Topics for Theses and Projects

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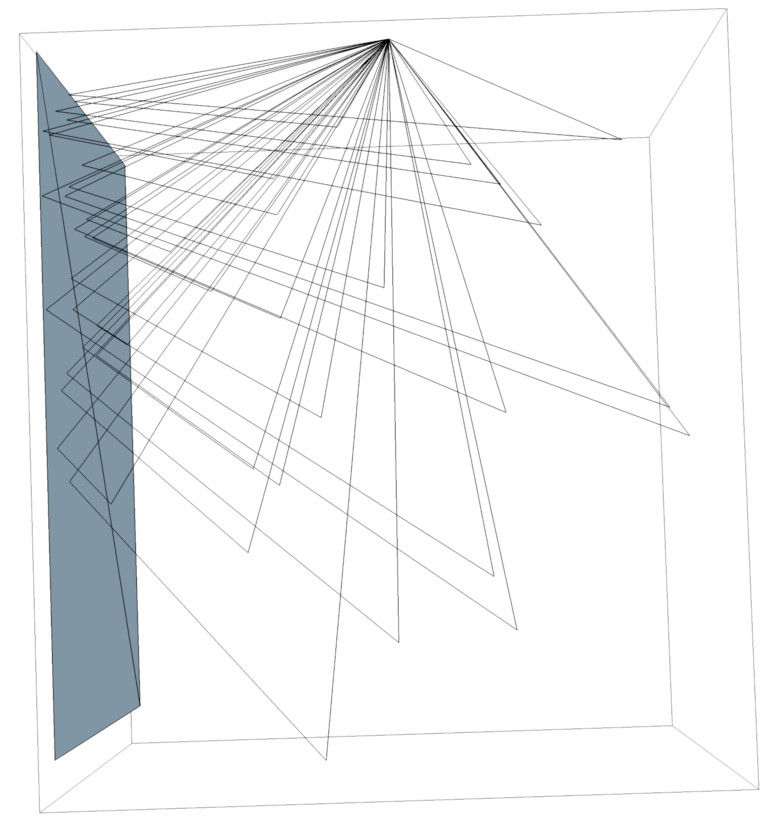
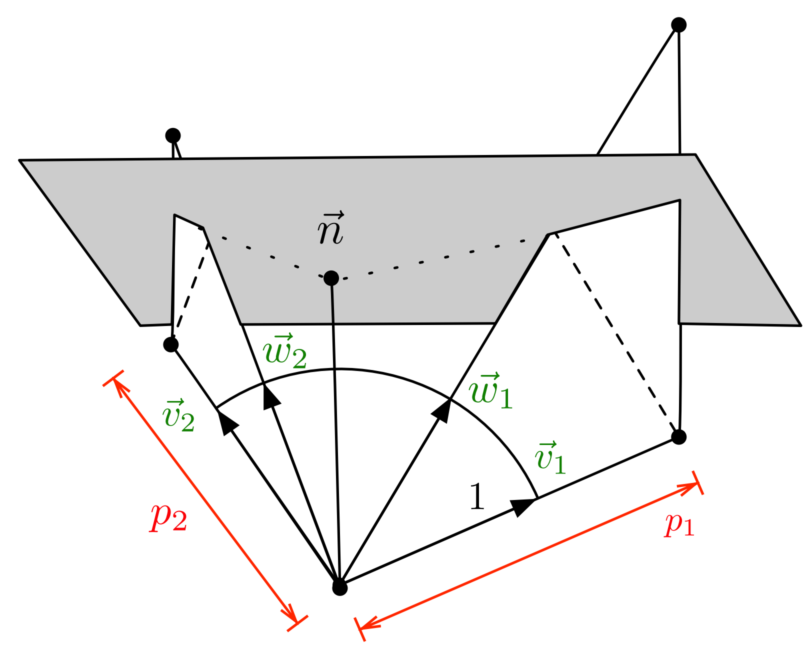
ILDARS

- Indoor-Localization using Directional and Reflected Sound Signals
  - Signal Processing
    - differentiate and detect reflected and LOS signal
  - System Integration
  - Algorithms
    - Learning Walls

