57th Photogrammetric Week

3D Micro-Mapping

Crowdsourcing to Support Image and 3D Point Cloud Analysis

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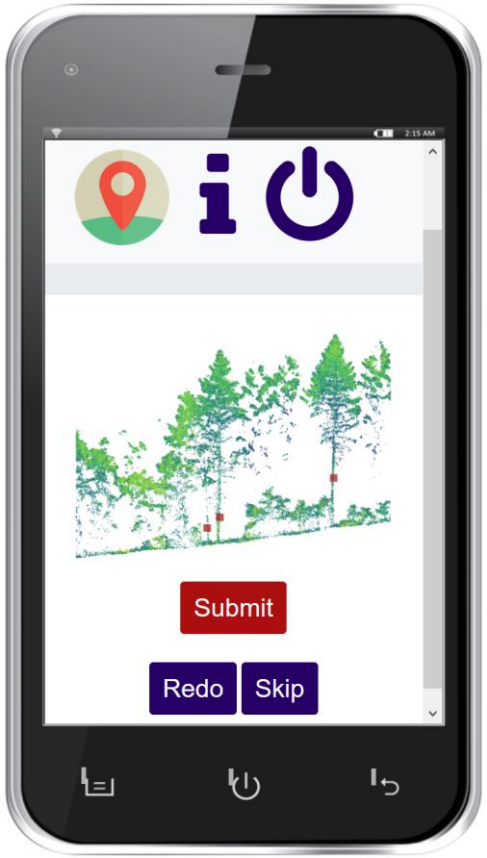
3D Micro-Mapping

Mapping of 3D geoinformation

within a few **seconds**

using a simple **web browser**

feasible for **non-experts**



Micro-Mapping: My definition

- "**Micro**" refers to quick and easy single mapping task that can be solved in a few seconds

- Perception tasks that **complex for computers** but **easy for human interpreters**
  - e.g. complex objects (high inner-class variation)

- **Context and local knowledge** can be incorporated
- **Makes use of visual interpretation** strengths and high data redundancy

Refs: Herfort (2017), Herfort et al. (2018)

Dimensions of crowdsourcing

TECHNICAL

- Backend server
- Web 2.0 mapping tools
- Databases
- …

DATA

- Data availability
- Data preparation
- Rights and privacy
- …

SOCIAL

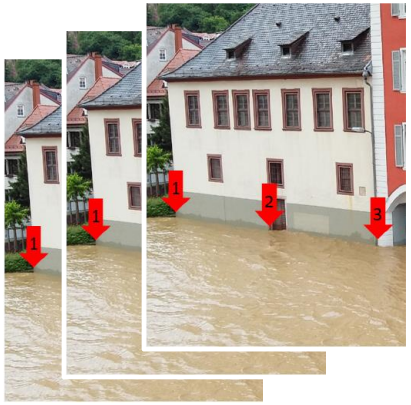
- Activate crowd
- Training material
- Education effects
- …

INTEGRATED VIEWS

- Design of tasks
- Training material
- Quality assessment
- …

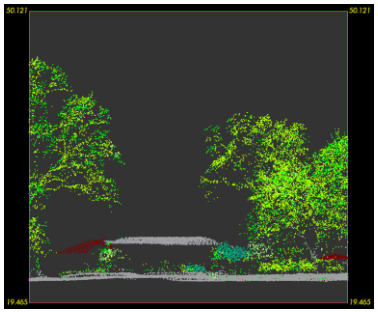
Refs: cf. Heipke (2010)

3D Micro-Mapping: Principle concepts



2D → 3D

3D → 2D → 3D

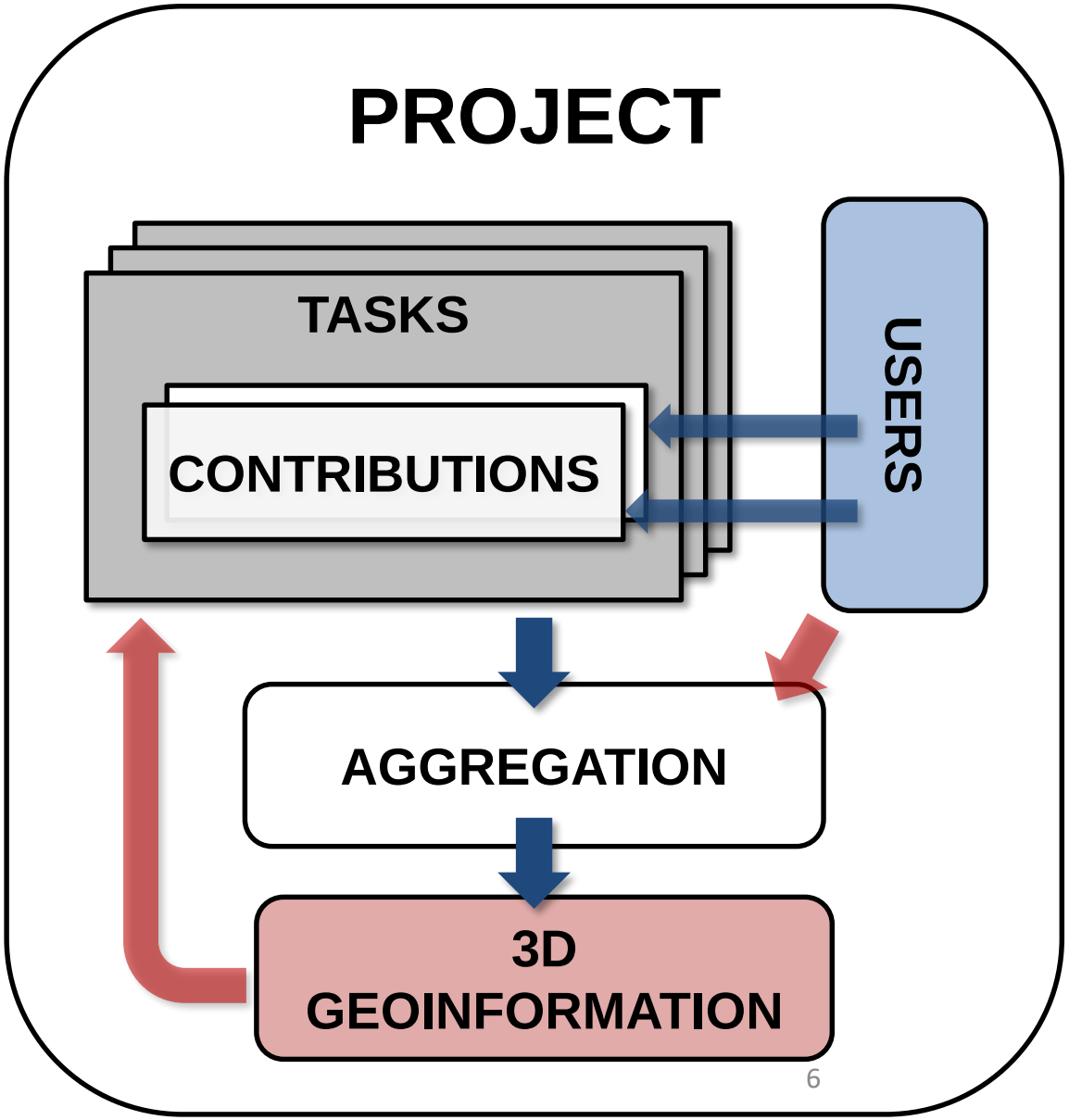


3D → 3D

3D GEO-INFORMATION

Refs: Griesbaum et al. (2017), Herfort et al. (2018)

Structure and challenges of 3D Micro-Mapping



Refs: Barrington et al. (2011)

