and precise way?

□ Observations are either missing or are unclear or imprecise. (0 point)

□ Clear and precise observations (e.g. a few bullet points or a few sentences) complement the results. (0.5 point)

##### AC02: Are the observations of the results use case oriented?

□ Observations are generic or missing. (0 point)

□ The noted observations are specifically targeted to the use case or problem statement. (0.5 point)

##### AC03: Have interpretations of the results been written in a clear and precise way?

□ Interpretations are either missing or are unclear or imprecise. (0 point)

□ Clear and precise interpretations (e.g. a few sentences) complement the results. (0.5 point)

##### AC04: Are the interpretations of the results use case oriented?

□ Interpretations are generic or missing. (0 point)

□ The found interpretations are specifically targeted to the use case or problem statement. (0.5 point)

##### AC05: Has a discussion of the results been written in a clear and precise way?

□ The discussion is either missing or is unclear or imprecise. (0 point)

□ A clear and precise discussion completes the results. (0.5 point)

##### AC06: Is the discussion use case oriented?

□ The discussion is generic or missing. (0 point)

□ The discussion are specifically targeted to the use case or problem statement. (0.5 point)

##### AC07: Does the discussion raise interesting aspects?

□ The discussion is rather a protocol of WHAT has been done HOW in what order. (0 point)

□ The discussion critically questions the results or elaborates on specific good/bad results or raises benefits or disadvantages of the applied methods. (0.5 point)

##### AC08: Was there a reasoning WHY WHICH methods were chosen?

□ No, there is no reasoning for the choice of methods. (0 point)

□ There are reasons for the choice of methods. (0.5 point)

□ The choice of methods is excellently reasoned and targeted towards the use case. (1 point)

##### AC09: Was there a reasoning WHY WHICH parameters were chosen?

□ No, the reasons for the choice of parameters are missing. (0 point)

□ There are reasons for the choice of parameters. (0.5 point)

□ The choice of parameters is excellently reasoned and targeted towards the use case. (1 point)

##### AC10: How is the choice of metric reasoned?

□ Metrics are used without reasoning why. (0 point)

□ The choice of metrics is usually reasoned. (0.5 point)

□ The choice of metrics is excellently reasoned and targeted towards the use case. (1 point)

##### AC11: The visualizations are accompanied by statistical key performance indicators (KPIs, Kennzahlen). E.g. mean, median, std, ...

□ No, there is no systematic evaluation of the KPIs for the visualizations. (0 point)

□ KPIs for the visualizations are occasionally provided. (0.5 point)

□ KPIs for the visualizations are systematically provided. (1 point)

##### AC12: Are there any visualizations that show the experiments carried out particularly well/accurately?

□ The visualizations are standard or not available. (0 point)

□ There are some particularly successful visualizations that demonstrate the experiments. (1 point)

##### AC13: In what form was the profile (Steckbrief) themed to the selected country? (is graded once at end of one task for all days)

□ There is little or no connection between the country and the selected data. (0 point)

□ The data was chosen to fit a country, but an overarching context is missing. (1 point)

□ It is a profile of a country with a personal touch. (2 points)

□ Extremely excellent profile, e.g. through story telling or other valuable information. (3 points)

##### AC15: Were resources such as tools, links referenced (is graded once at end of one task for all days)?

□ No (0 point)

□ Yes (0.5 point)

##### AC16: Were resources related to advanced methods referenced (e.g., article)? (is graded once at end of one task for all days)

□ No (0 point)

□ Yes (0.5 point)

# 1.2. 1D Signals or 2D Images: Convolution - Filtering in the Spatial Domain

## Day 8: Convolution - Implementing a Filtering Algorithm

Implement a classic algorithm for filtering either a signal (1D) or image (2D) in the spatial domain (windowing, convolution). What elements should such an algorithm contain? Start a new Notebook.