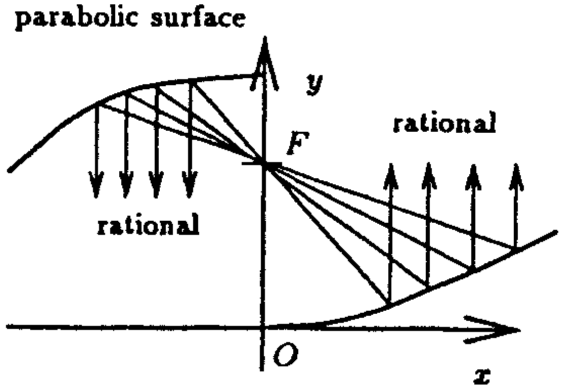


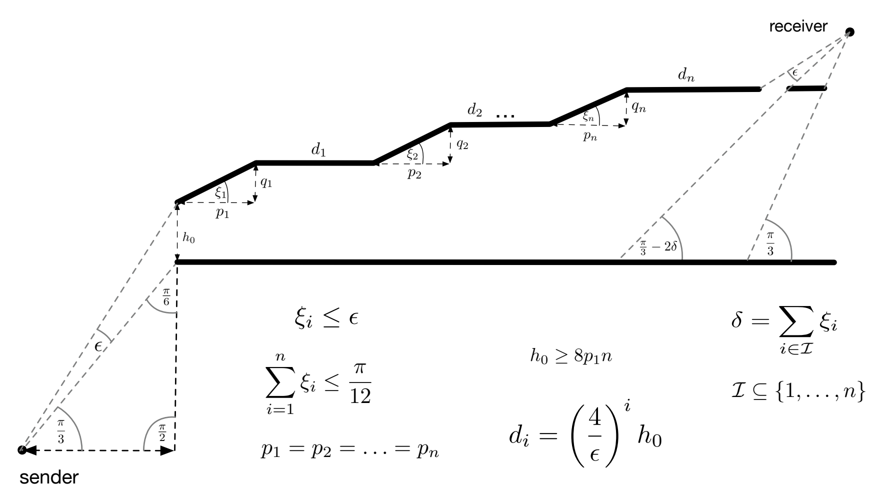


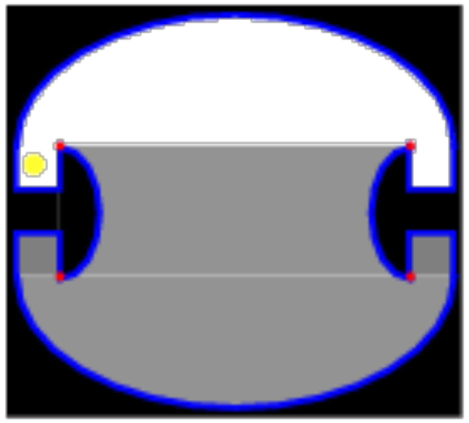
- Supervisors:
  - Christian Schindelhauer

Analyses of Multiple Reflections - The Illumination Problem - Brainy Bat

- Assumption
  - perfect ray model
- Given
  - senders and receivers of unknown position
  - walls/shapes of unknown position
- Compute
  - the relative positions
- Restraints
  - shapes (planes, spheres, cylinders)
  - number of reflections
  - 2D/3D
- Supervisors:
  - Sneha Mohanty, Christian Schindelhauer