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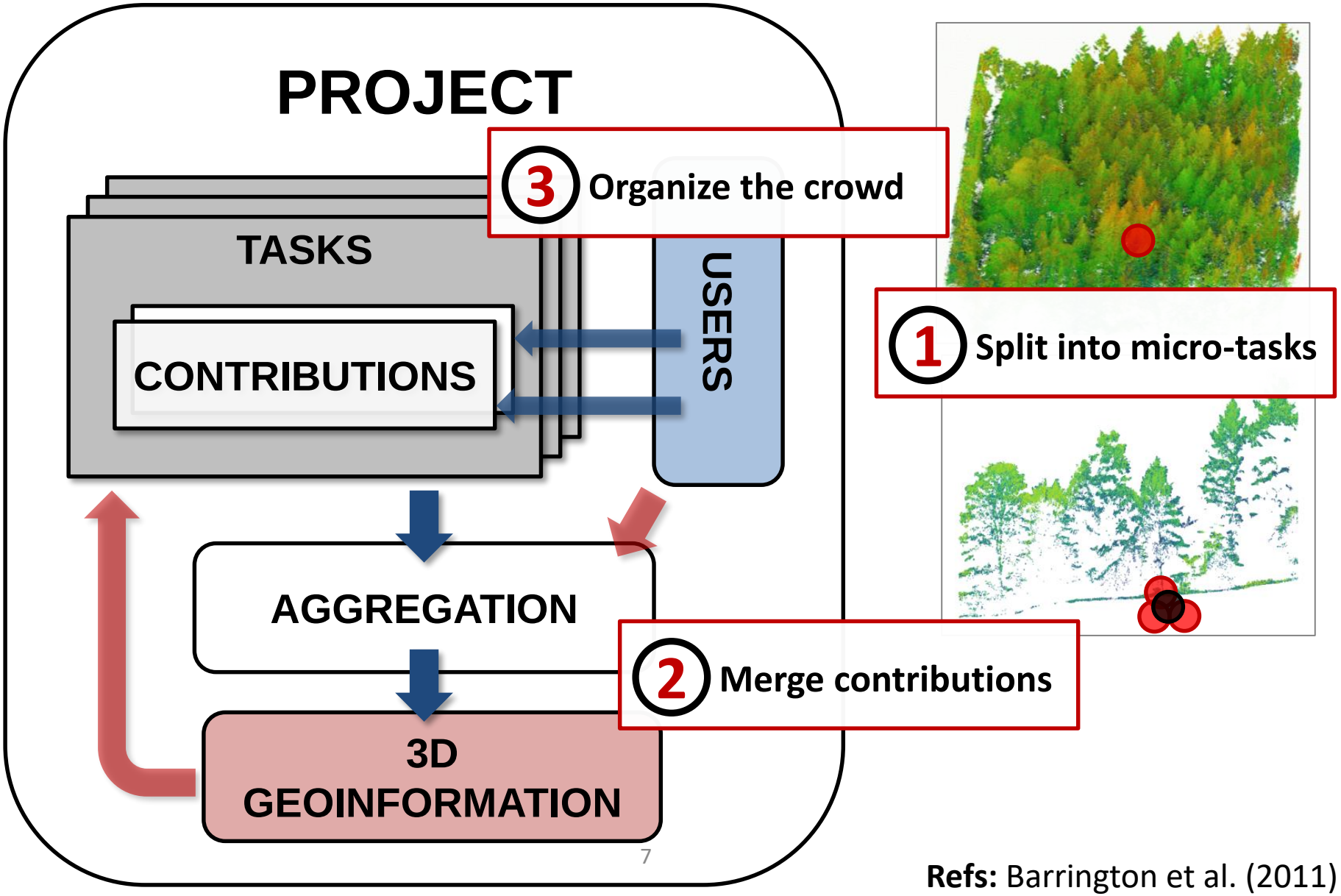

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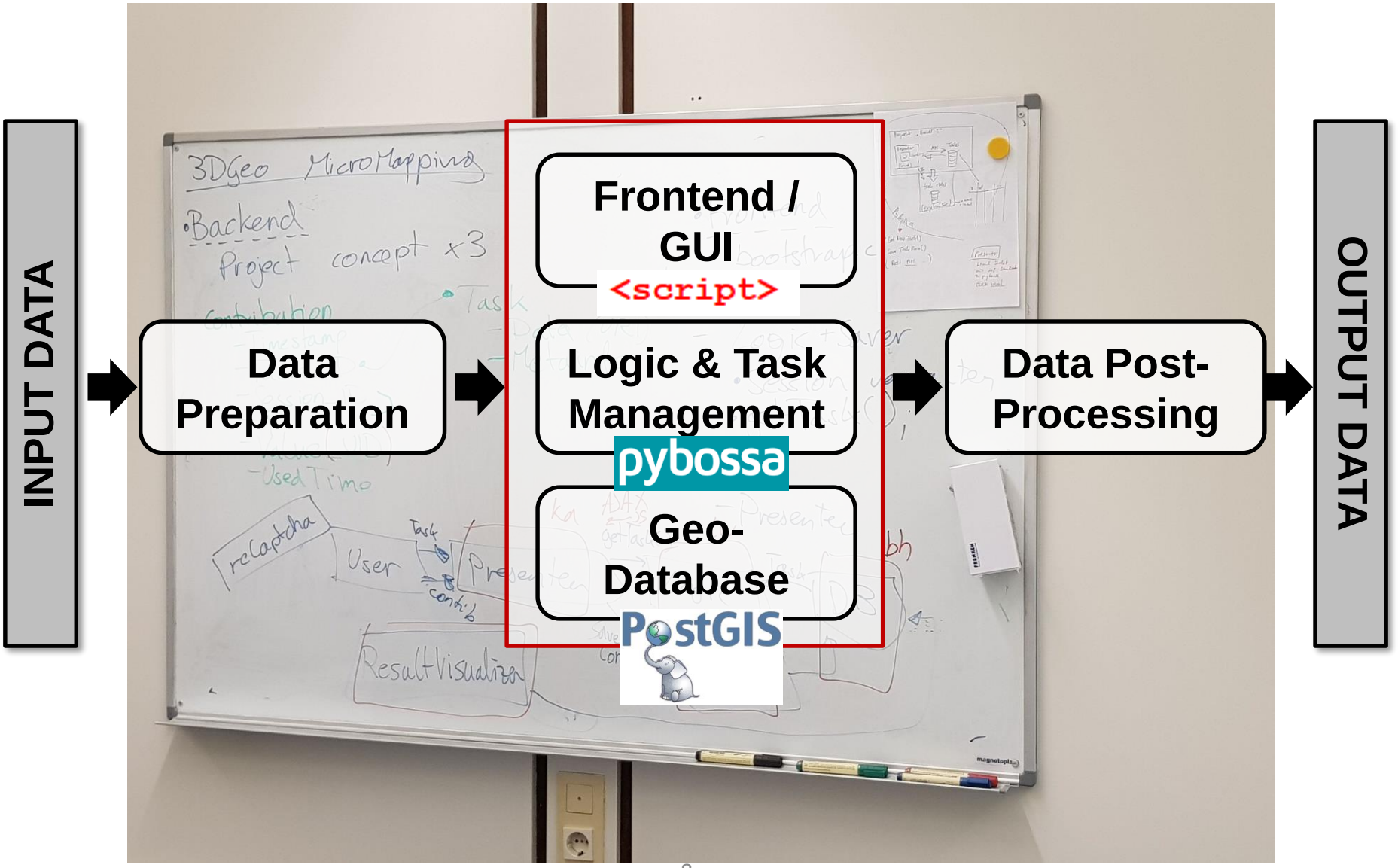
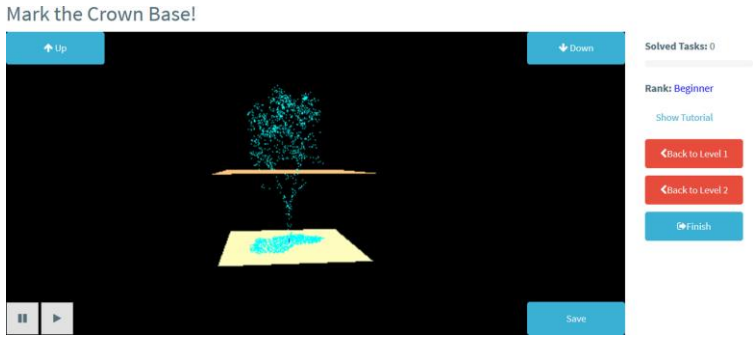
Minimal technical system