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

##### TC1.2a: Was the convolution correctly implemented?

□ Convolution was not implemented or libraries were used instead. Or the implementation was wrong. (0 point)

□ The convolution is a suitable own implementation in 1D or 2D. (2 points)

□ The convolution is a suitable own implementation in 1D or 2D including the relevant elements. (5 points)

## Day 9: Convolution - Kernels

Test your function with a signal or an image related to your country with 1-2 suitable convolution kernel(s) of appropriate size. You may reuse data from before or choose a new signal/image. In order to demonstrate your results, you may work on a selected part of your original signal. What problem do you want to address/solve for which use case (WHAT and WHY)? Visualize and quantify. Discuss the choice of methods (kernels) and parameters.

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### DD01: WHAT: Is the problem to be addressed/solved stated clearly and precisely?

□ No, there is no problem stated or it is imprecise or unclear. (0 point)

□ Yes, the problem was stated clearly and precisely. (0.5 point)

##### DD02: WHAT: Is the use case of the stated problems formulated clearly and precisely?

□ The use case was either not formulated at all or was unclear or imprecise. (0 point)

□ The use case was formulated clearly and precisely. (0.5 point)

##### DD03: WHAT: Were the objectives of the experiments described clearly and precisely?

□ The information on the objectives of the experiments is incomplete or imprecise. (0 point)

□ The objectives of the experiments are clearly and precisely described. (0.5 point)

##### DD04: WHY: Is it explained why the stated problem and the use case are addressed or relevant?

□ There is a lack of explanation as to why the problem and use case are addressed/relevant. (0 point)

□ It explains either why the problem or use case is addressed/relevant, but not both. (0.25 point)

□ It explains why both the problem and use case are addressed/relevant. (0.5 point)

##### DD05: Are the selected images/signals suitable for the assigned tasks?

□ No, the images/signals are not specially chosen to answer the assigned tasks. (0 point)

□ The images/signals chosen are suitable to demonstrate the assigned tasks. (1 point)

□ The images/signals chosen are particularly apt to demonstrate the assigned tasks. (3 points)

##### DD06: Were data sources referenced?

□ No (0 point)

□ Yes (0.5 point)

##### DD07: Was added value provided related to background information on the use case or problem statement?

□ Additonal background information is missing. (0 point)

□ Additional background information was provided. (1 point)

##### DD08: Was "own" data used? E.g. from a company, from holidays, a hobby, etc.

□ No, only public data was used. (0 point)

□ Own data was used. (1 point)

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

##### TC1.2b: Were the convolution filters created correctly for the given tasks? In 1D or in 2D.

□ The filters have either not been defined or were not applied to data. (0 point)

□ 1 suitable filter was chosen and applied to the data. (1 point)

□ 2+ suitable filters were chosen and applied to the data. (2 points)

##### TC1.2c: Were the convolution filters for the given task applied to a suitable use case?

□ The use case for the filter is not given. (0 point)

□ Suitable filters were chosen and applied to data fitting the given tasks. (1 point)

□ Suitable filters were chosen and applied to data fitting the given tasks and defined use case well. (2 points)

##### TC1.2d: Were advanced filters used?

□ No, standard filters were used. (0 point)

□ At least one advanced filter was used. (3 points)

##### TC1.2e: Have different filter parameters been compared?

□ No, only one filter with the same parameters was used. (0 point)

□ 2+ variations of filter parameters were compared. (1 point)

##### TC1.2f: Have different filters for the same task been compared?

□ No, only one filter was used. (0 point)

□ 2+ filters for the same task were compared. (1 point)

##### AC08: Was there a reasoning WHY WHICH methods were chosen?

□ No, there is no reasoning for the choice of methods. (0 point)

□ There are reasons for the choice of methods. (0.5 point)

□ The choice of methods is excellently reasoned and targeted towards the use case. (1 point)

##### AC09: Was there a reasoning WHY WHICH parameters were chosen?

□ No, the reasons for the choice of parameters are missing. (0 point)

□ There are reasons for the choice of parameters. (0.5 point)

□ The choice of parameters is excellently reasoned and targeted towards the use case. (1 point)

##### AC12: Are there any visualizations that show the experiments carried out particularly well/accurately?

□ The visualizations are standard or not available. (0 point)

□ There are some particularly successful visualizations that demonstrate the experiments. (1 point)

##### AC14: Have the axes of the visualizations been labeled? (is graded once at end of one task for all days)

□ Some axis labels are missing (0 point)

□ The axis labels are complete for all variables (1 point)

## Day 10: Convolution - Measuring Differences Before and After Filtering

Measure the differences in your data before and after filtering using a quantitative method. Choose specific methods that are particularly suitable for your use case. Visualize and quantify. Discuss the choice of quantitative analysis and chosen parameters.