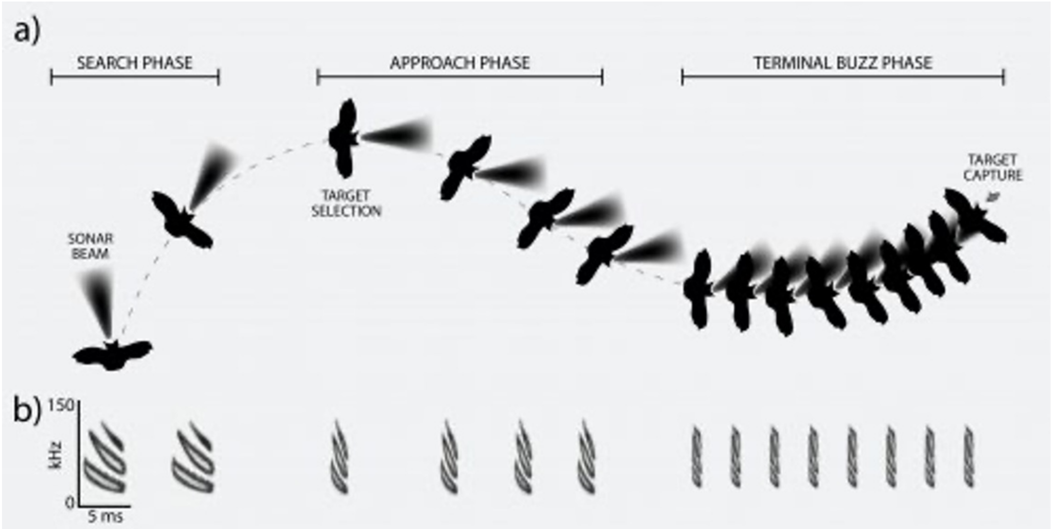






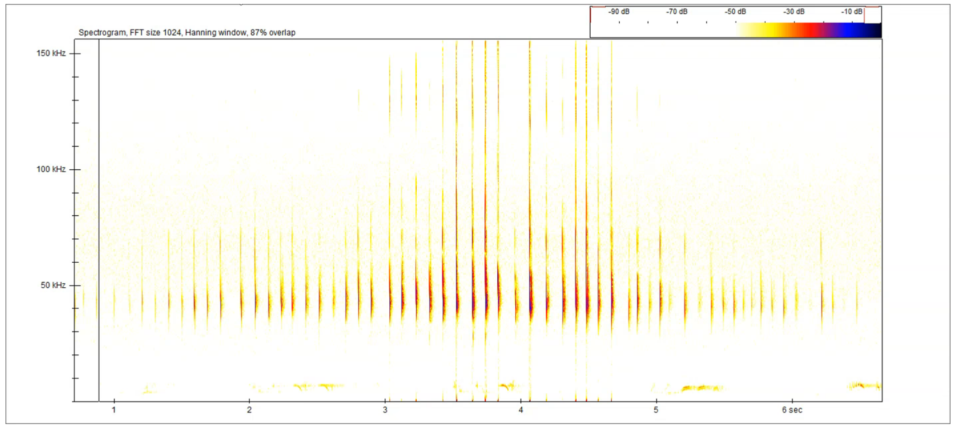
Master Lab Soundscape Ecology

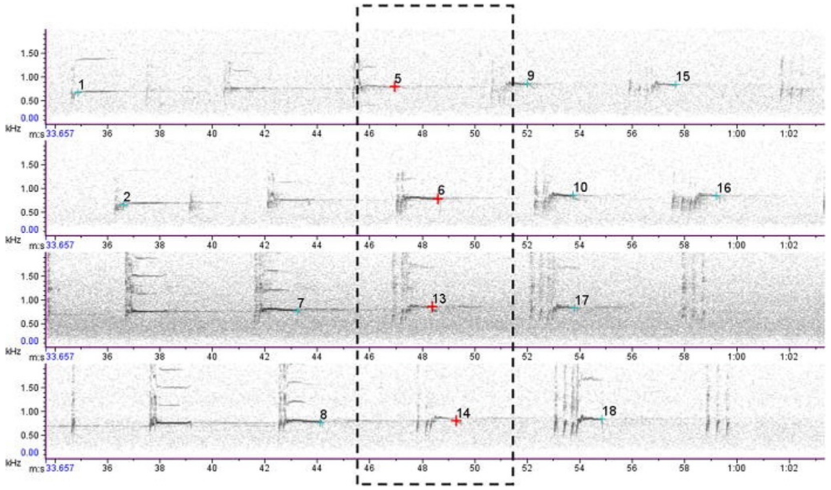
- Cooperation with Geobotany/Forest Science
- Computer science to improve current acoustic monitoring methods
- Supervisors:
  - Prof. Dr. Christian Schindelhauer
  - Dr. Johannes Wendeberg
  - Sneha Mohanty
- Schedule
  - April 2021- March 2022
  - Courses, practical field courses, jour fixe, campfire sessions



Master Lab Soundscape Ecology

- Possible projects
  - Soundscapes and bats
    what can we learn from ecoacoustic approaches for bat monitoring?
  - Developing methods and/or hardware for 3D-locating bats and other animals
  - Testing newly developed methods on spatial sound detection in the field.
  - Set up an array of autonomous recorders
    - Raspberry Pi nodes with audio recorder shield
- Develop your own!



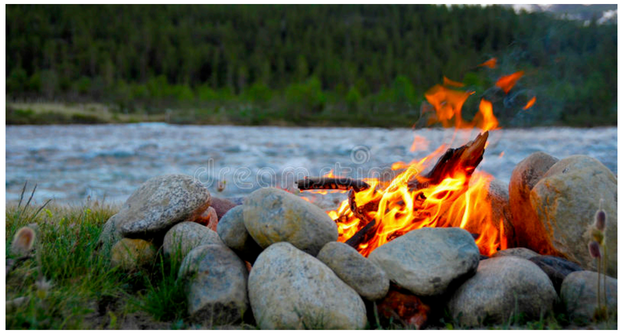


Master-Lab
Related Courses

- Basics of Soundscape Ecology and the functional role of sound in a landscape
  - 3 hour lecture
- Seminar (four sessions, half day each)
  - Students present their work to each other and give background of their discipline to the whole group.
- Practical Field Courses
  - 2 days practical in the field with researchers (PhD-students and Postdocs). Students broaden their experience and methods skills by accompanying scientists in the field.
- Spring Soundscape Ecology School, Eco- and Bioacoustic Methods
  - Workshop (5 days, online): handling of acoustic equipment, Sound Analysis in R, Sound Analysis and Call identification in Kaleidoscope, Basics in Programming in R for automatic classification of acoustic files.
  - Keynote presentations given by invited international experts in the field of soundscape ecology, bio- and ecoacoustics, acoustic and computer technologies, environmental monitoring, sociology and public health.
- Soundscape Ecology Campfire Sessions
  - Campfire Sessions (bi-monthly): Conversation and networking in an informal setting, outdoors.
- GRK Jour Fixe and Courses

Master Lab Soundscape Ecology Schedule

- April 2021
  - Kickoff-meeting: Welcome of Master Lab students. Introduction to the Research Topics and Courses.
  - Lecture: Basics of Soundscape Ecology and the functional role of sound in a landscape
  - Self-study phase: independent literature search, development of research questions and methods, meeting with co-students and mentors.
  - Seminar (Session 1): presentation of planned Research Projects.
  - Campfire Session: first Session to get to know each other.
- May – August 2021
  - Spring School Workshop (first week of May 2021): Soundscape Ecology, Eco- and Bioacoustic Methods.
  - Field and lab work: exact timing will depend on research question and phenology of target study species
  - Seminar (Session 2): Results from first pilot studies and literature review
  - GRK Jour Fixe and Campfire Sessions: ongoing
- September – December 2021
  - Self-study phase: Analysis of data, data interpretation; meeting with co-students and mentors
  - Seminar (Session 3): Discussion of results, feedback for further analyses and interpretation
  - GRK Jour Fixe and Campfire Sessions: ongoing
- January – February 2021
  - Self-study phase: Preparation of final report on the Research Project.
  - GRK Jour Fixe and Campfire Sessions: ongoing
- March 2022
  - Final meeting: Seminar (Session 4): Presentation of results. Fare-well party.