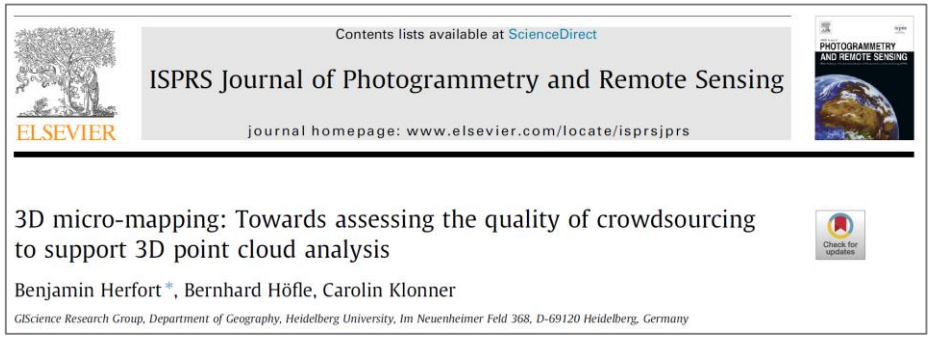


Research Studies

Selected research examples

Crown Base Estimation
3D → 3D





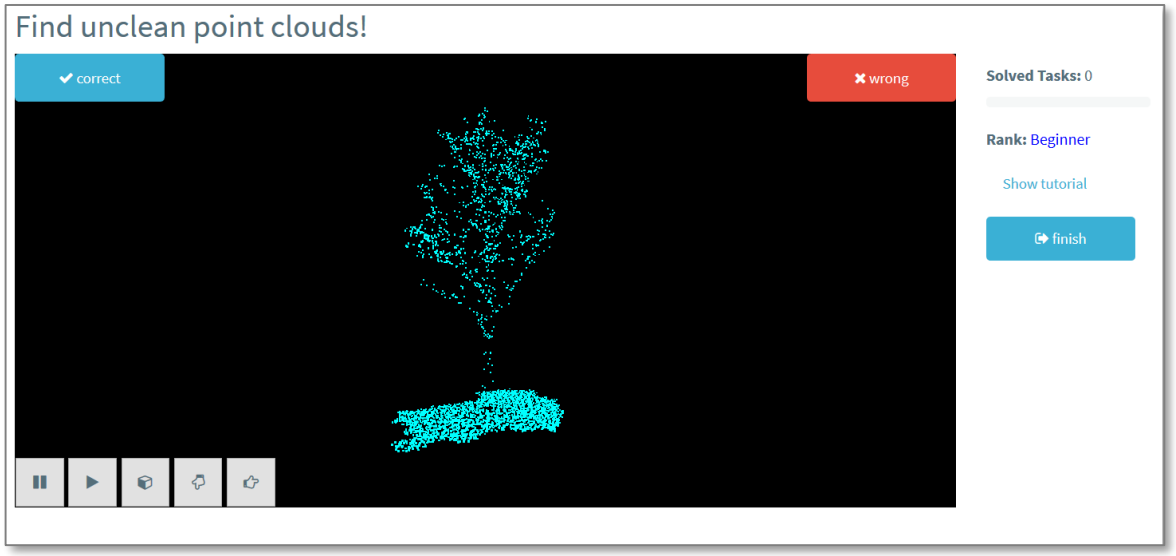
Tree Localization
2D → 3D

► Release of new mapping project

Refs: Herfort et al. (2018)

Conceptual approach

- **Input:** Segmented ALS point clouds of trees in Vienna
- **Several tasks** by simple answer or user interaction
- **Implementation**: Web browser (Pybossa + WebGL,…)



Refs: Höfle et al. (2012), Herfort et al. (2018)

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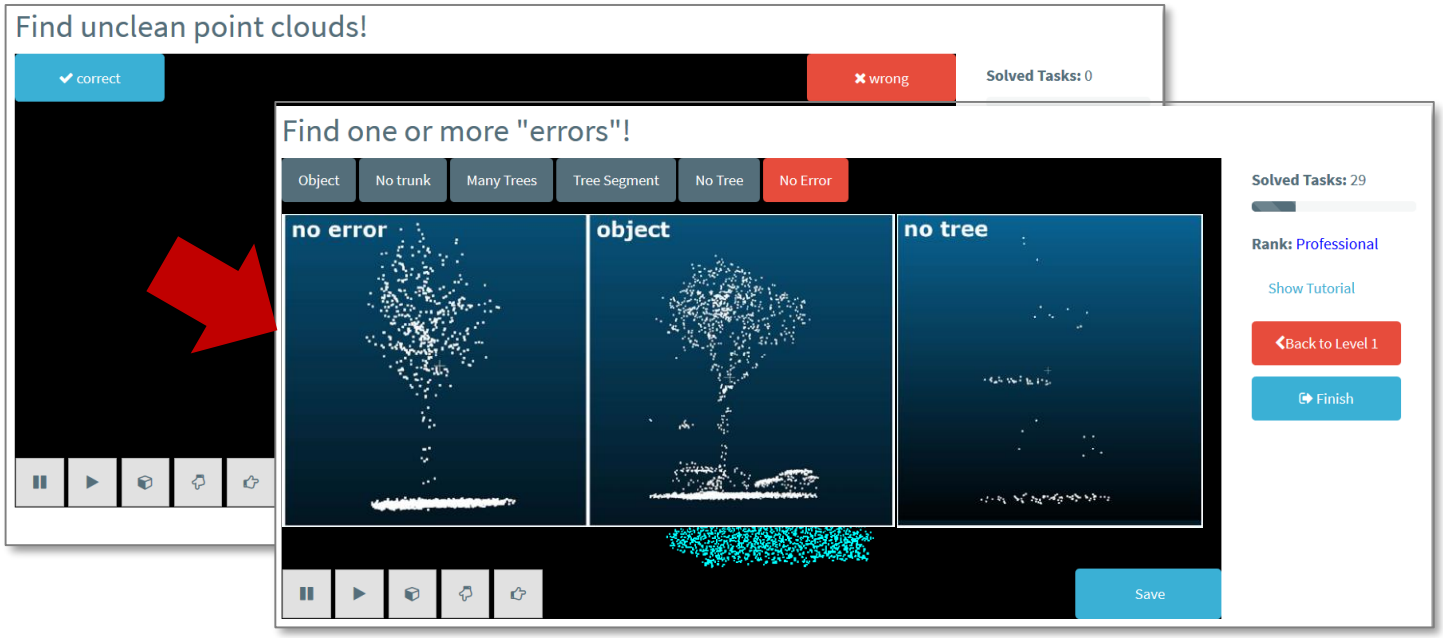

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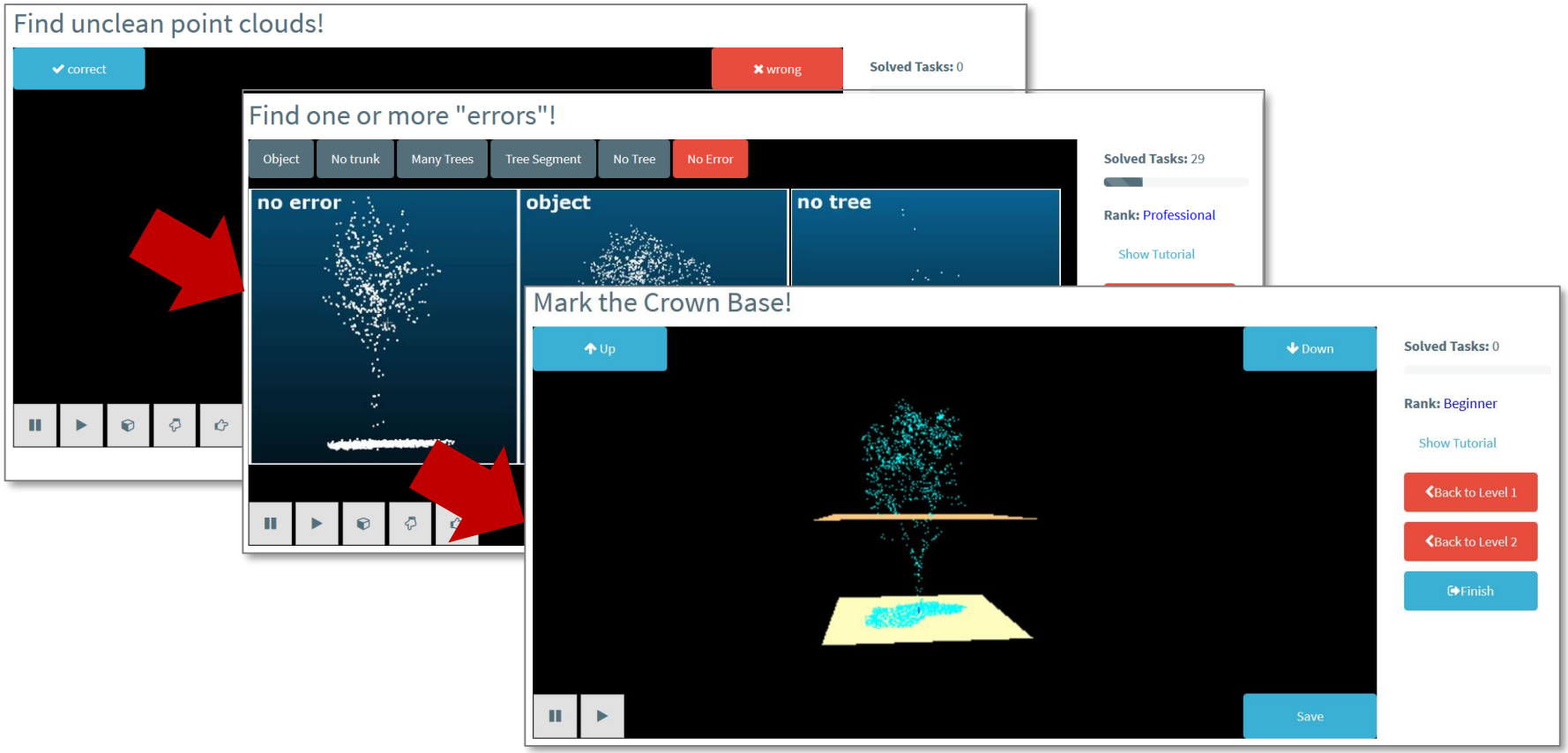