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

##### TC03: Were interesting intermediate steps demonstrated?

□ No. (0 point)

□ Yes. (3 points)

##### TC04: Were the data or experiments quantitatively analyzed using code? E.g., using KPIs or curves.

□ No, calculated KPIs are missing. (0 point)

□ The calculated metrics are generic and not tailored to the use case. (1 point)

□ The calculated KPIs are selected and calculated to suit the use case. (3 points)

##### TC05: Were advanced methods used for the quantitative analysis?

□ No, standard quantitative methods were used. (0 point)

□ Yes, at least one advanced quantitative methods applied. (3 points)

##### AC08: Was there a reasoning WHY WHICH methods were chosen?

□ No, there is no reasoning for the choice of methods. (0 point)

□ There are reasons for the choice of methods. (0.5 point)

□ The choice of methods is excellently reasoned and targeted towards the use case. (1 point)

##### AC09: Was there a reasoning WHY WHICH parameters were chosen?

□ No, the reasons for the choice of parameters are missing. (0 point)

□ There are reasons for the choice of parameters. (0.5 point)

□ The choice of parameters is excellently reasoned and targeted towards the use case. (1 point)

##### AC10: How is the choice of metric reasoned?

□ Metrics are used without reasoning why. (0 point)

□ The choice of metrics is usually reasoned. (0.5 point)

□ The choice of metrics is excellently reasoned and targeted towards the use case. (1 point)

##### AC11: The visualizations are accompanied by statistical key performance indicators (KPIs, Kennzahlen). E.g. mean, median, std, ...

□ No, there is no systematic evaluation of the KPIs for the visualizations. (0 point)

□ KPIs for the visualizations are occasionally provided. (0.5 point)

□ KPIs for the visualizations are systematically provided. (1 point)

##### AC12: Are there any visualizations that show the experiments carried out particularly well/accurately?

□ The visualizations are standard or not available. (0 point)

□ There are some particularly successful visualizations that demonstrate the experiments. (1 point)

##### AC14: Have the axes of the visualizations been labeled? (is graded once at end of one task for all days)

□ Some axis labels are missing (0 point)

□ The axis labels are complete for all variables (1 point)

## Day 11: Deconvolution - Implementing and Evaluating

Implement now the corresponding deconvolution operation and apply it to your data with one filter kernel with suitable parameters. Compare the original data with the reconstructed one. Visualize or quantify. For WHAT and WHY could the deconvolution be useful in your use case?

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### DD01: WHAT: Is the problem to be addressed/solved stated clearly and precisely?

□ No, there is no problem stated or it is imprecise or unclear. (0 point)

□ Yes, the problem was stated clearly and precisely. (0.5 point)

##### DD02: WHAT: Is the use case of the stated problems formulated clearly and precisely?

□ The use case was either not formulated at all or was unclear or imprecise. (0 point)

□ The use case was formulated clearly and precisely. (0.5 point)

##### DD03: WHAT: Were the objectives of the experiments described clearly and precisely?

□ The information on the objectives of the experiments is incomplete or imprecise. (0 point)

□ The objectives of the experiments are clearly and precisely described. (0.5 point)

##### DD04: WHY: Is it explained why the stated problem and the use case are addressed or relevant?

□ There is a lack of explanation as to why the problem and use case are addressed/relevant. (0 point)

□ It explains either why the problem or use case is addressed/relevant, but not both. (0.25 point)

□ It explains why both the problem and use case are addressed/relevant. (0.5 point)

##### DD07: Was added value provided related to background information on the use case or problem statement?

□ Additonal background information is missing. (0 point)