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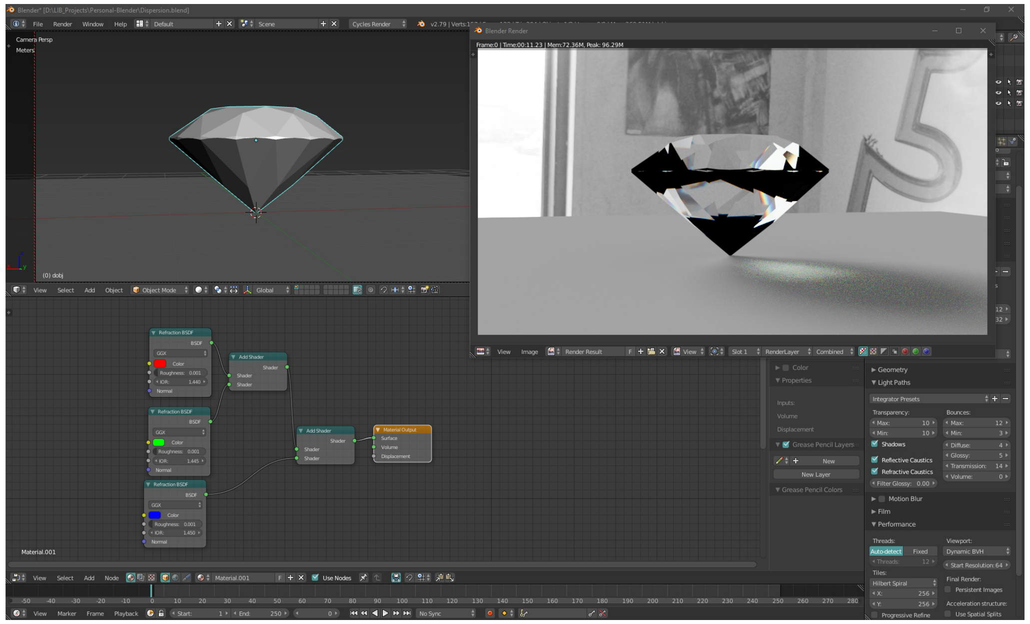
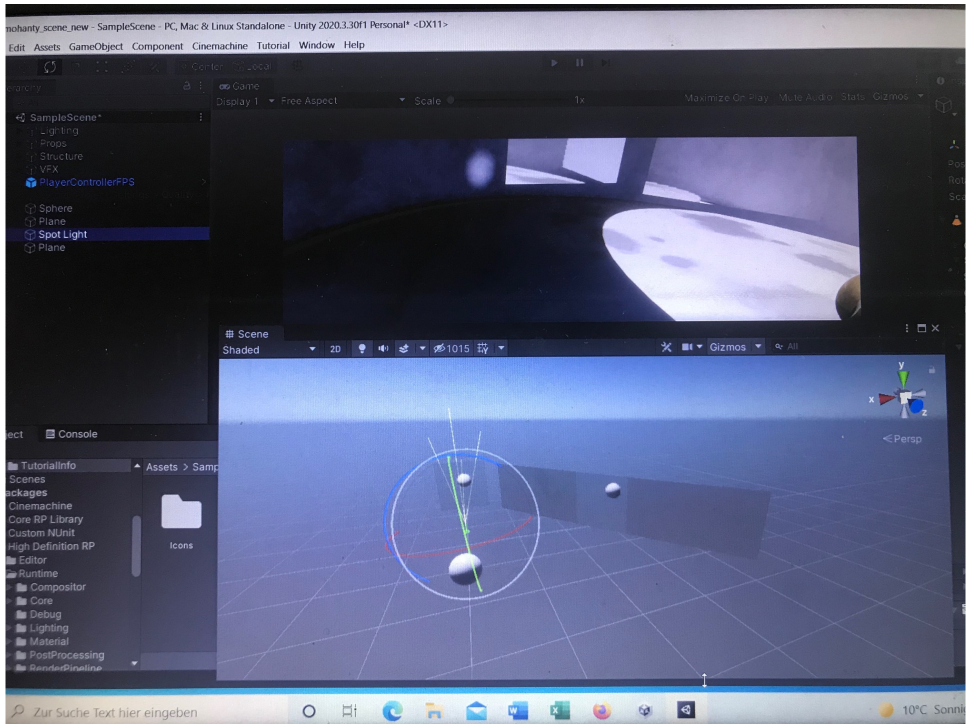
Visual Cryptography

- Tracing the path of a light ray or beam in 2D and 3D - Given an optical system consisting of reflective and/or refractive surfaces
  - Surface boundaries could be rational / irrational or a mixture of these two
  - Represented by system of linear/ quadratic equalities and inequalities ·
- Task
  - Determine if the ray of light/beam emerges at a fixed point P.
  - Determine limitations for such an optical system
- Supervisors
  - Sneha Mohanty, Christian Schindelhauer





Analysis of Sparse Matrices

- Application in Coding theory
- Given a matrix with given positions where the entries are chosen randomly
- What is the probability of a certain rank