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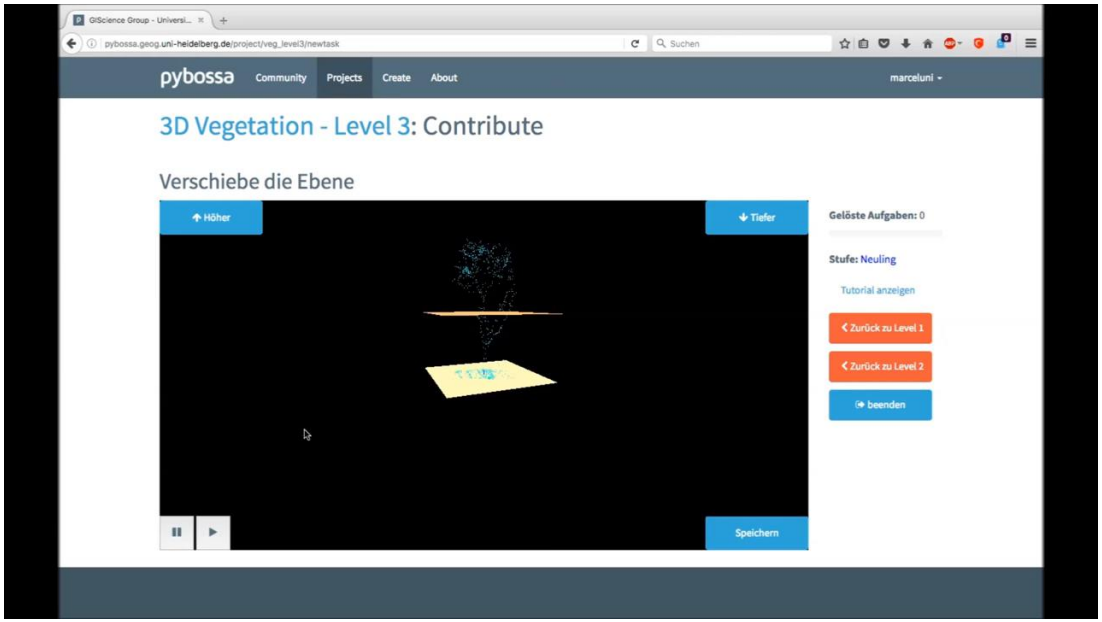
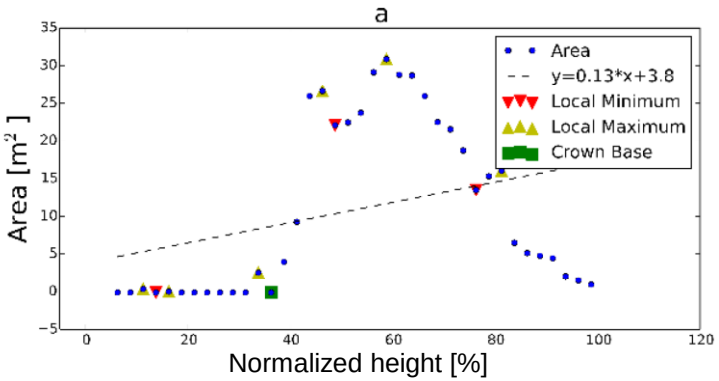
Crown base height

3D Micro-Mapping ⟷ **Automatic method**



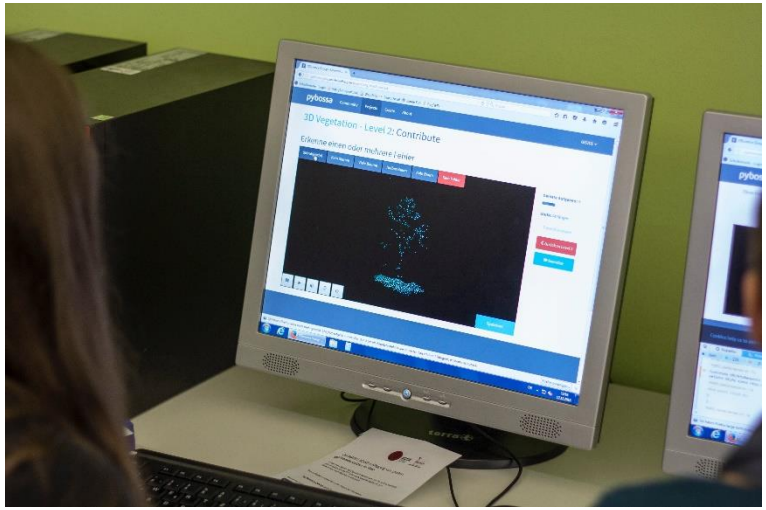


Reference
by experts

Refs: Koma et al. (2016)

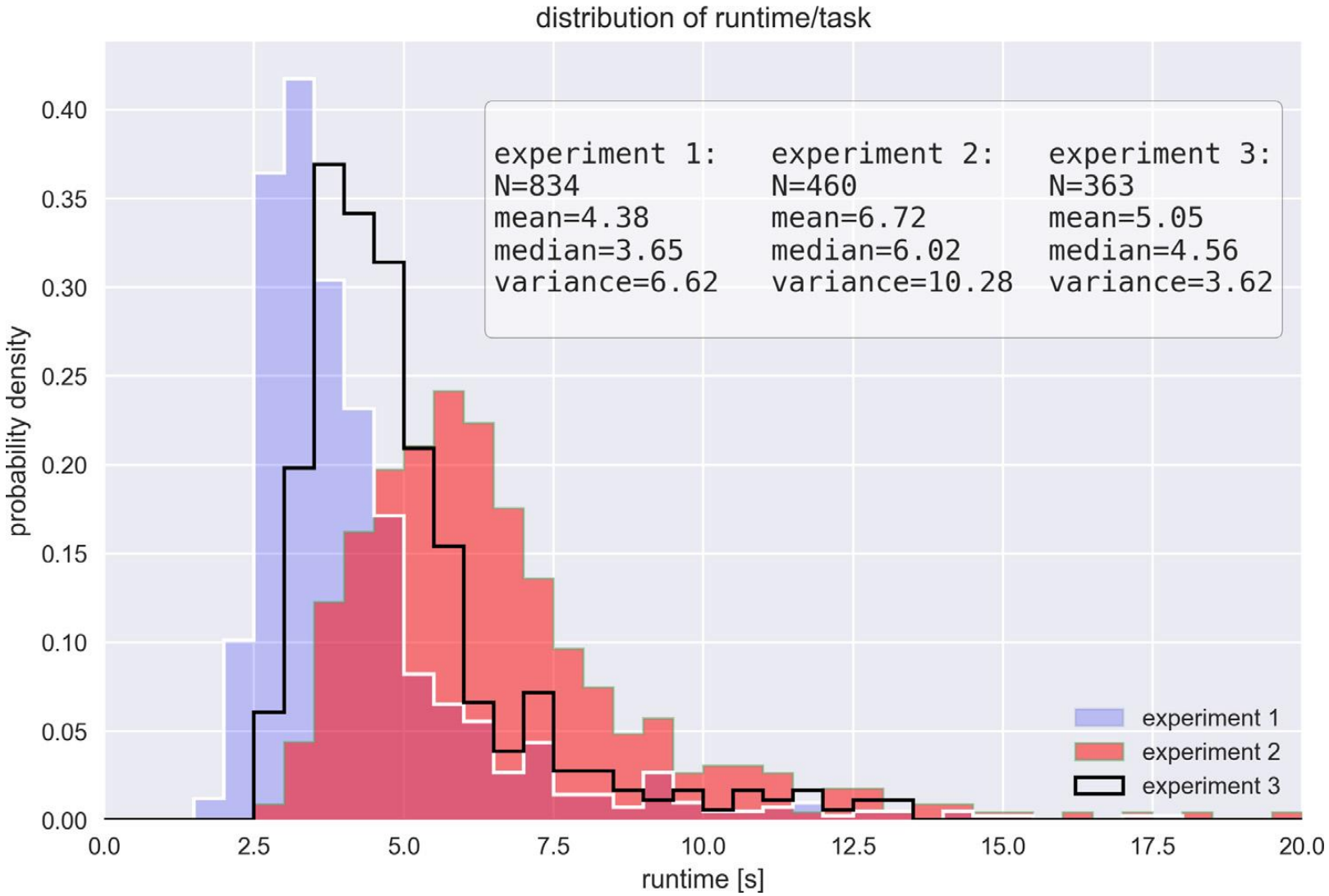
Users and contributions

	Tasks	Contributions	Users	Contributions/task	Tasks/user
Experiment 1	834	9,906	152	11.9	65.2
Experiment 2	460	5,580	110	12.1	50.7
Experiment 3	363	7,110	96	19.6	74.1



