Title: **Distributed Acoustic Sensing Data Analysis**

Name: **Murad Ganbarli**

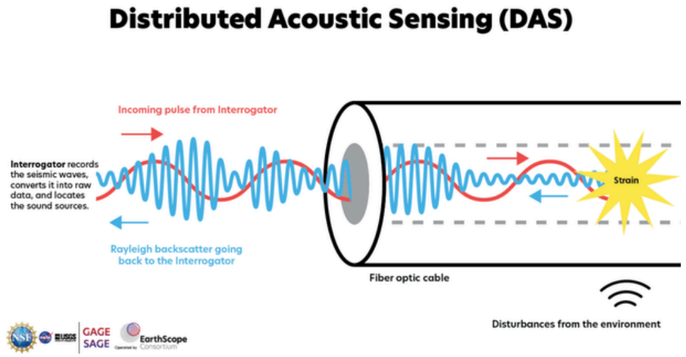
Date: **17.09.2024**

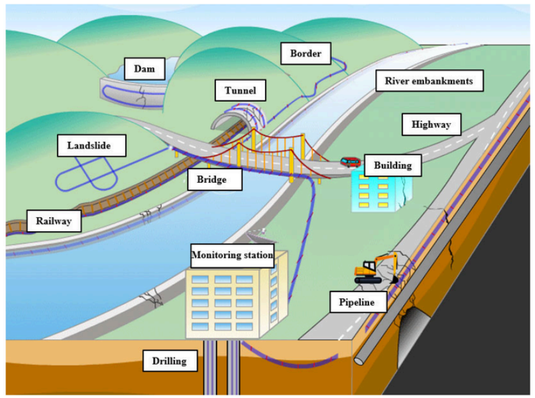
- Introduction to Distributed Acoustic Sensing (DAS)
- Purpose of the project
- Main objectives:
  1. Data observations and statistical analysis
  2. Edge and line detection
  3. Analysis of detected lines

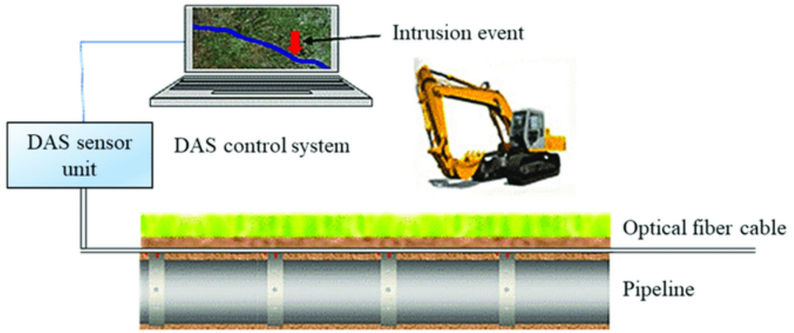
DAS uses fiber optic cables to detect acoustic signals

Applications:

- Pipeline monitoring
- Seismic activity detection
- Structural health monitoring