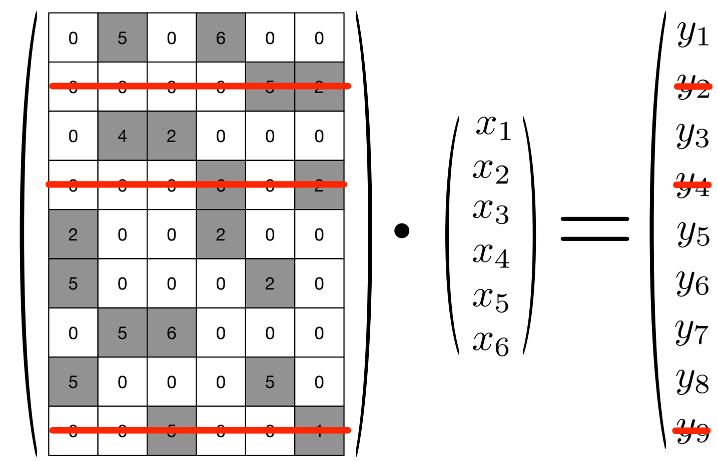


Figure 3. y_2, y_4, y_9 are erased

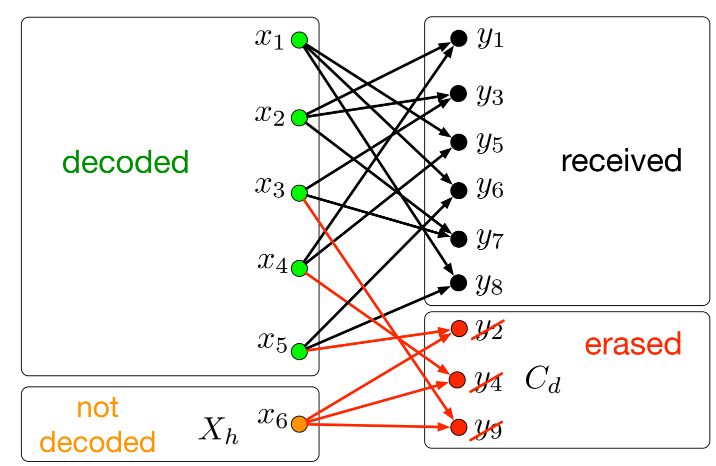


Figure 4. Graph interpretation of erasure of y_2, y_4, y_9

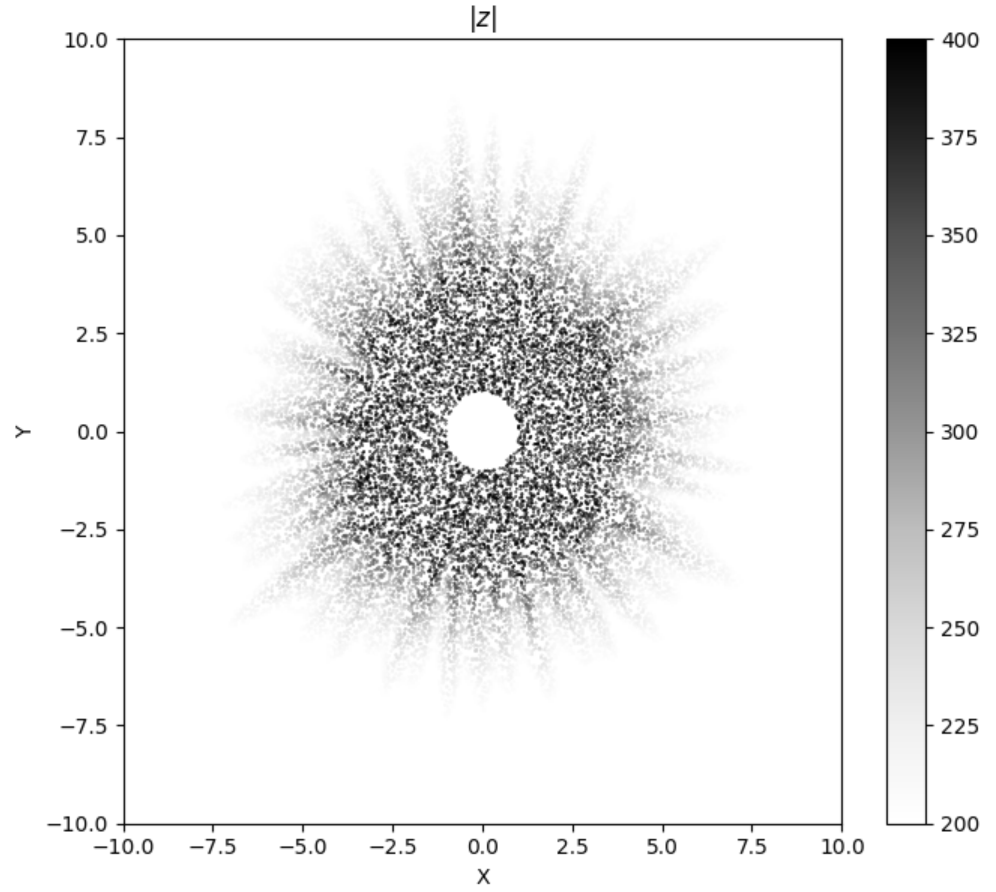
- Cooperation with Uni Weimar
  - Supervisors: Sneha Mohanty

1	0	1	0	0	0
1	1	1	0	0	0
0	1	1	0	0	0
0	0	0	1	1	0
1	0	1	0	1	1
0	0	0	0	1	1

1	0	1	0	0	1
1	1	1	0	0	0
0	1	1	0	0	0
0	0	0	1	1	0
1	0	1	0	1	1
0	0	0	0	0	1

MIMO and Near-Field Antenna Fields

- Given
  - set of sender/receiver antenna
  - signal produced
- Compute/Simulate
  - power gain/diversity gain
- Tools:
  - Simulation in 2D/3D with physical models
- Related Lecture
  - Fundamentals of Wireless Communications
- Supervisor:
  - Christian Schindelhauer & Peter Krämer



(b) Supernova

MIMO and Near-Field Antenna Fields

- MIMO
  - Thesis of Dennis Gauß (2011)
    Implementation of a Simulator for Wireless Networks with Smart Antennas