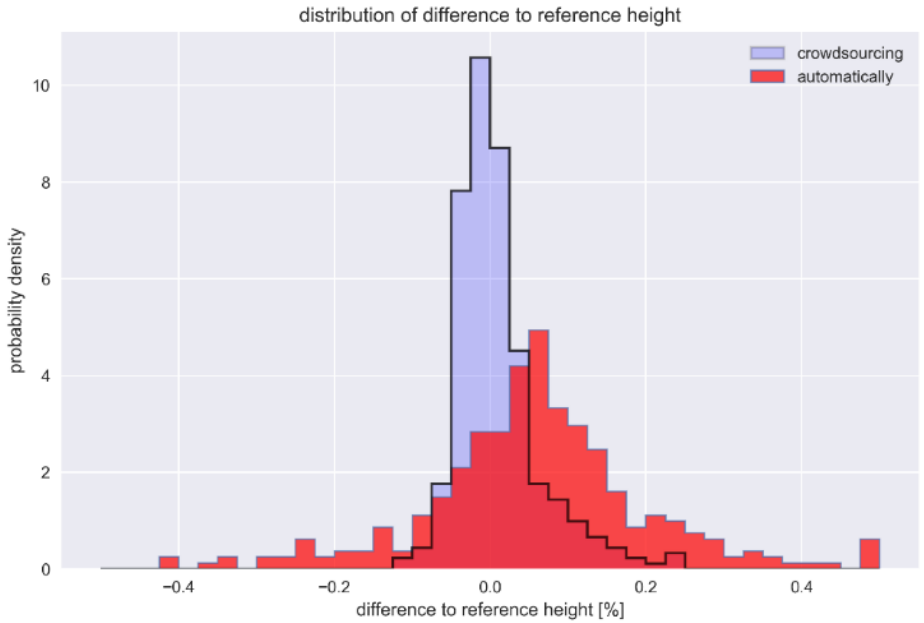
Refs: Herfort et al. (2018)

Duration per task



Refs: Herfort et al. (2018)

Evaluation of crown base height



	N	Average difference [m]	RMSE [m]
crowdsourcing	363	0.008	0.054
computer (automatic)	324	0.058	0.147

► Difference to reference correlates (R=0.46) with **user agreement** (std.dev.)

Refs: Herfort et al. (2018)

Learning moment

- **Data quality** dependent on **task design**
  - Single annotation and crown base height easier to solve
  - Multi-answer classification is difficult: no micro-task?
- **User agreement** as intrinsic quality indicator
- **Crown base height**: Higher accuracy and completeness than applied automatic method
- **Strong visual component** in task design leads to better results in 3D crowdsourcing

Refs: Herfort et al. (2018)

Selected research examples

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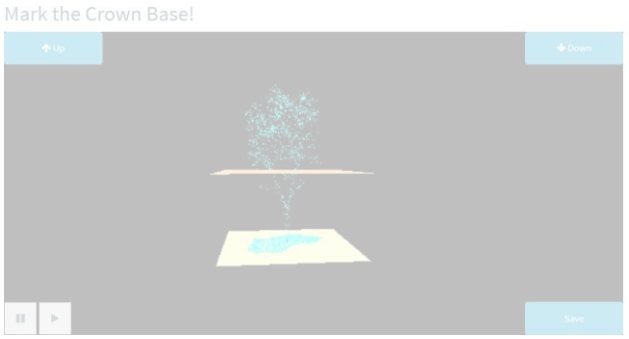
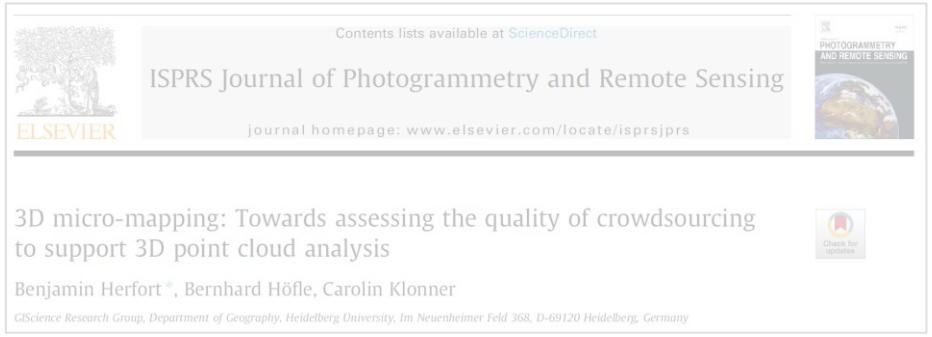
3D → 3D





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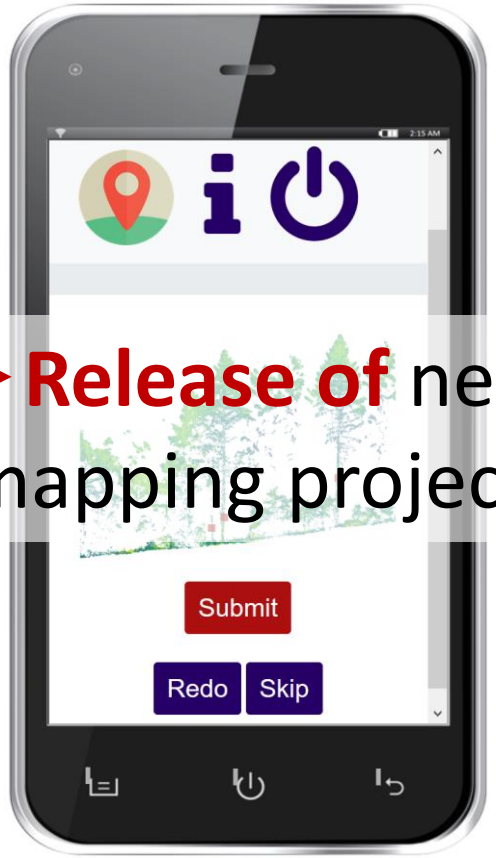


- **Release of** new mapping project

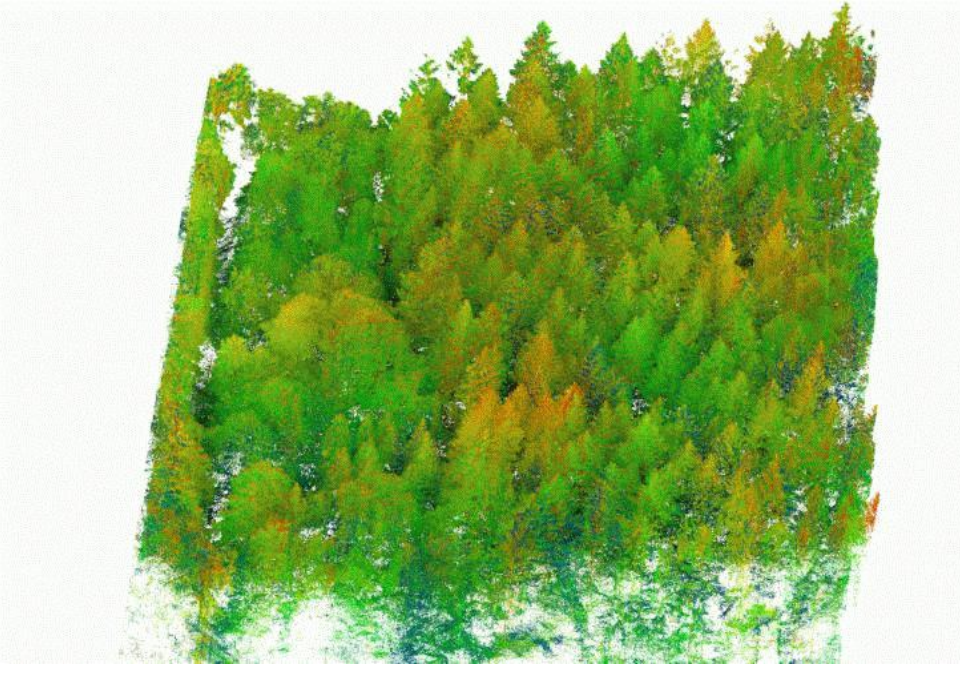
Refs: Herfort et al. (2018)

Design of project and single tasks

- **Goal:** Retrieve positions (xyz) of tree stems from **UAV-LiDAR point clouds**

- **Reduce complexity for users**
  - My kids and beloved granny should be able to do the job