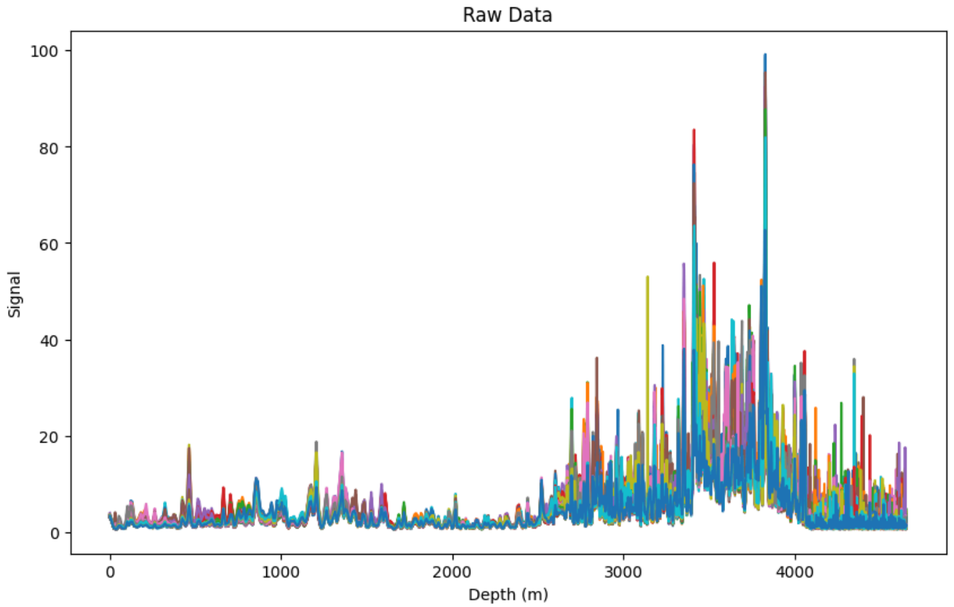


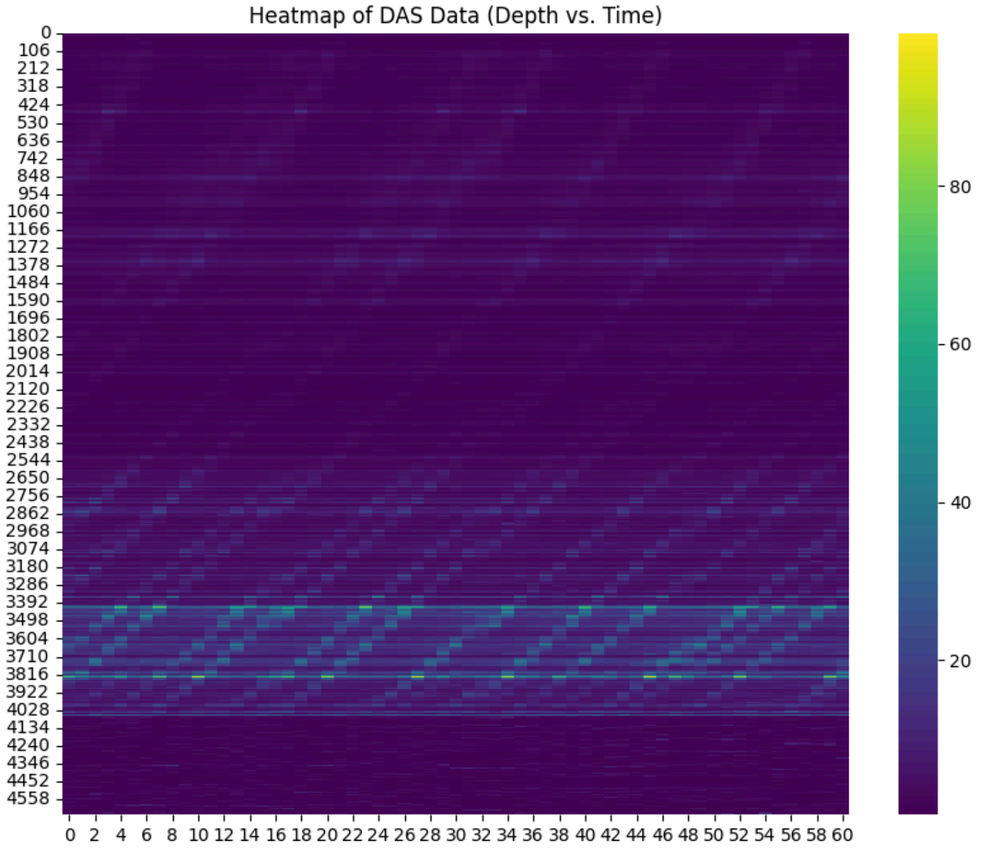
Dataset description:

- Spatial resolution: 1m
- Temporal resolution: 1 minute

Basic statistics:

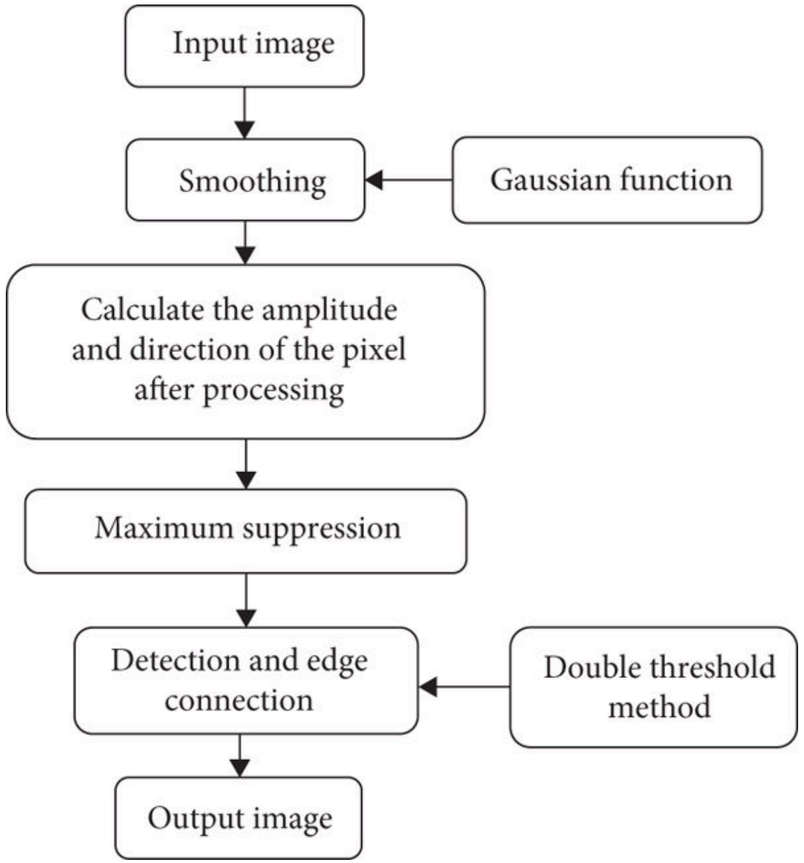
- signal values
- Heatmap of spatiotemporal data





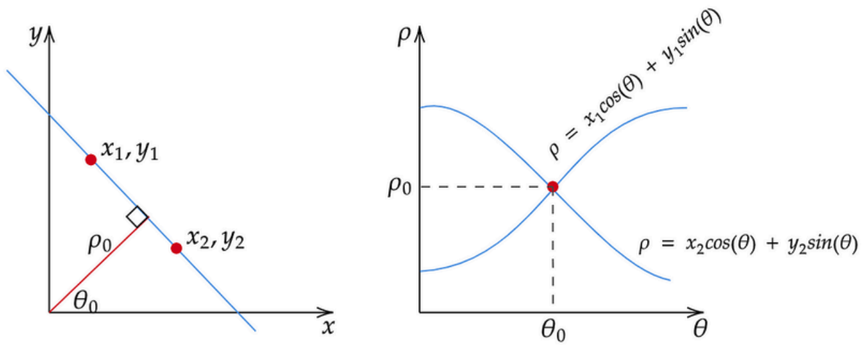
Edge detection using Canny algorithm

1. **Input Image**: The process begins with an input image that will undergo edge detection.
2. **Smoothing**: The image is smoothed using a **Gaussian function** to reduce noise and detail, making edge detection easier.
3. **Gradient Calculation**: After smoothing, the **amplitude and direction of the pixel gradient** are calculated, indicating the strength and direction of edges.
4. **Non-maximum Suppression**: The process reduces false edges by suppressing pixels that are not the maximum in their gradient direction, leaving only the strongest edges.
5. **Edge Detection**: The edges are finalized using a **double threshold method** to distinguish strong edges from weak ones, followed by edge connection, which outputs the final detected edges in the image.