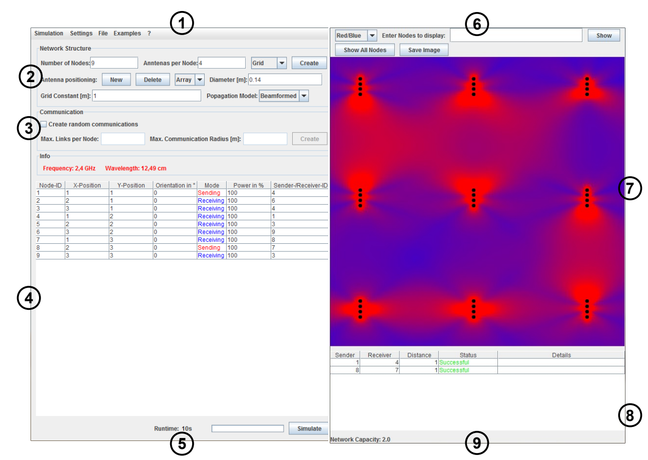
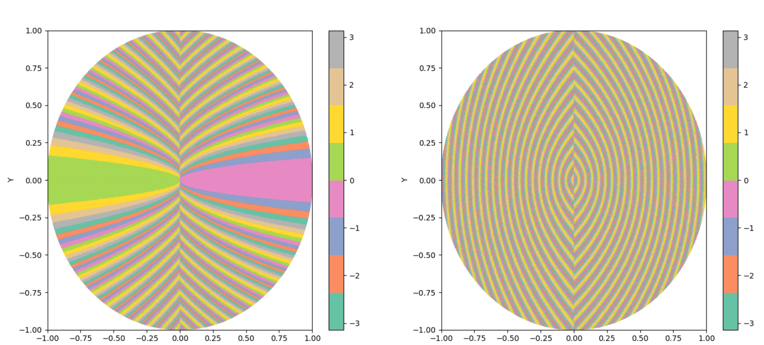


Figure 14: The editing window

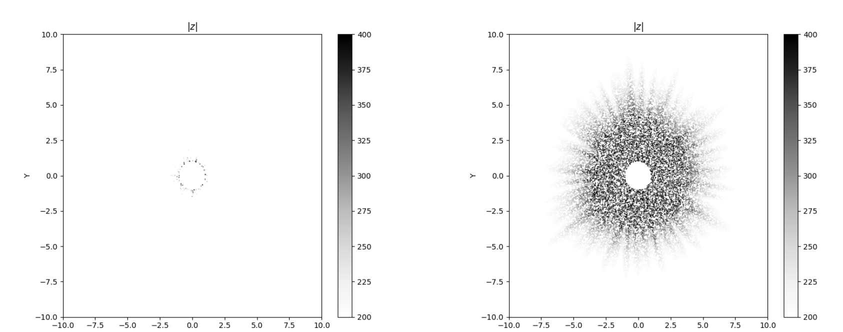
Figure 15: The result window

$$h(p,q) = |\alpha| \cdot \sum_{i=1}^{n_s} \sum_{j=1}^{n_r} \frac{e^{-j2\pi f \left(\text{delay}(q_1, q_j, \phi_r) + \text{delay}(p_1, p_i, \phi_s) + \frac{\text{distance}(p_i, q_j)}{\lambda_c} \right)}}{\text{distance}(p_i, q_j)}$$

  - Thesis of Till-Hagen Mugele (2020)
    Simulation and Analysis of Different Variants of a Collaborative Broadcast Algorithm Regarding Different Path-Loss-Models


(a) Receiver at (10,0,0)

(b) Receiver at (-10,0,0)


(a) No Phase Shift

(b) Supernova

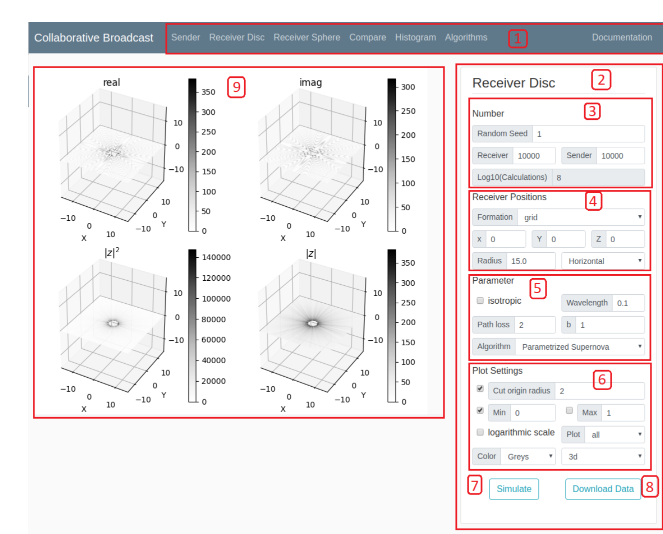
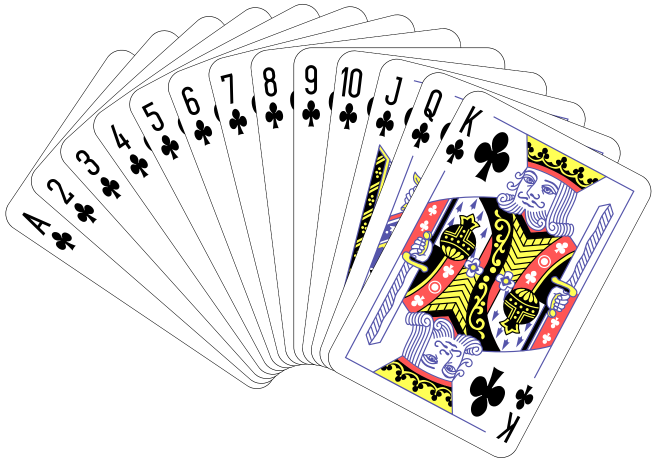


Figure 22: Screenshot of the Receiver-Disk-Module User Interface.