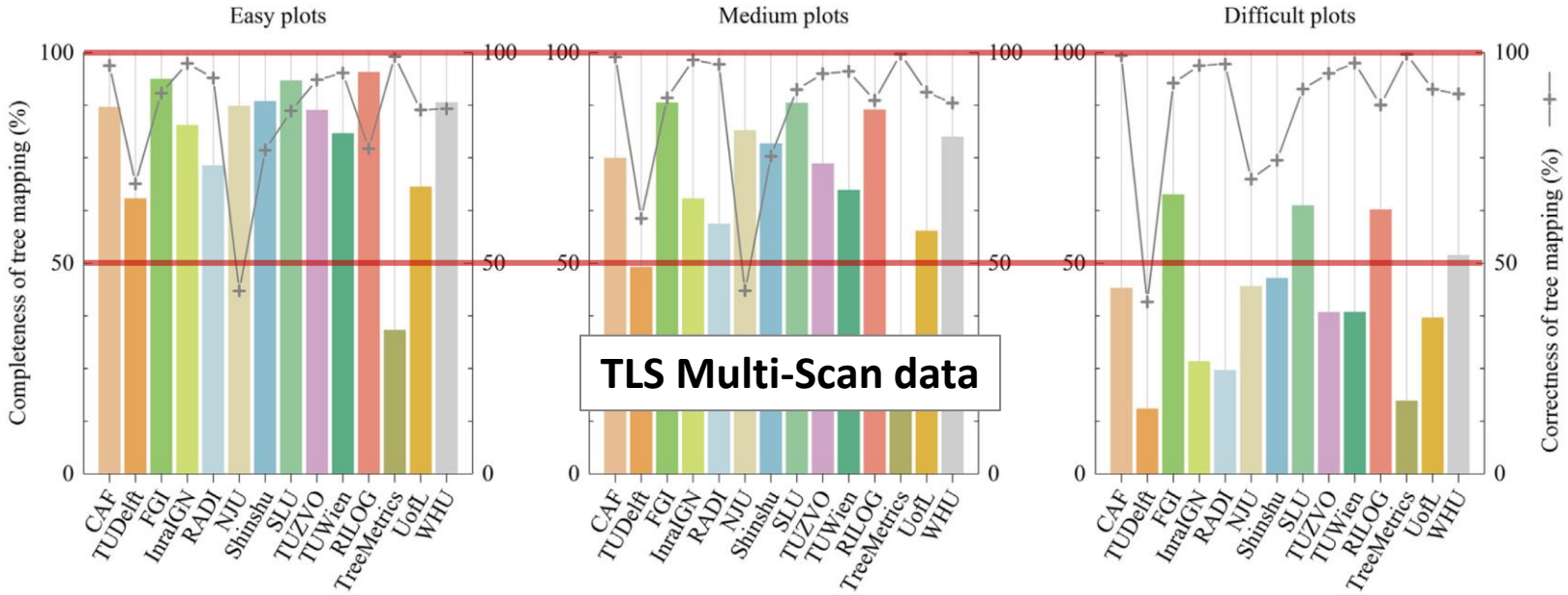
- **Full 3D task not possible** due to forest complexity



Motivation

Why crowdsourcing and not with automatic methods?

- Co-registration of diverse point clouds (TLS, ULS, ALS)
- Validation / Training of automatic approaches
- Development of hybrid approaches: Crowd + Algorithm



Refs: Liang et al. (2018)

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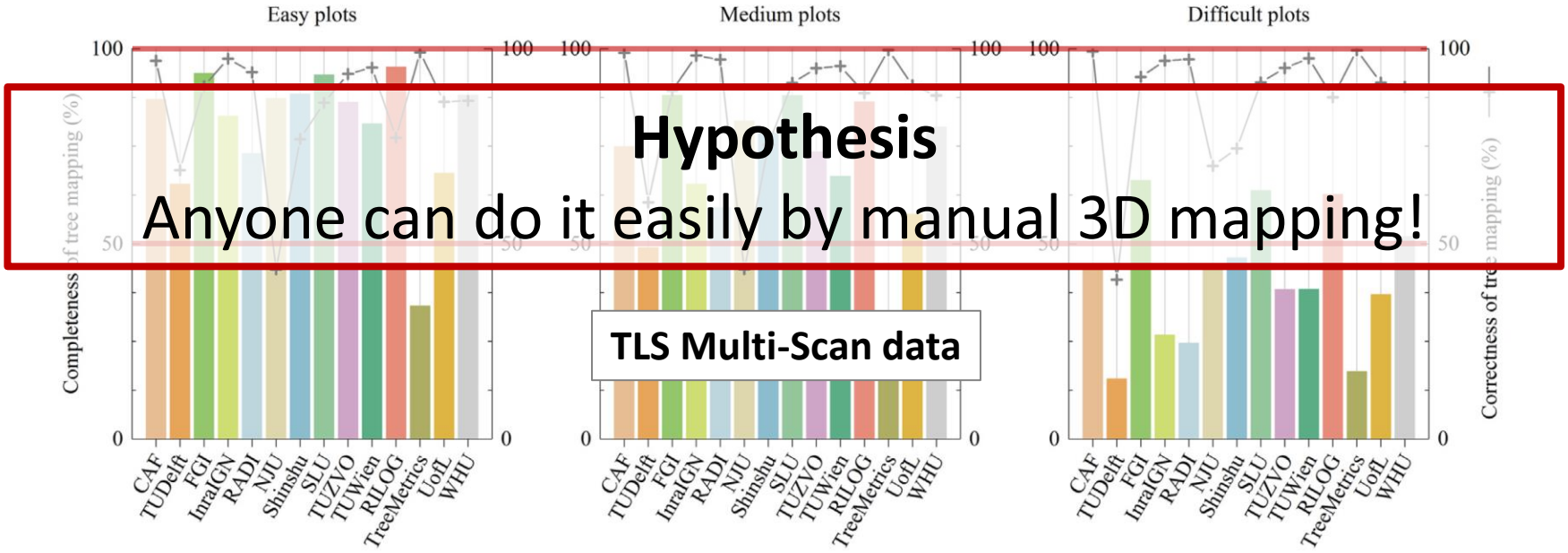
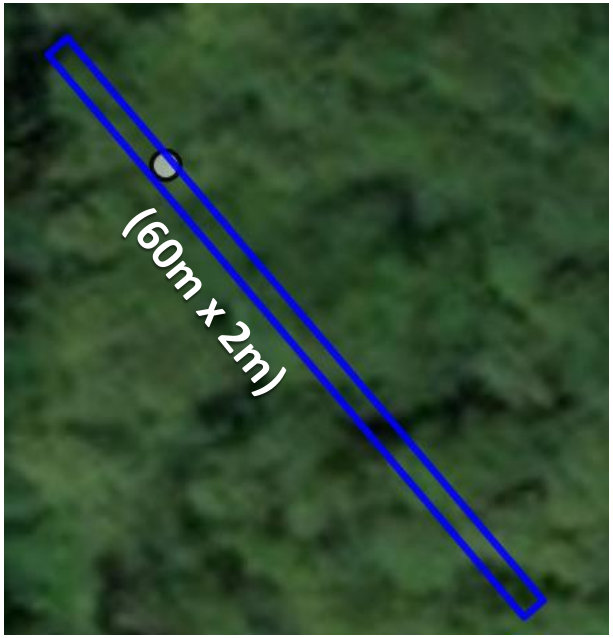
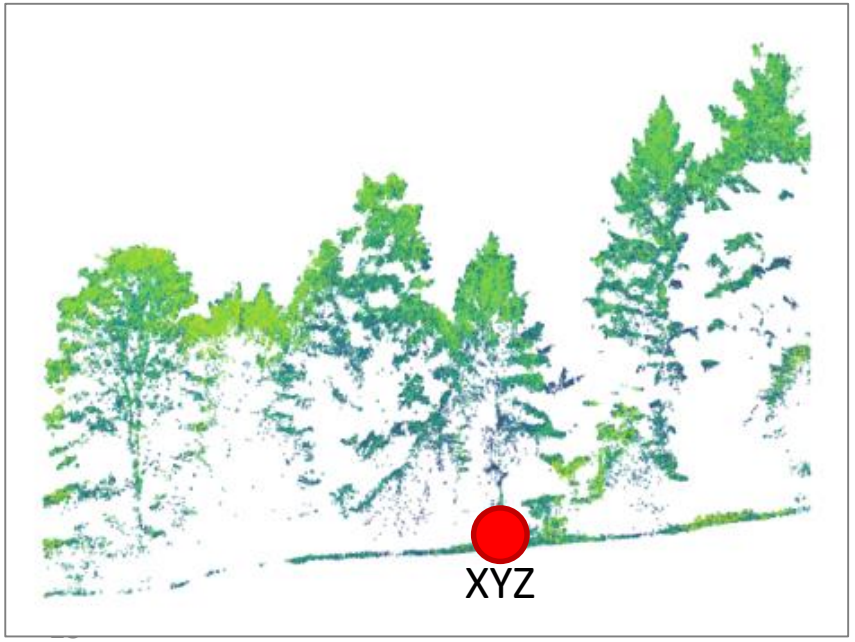