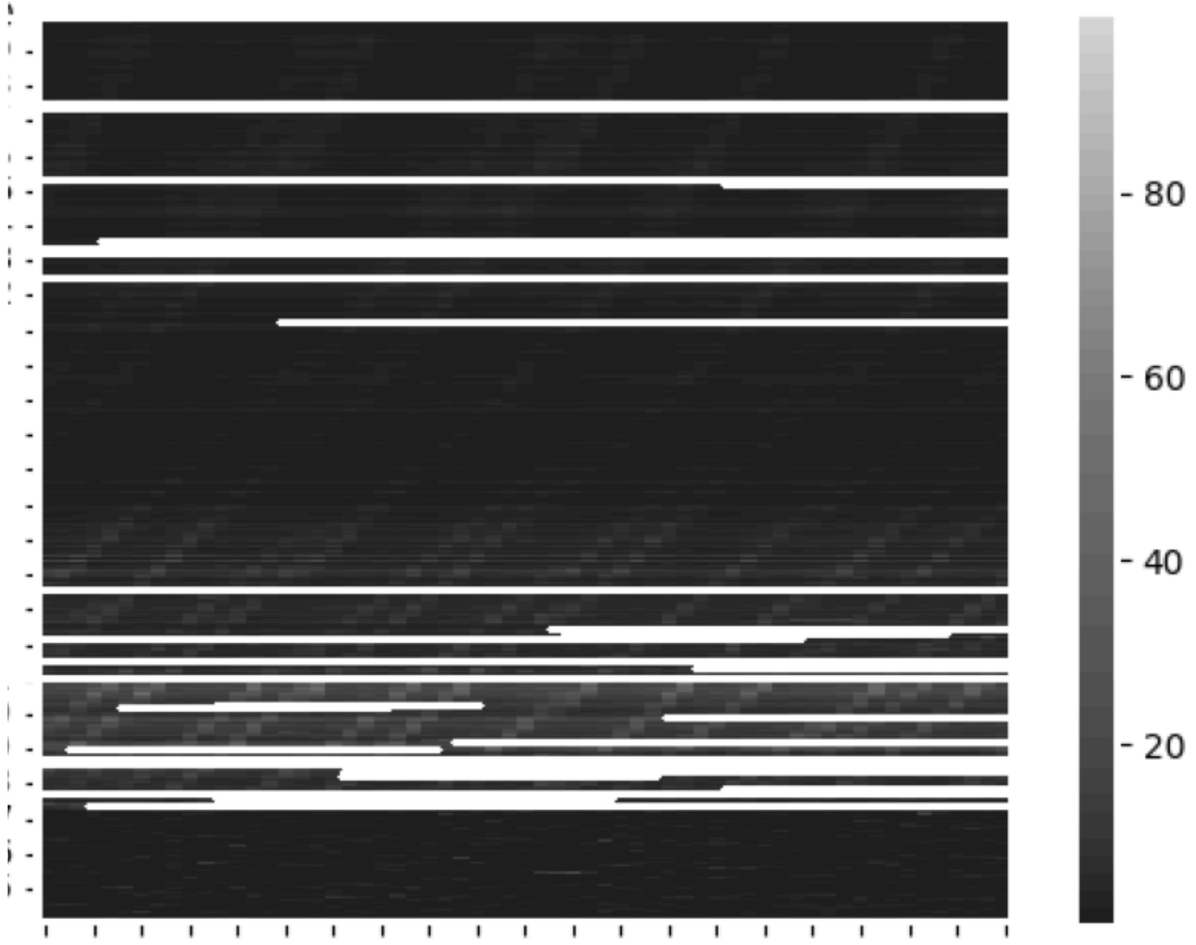


Line detection using Hough Line Transform

1. **Input Image**: The process starts with an edge-detected image (here from Canny edge detection).
2. **Hough Space Transformation**: Each edge point in the image is transformed into a set of possible lines in Hough space, represented by parameters (angle **θ** and distance **ρ**).
3. **Voting**: A voting mechanism is applied in Hough space where each potential line "votes" for corresponding parameters. Points that belong to the same line will accumulate votes.
4. **Peak Detection**: The points with the highest votes in Hough space correspond to the most likely lines in the original image.
5. **Line Extraction**: The lines are extracted from the original image based on the peaks detected in Hough space, giving the final detected lines.



Visualizations of detected lines



Limitations and Challenges:

- Noise in Data
- Parameter Tuning
- Complexity of Data

Future Work Suggestions:

1. Advanced Noise Reduction
2. machine learning-based denoising methods.
3. Algorithm Optimization
4. Feature Extraction
5. Integration with Other Data
6. Real-time Processing