Cryptography

- Bullet Proofs for Mental Card Games
  - Given a formal description of a card game
  - automatically construct all interactive zero-knowledge games for playing the game only
    - (without trusted third party)



- To do
  - Design an interpreter/compile which translate card game languages into interactive proof systems

Protocol 7 Agreeing on a Permutation

TODO output product of powers with distinct exponents (modulo q)

Input: size m of permutation

Output: masked permutation in the form $\prod_{i=1}^{m} p_i^{e_i}$ and the value ℓ

	Player P_1		**Players P_j with $j > 1$**
1.	Fix random seed and draw m random exponents $e_{i,1} \in \{0, 1, \dots, q-1\}$ for $i \in \{1, 2, \dots, m\}$ Send commitment $c_1 = \text{mask}(r_1, \prod_{i=1}^{m} p_i^{e_{i,1}})$	⇄	Fix random seed and draw m random exponents $e_{i,j} \in \{0, 1, \dots, q-1\}$ for $i \in \{1, 2, \dots, m\}$ Send commitment $c_j = \text{mask}(r_j, \prod_{i=1}^{m} p_i^{e_{i,j}})$
2.		←	Send random seed used in step 1
3.	Verify c_2 to c_n have been generated with provided seed and set $\ell := 0$.		
4.	Let $e_i = (\ell(i-1) + \sum_j e_{i,j})$ and publish ℓ and $c = \text{mask}(\sum_{i=1}^{n} r_i, \prod_{i=1}^{m} p_i^{e_i})$	→	
5.			Check that $c = (1, \prod_{i=1}^{m} p_i^{\ell(i-1)}) \cdot \prod_{i=1}^{n} c_i$
	If e_i are not distinct modulo q:		
6.	Prove that two e_i are equal modulo q, increment ℓ by 1, and go to step 4		

- Supervisor:
  - Christian Schindelhauer

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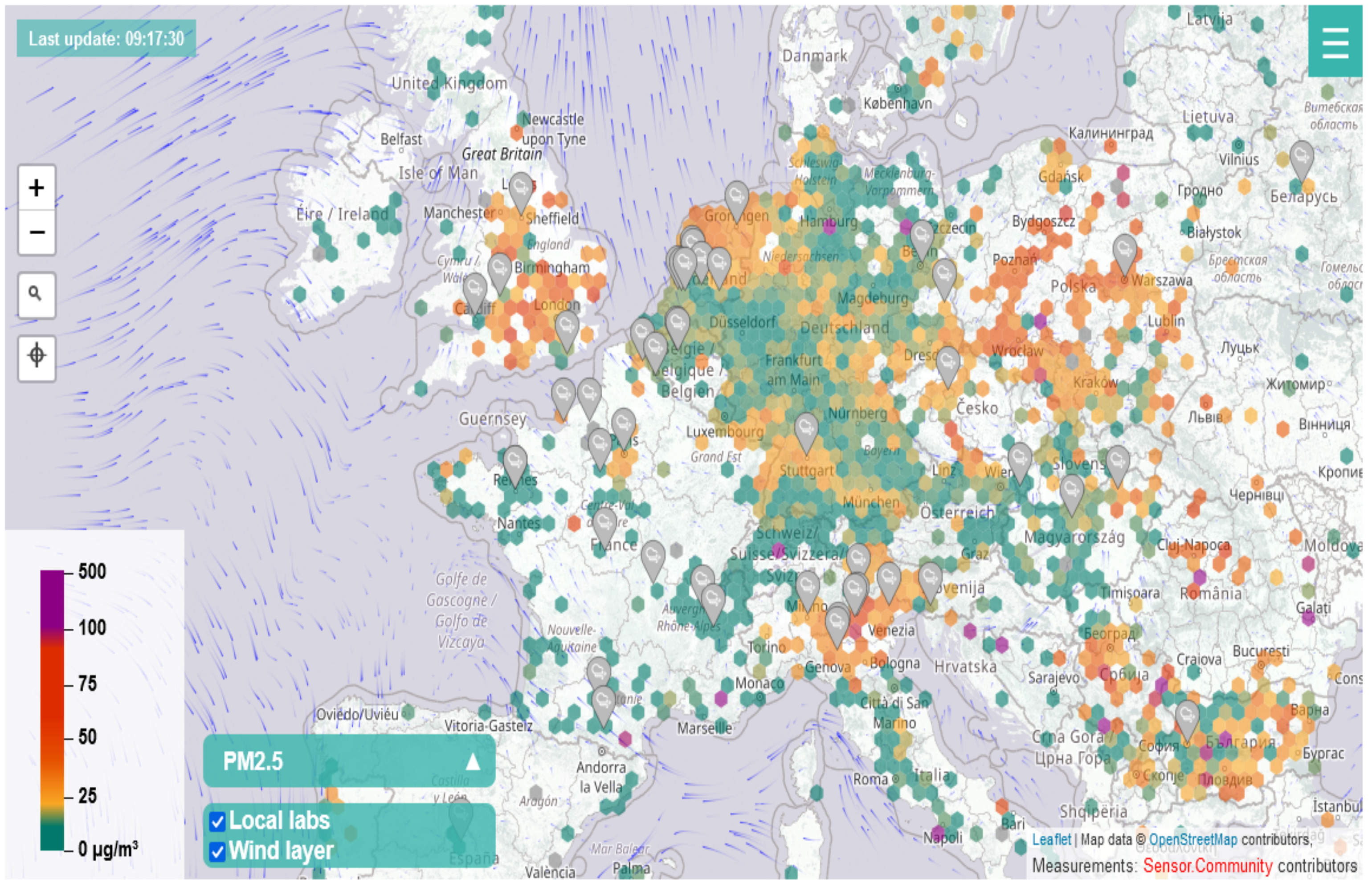
Data Aggregation in Peer to Peer Network