Refs: Liang et al. (2018)

Design of project and single tasks

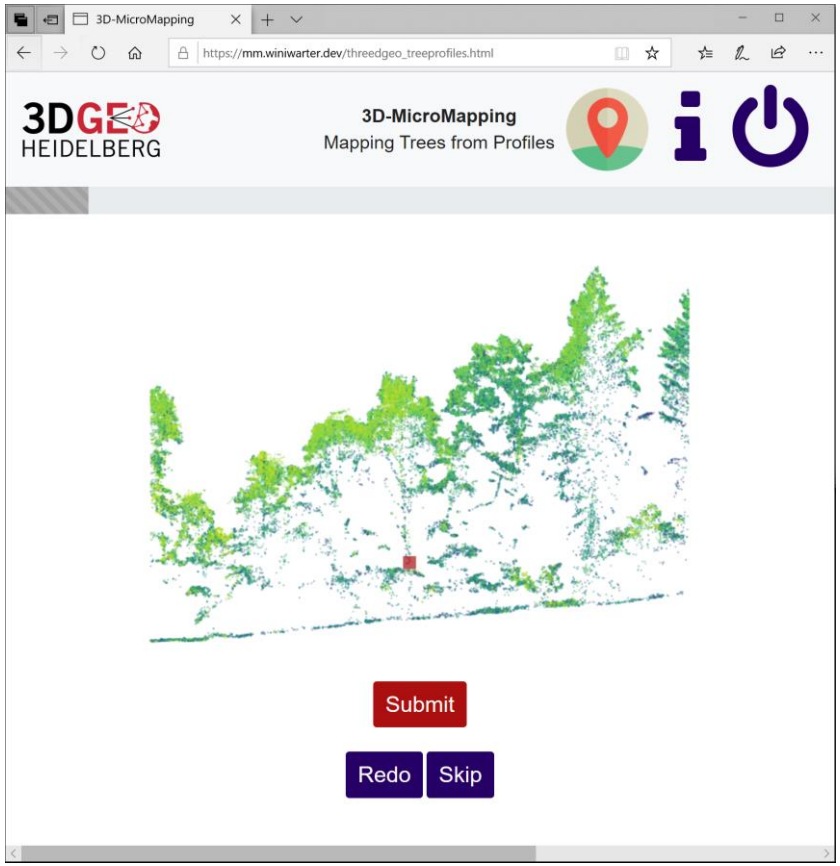
- **Development of 2D→3D tasks**
  - Mapping trees in **point cloud cross-sections**
  - Complete area is covered with overlapping sections