□ Additional background information was provided. (1 point)

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

##### TC03: Were interesting intermediate steps demonstrated?

□ No. (0 point)

□ Yes. (3 points)

##### TC04: Were the data or experiments quantitatively analyzed using code? E.g., using KPIs or curves.

□ No, calculated KPIs are missing. (0 point)

□ The calculated metrics are generic and not tailored to the use case. (1 point)

□ The calculated KPIs are selected and calculated to suit the use case. (3 points)

##### TC05: Were advanced methods used for the quantitative analysis?

□ No, standard quantitative methods were used. (0 point)

□ Yes, at least one advanced quantitative methods applied. (3 points)

##### TC1.2g: Was the deconvolution correctly implemented?

□ The deconvolution was not implemented or libraries were used instead. Or the implementation was wrong. (0 point)

□ The deconvolution is a suitable own implementation in 1D or 2D. (2 points)

□ The deconvolution is a suitable own implementation in 1D or 2D including the relevant elements. (5 points)

## Day 12: Convolution/Deconvolution - Discussion

Observe, interpret, and discuss your convolution and deconvolution results in 1-3 sentences each in relation to your problem statement and use case. What worked well vs. bad?

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

##### AC01: Have observations of the results been written in a clear and precise way?

□ Observations are either missing or are unclear or imprecise. (0 point)

□ Clear and precise observations (e.g. a few bullet points or a few sentences) complement the results. (0.5 point)

##### AC02: Are the observations of the results use case oriented?

□ Observations are generic or missing. (0 point)

□ The noted observations are specifically targeted to the use case or problem statement. (0.5 point)

##### AC03: Have interpretations of the results been written in a clear and precise way?

□ Interpretations are either missing or are unclear or imprecise. (0 point)

□ Clear and precise interpretations (e.g. a few sentences) complement the results. (0.5 point)

##### AC04: Are the interpretations of the results use case oriented?

□ Interpretations are generic or missing. (0 point)

□ The found interpretations are specifically targeted to the use case or problem statement. (0.5 point)

##### AC05: Has a discussion of the results been written in a clear and precise way?

□ The discussion is either missing or is unclear or imprecise. (0 point)

□ A clear and precise discussion completes the results. (0.5 point)

##### AC06: Is the discussion use case oriented?

□ The discussion is generic or missing. (0 point)

□ The discussion are specifically targeted to the use case or problem statement. (0.5 point)

##### AC07: Does the discussion raise interesting aspects?

□ The discussion is rather a protocol of WHAT has been done HOW in what order. (0 point)

□ The discussion critically questions the results or elaborates on specific good/bad results or raises benefits or disadvantages of the applied methods. (0.5 point)

##### AC09: Was there a reasoning WHY WHICH parameters were chosen?

□ No, the reasons for the choice of parameters are missing. (0 point)

□ There are reasons for the choice of parameters. (0.5 point)

□ The choice of parameters is excellently reasoned and targeted towards the use case. (1 point)

##### AC10: How is the choice of metric reasoned?

□ Metrics are used without reasoning why. (0 point)

□ The choice of metrics is usually reasoned. (0.5 point)

□ The choice of metrics is excellently reasoned and targeted towards the use case. (1 point)

##### AC11: The visualizations are accompanied by statistical key performance indicators (KPIs, Kennzahlen). E.g. mean, median, std, ...

□ No, there is no systematic evaluation of the KPIs for the visualizations. (0 point)

□ KPIs for the visualizations are occasionally provided. (0.5 point)

□ KPIs for the visualizations are systematically provided. (1 point)

##### AC12: Are there any visualizations that show the experiments carried out particularly well/accurately?

□ The visualizations are standard or not available. (0 point)

□ There are some particularly successful visualizations that demonstrate the experiments. (1 point)

##### AC13: In what form was the profile (Steckbrief) themed to the selected country? (is graded once at end of one task for all days)

□ There is little or no connection between the country and the selected data. (0 point)

□ The data was chosen to fit a country, but an overarching context is missing. (1 point)