Source picture: https://sensor.community/en/

Given

- Sensors and data from sensor.community

To do

- Compute/Simulate
- Aggregation Function (Min, Max, Average, Sum, Count)
- Clustering over P2P

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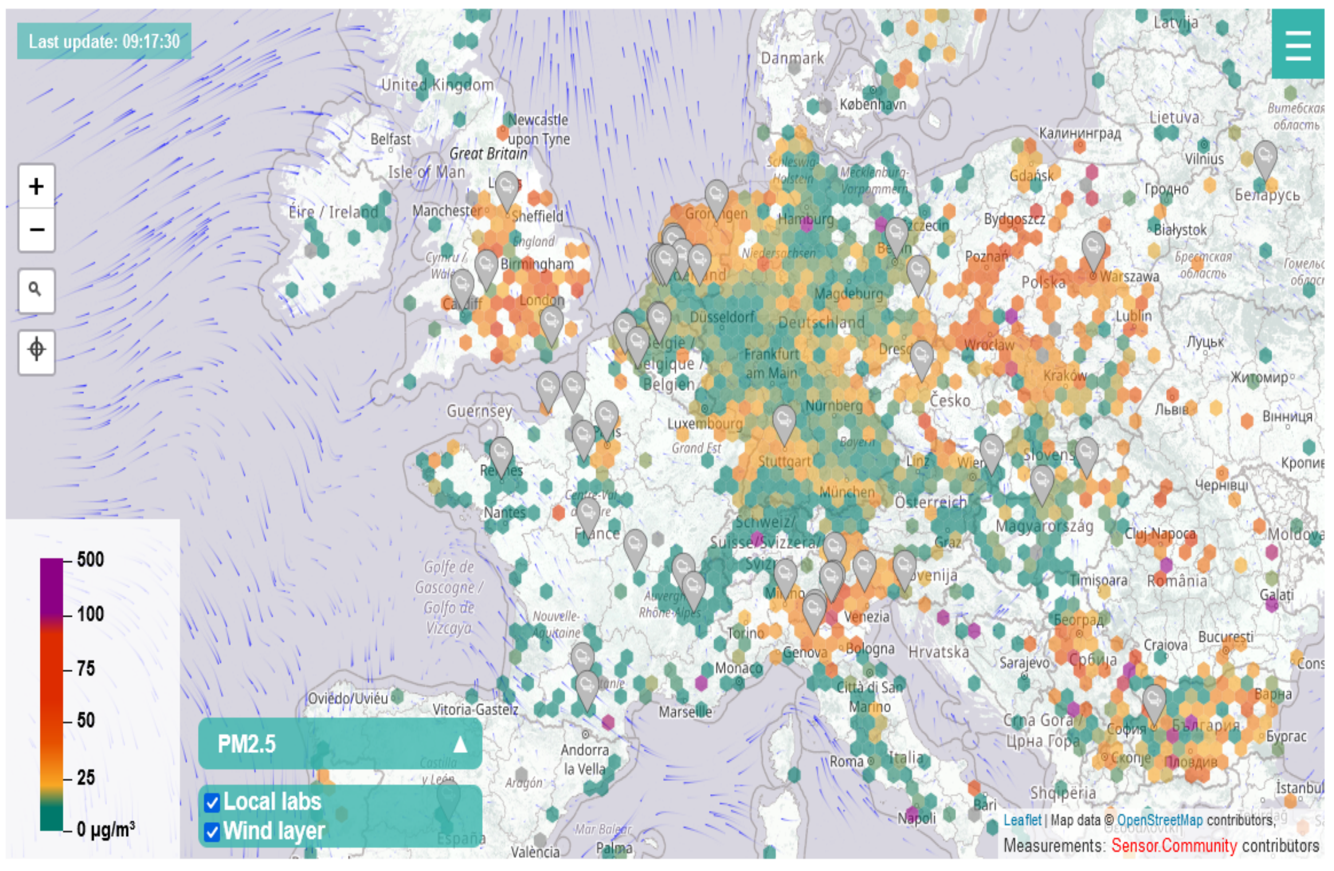
Data Aggregation in Peer to Peer Networks – Previous Work

- "Design and Implementation of a Simulation Environment for Peer-to-Peer-based Data Aggregation of Emulated Time-Series Data“, Bachelor Thesis, Alexander Weinmann, 2019
  - Supervisors : Professor Dr. Christian Schindelhauer & Saptadi Nugroho
- “Simulation, Evaluation, and Analysis of Data Aggregation Methods under Different Random Call Models Suitable for Time Series Data”, Master Thesis, Alexander Weinmann, 2022
  - Supervisors : Professor Dr. Christian Schindelhauer & Saptadi Nugroho

Data Aggregation in Peer to Peer Networks – References



Source picture: https://sensor.community/en/

- Peer to Peer K-Means Clustering
  - S. Datta, C. Giannella and H. Kargupta, "Approximate Distributed K-Means Clustering over a Peer-to-Peer Network," in IEEE Transactions on Knowledge and Data Engineering, vol. 21, no. 10, pp. 1372-1388, Oct. 2009, doi: 10.1109/TKDE.2008.222.
- LEACH
  - W. B. Heinzelman, A. P. Chandrakasan and H. Balakrishnan, "An application-specific protocol architecture for wireless microsensor networks," in IEEE Transactions on Wireless Communications, vol. 1, no. 4, pp. 660-670, Oct. 2002, doi: 10.1109/TWC.2002.804190.
- Supervisors
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