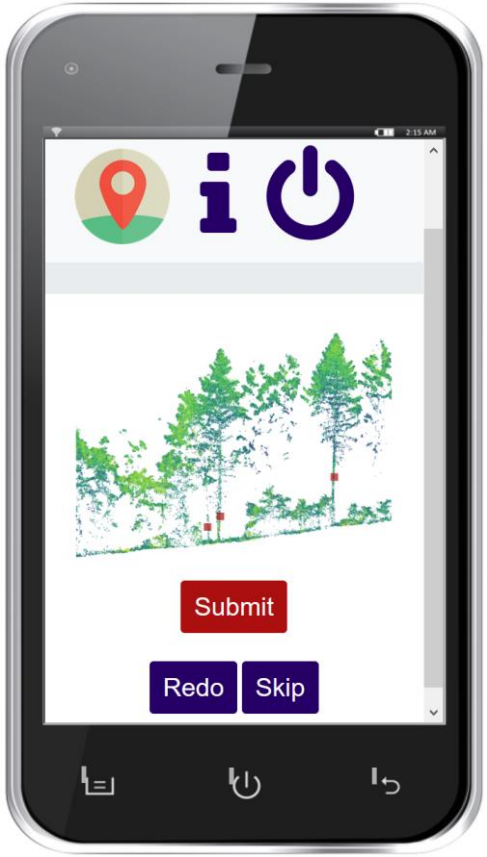




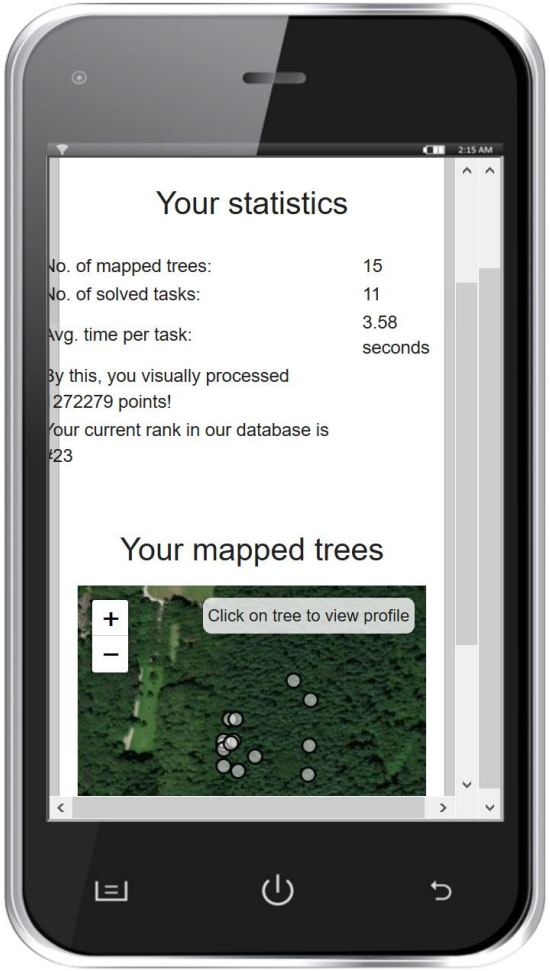
Implementation of project

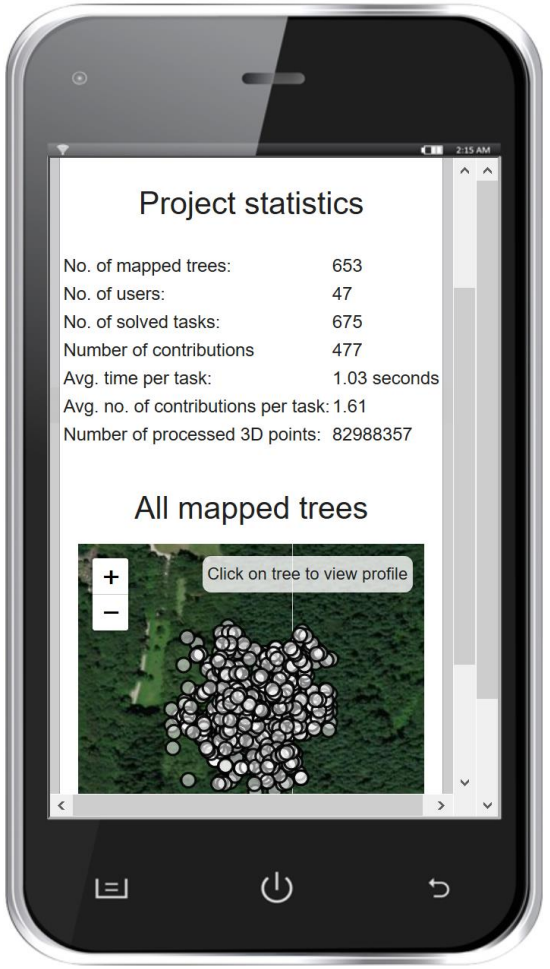
Web browser app





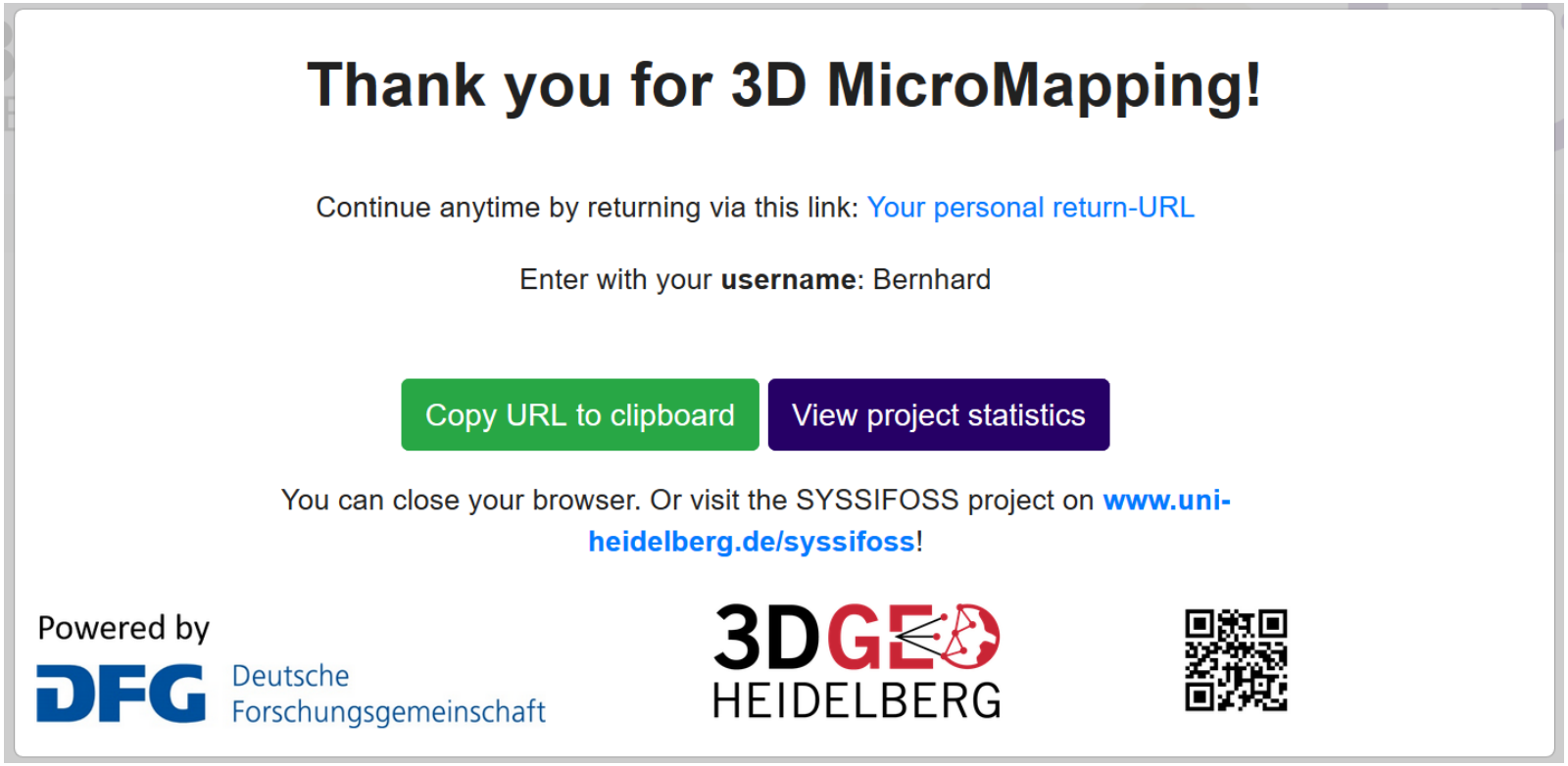
Live statistics





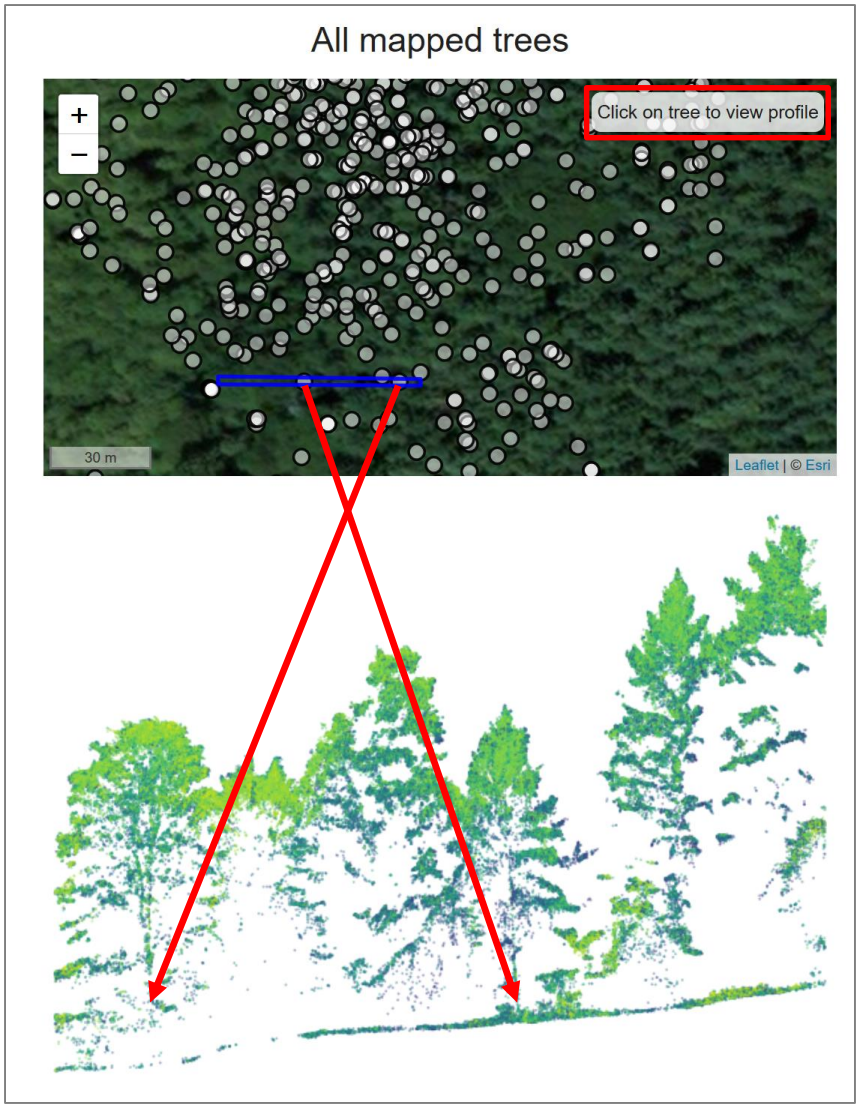
You can come back anytime

- to continue and improve your statistics!

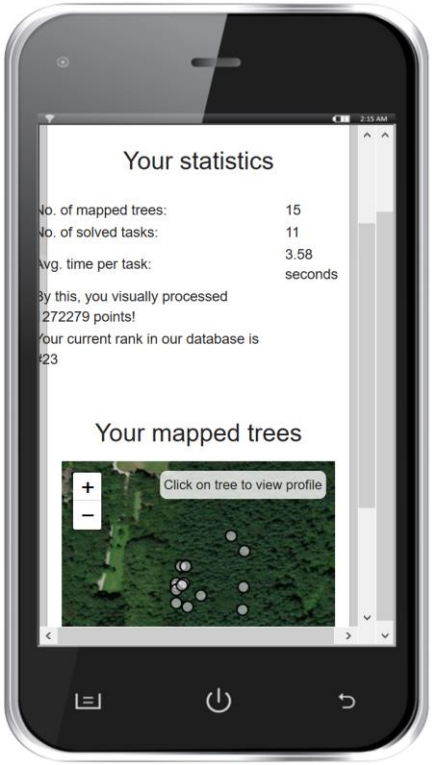


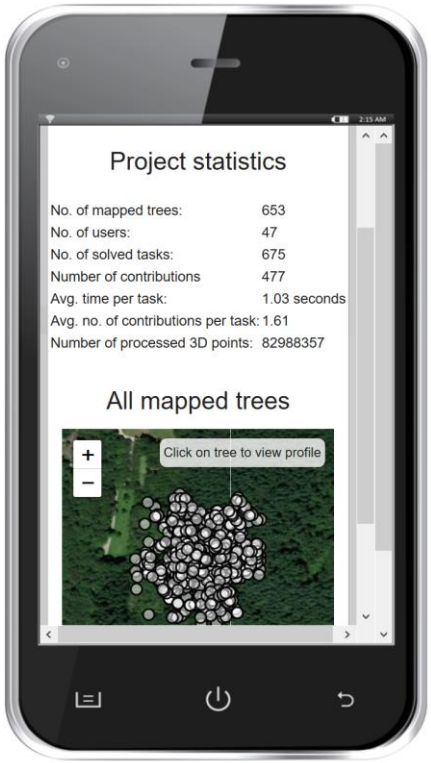
Results

Tree position candidates



Statistics





Phowo 3D Micro-Mapathon results will be released on https://uni-heidelberg.de/3dgeo

Results and data

We expect to

- identify **challenging issues** for users
- evaluate different **methods to aggregate** user contributions in a robust way
- evaluate **data quality** (180 TLS trees)

- push forward the **combination of automatic methods, simulation and crowdsourcing** in an effective way
  - reduce crowdsourcing effort (cf. Herfort et al. 2019)

Refs: Herfort et al. (2019)

Value of crowdsourcing for algorithms

Current bottlenecks of computer-based methods

- **Long process** of algorithm development
- Missing understanding of **causality** of results
- **Lack of data:** Training / test / validation data *etc.*

Independent data
& information

Refs: Griffiths & Böhm (2019)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simple and effective as possible
Let's map: https://uni-heidelberg.de/3dgeo

References

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