□ It is a profile of a country with a personal touch. (2 points)

□ Extremely excellent profile, e.g. through story telling or other valuable information. (3 points)

##### AC15: Were resources such as tools, links referenced (is graded once at end of one task for all days)?

□ No (0 point)

□ Yes (0.5 point)

##### AC16: Were resources related to advanced methods referenced (e.g., article)? (is graded once at end of one task for all days)

□ No (0 point)

□ Yes (0.5 point)

# 1.3. 1D Signals: Nyquist-Shannon Sampling Theorem

## Day 13: Nyquist-Shannon Sampling Theorem - Understanding

Find a use case/problem statement themed to your country of choice where the Nyquist-Shannon sampling theorem is relevant. Describe WHAT the Nyquist rate and Nyquist frequency mean in the context of your use case and WHY they need to be considered. Choose a sample 1D signal (may be the same as before or a new one). Calculate the Nyquist rate and the Nyquist frequency theoretically according to your use case/problem statement with the data-specific (target) sampling rates. Comment on your expectations in 1-2 sentences. Start a new Notebook.

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### DD01: WHAT: Is the problem to be addressed/solved stated clearly and precisely?

□ No, there is no problem stated or it is imprecise or unclear. (0 point)

□ Yes, the problem was stated clearly and precisely. (0.5 point)

##### DD02: WHAT: Is the use case of the stated problems formulated clearly and precisely?

□ The use case was either not formulated at all or was unclear or imprecise. (0 point)

□ The use case was formulated clearly and precisely. (0.5 point)

##### DD03: WHAT: Were the objectives of the experiments described clearly and precisely?

□ The information on the objectives of the experiments is incomplete or imprecise. (0 point)

□ The objectives of the experiments are clearly and precisely described. (0.5 point)

##### DD04: WHY: Is it explained why the stated problem and the use case are addressed or relevant?

□ There is a lack of explanation as to why the problem and use case are addressed/relevant. (0 point)

□ It explains either why the problem or use case is addressed/relevant, but not both. (0.25 point)

□ It explains why both the problem and use case are addressed/relevant. (0.5 point)

##### DD05: Are the selected images/signals suitable for the assigned tasks?

□ No, the images/signals are not specially chosen to answer the assigned tasks. (0 point)

□ The images/signals chosen are suitable to demonstrate the assigned tasks. (1 point)

□ The images/signals chosen are particularly apt to demonstrate the assigned tasks. (3 points)

##### DD06: Were data sources referenced?

□ No (0 point)

□ Yes (0.5 point)

##### DD07: Was added value provided related to background information on the use case or problem statement?

□ Additonal background information is missing. (0 point)

□ Additional background information was provided. (1 point)

##### DD08: Was "own" data used? E.g. from a company, from holidays, a hobby, etc.

□ No, only public data was used. (0 point)

□ Own data was used. (1 point)

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

##### TC05: Were advanced methods used for the quantitative analysis?

□ No, standard quantitative methods were used. (0 point)

□ Yes, at least one advanced quantitative methods applied. (3 points)

##### TC1.3a: Was the Nyquist rate properly calculated?

□ No suitable method was used. (0 point)

□ The Nyquist rate was calculated correctly. (1 point)

##### TC1.3b: Was the Nyquist frequency properly calculated?

□ No suitable method was used. (0 point)

□ The Nyquist frequency was calculated correctly. (1 point)

##### AC05: Has a discussion of the results been written in a clear and precise way?

□ The discussion is either missing or is unclear or imprecise. (0 point)

□ A clear and precise discussion completes the results. (0.5 point)

##### AC06: Is the discussion use case oriented?

□ The discussion is generic or missing. (0 point)

□ The discussion are specifically targeted to the use case or problem statement. (0.5 point)

##### AC07: Does the discussion raise interesting aspects?

□ The discussion is rather a protocol of WHAT has been done HOW in what order. (0 point)

□ The discussion critically questions the results or elaborates on specific good/bad results or raises benefits or disadvantages of the applied methods. (0.5 point)

## Day 14: Nyquist-Shannon Sampling Theorem - Demonstrating and Aliasing

Demonstrate either the Nyquist rate or frequency at suitable points in your chosen signal with appropriate methods, visualizations, etc. Show aliasing effects. Justify your choice of methods, parameters, and methods. Observe, interpret, and discuss your findings in relation to your use case in 1-2 sentences each.

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### TC02: Are the results tracable and all signals, visuals and images are integrated in the HTML. E.g., audios are playable, images are displayed

□ No, at least one thing was missing. (0 point)

□ Yes, the HTML displayed all relevant content to trace the solution. (0.5 point)

##### TC1.3c: Was the Nyquist rate or frequency demonstrated related to the use case?

□ No suitable method was used. (0 point)

□ The Nyquist rate or frequency was demonstrated using an appropriate method and a meaningful example. (2 points)

□ The Nyquist rate or frequency was demonstrated using an appropriate method and a meaningful example related to your use case. (4 points)

##### TC1.3d: Were aliasing effects related to the Nyquist–Shannon sampling theorem demonstrated?

□ No. (0 point)

□ Yes. (1 point)

##### AC01: Have observations of the results been written in a clear and precise way?

□ Observations are either missing or are unclear or imprecise. (0 point)

□ Clear and precise observations (e.g. a few bullet points or a few sentences) complement the results. (0.5 point)

##### AC02: Are the observations of the results use case oriented?

□ Observations are generic or missing. (0 point)

□ The noted observations are specifically targeted to the use case or problem statement. (0.5 point)

##### AC03: Have interpretations of the results been written in a clear and precise way?

□ Interpretations are either missing or are unclear or imprecise. (0 point)

□ Clear and precise interpretations (e.g. a few sentences) complement the results. (0.5 point)

##### AC04: Are the interpretations of the results use case oriented?

□ Interpretations are generic or missing. (0 point)

□ The found interpretations are specifically targeted to the use case or problem statement. (0.5 point)

##### AC05: Has a discussion of the results been written in a clear and precise way?

□ The discussion is either missing or is unclear or imprecise. (0 point)

□ A clear and precise discussion completes the results. (0.5 point)

##### AC06: Is the discussion use case oriented?

□ The discussion is generic or missing. (0 point)

□ The discussion are specifically targeted to the use case or problem statement. (0.5 point)

##### AC07: Does the discussion raise interesting aspects?

□ The discussion is rather a protocol of WHAT has been done HOW in what order. (0 point)

□ The discussion critically questions the results or elaborates on specific good/bad results or raises benefits or disadvantages of the applied methods. (0.5 point)

##### AC12: Are there any visualizations that show the experiments carried out particularly well/accurately?

□ The visualizations are standard or not available. (0 point)

□ There are some particularly successful visualizations that demonstrate the experiments. (1 point)

##### AC13: In what form was the profile (Steckbrief) themed to the selected country? (is graded once at end of one task for all days)

□ There is little or no connection between the country and the selected data. (0 point)

□ The data was chosen to fit a country, but an overarching context is missing. (1 point)

□ It is a profile of a country with a personal touch. (2 points)

□ Extremely excellent profile, e.g. through story telling or other valuable information. (3 points)

##### AC14: Have the axes of the visualizations been labeled? (is graded once at end of one task for all days)

□ Some axis labels are missing (0 point)

□ The axis labels are complete for all variables (1 point)

##### AC15: Were resources such as tools, links referenced (is graded once at end of one task for all days)?

□ No (0 point)

□ Yes (0.5 point)

##### AC16: Were resources related to advanced methods referenced (e.g., article)? (is graded once at end of one task for all days)

□ No (0 point)

□ Yes (0.5 point)

# 1.4. MC1 Reflection

## Day 15: Final Reflection on MC1

Write a reflection on the MC in approximately 150 words. What went well? What would you do differently? What impressed you? What did you learn?

### Grading Criteria

DD: data and domain; TC: technical competencies; AC: analysis and communication

##### AC17: Was a reflection on the MC conducted?

□ No (0 point)

□ Yes (3 points)