Mobile phone as educational tool

Example: noise map project

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Dubrovnik, May 9th, 2023.

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„Smartphones are part of our daily life now. They're always with us, always on, always connected. They're incredibly powerful tools that have changed the way we interact with the world around us." - Elon Musk.

How are smartphone apps used in education?

Language Learning Apps

- Duolingo, Babbel, and Rosetta Stone help students learn languages through interactive lessons, exercises, and games.

Flashcard Apps

- Quizlet and Anki allow students to create and study flashcards on a variety of subjects

Educational Games

- Kahoot!, BrainPOP, and Socrative provide educational games and quizzes that can be used in the classroom or for independent study

Note-Taking Apps

- Evernote and OneNote allow students to take and organize notes on their mobile devices

Reference Apps

- Wolfram Alpha, Google Scholar, and JSTOR provide access to a variety of resources, including academic articles, research papers, and reference materials

Productivity Apps

- Google Drive and Dropbox allow students to access and share documents, presentations, and other materials from their mobile devices.

Math Apps

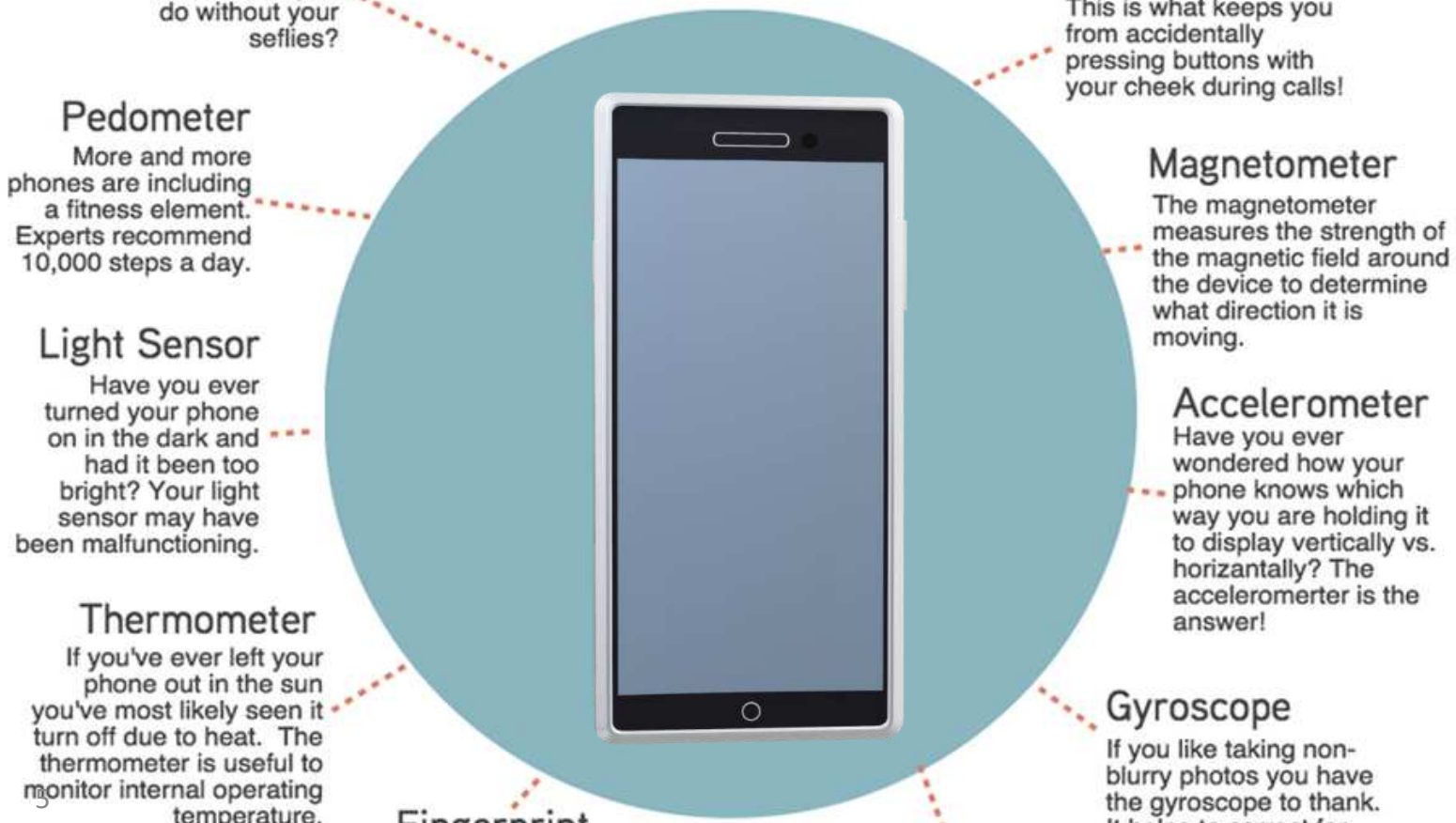
- Photomath and MyScript Calculator allow students to solve math problems by taking a photo or writing on the screen.

E-book Apps

- Kindle and Google Play Books allow students to access textbooks and other reading materials on their mobile devices.

Sensors Everywhere

The average smartphone has at least 10 sensors.
Here are the most common.



Camera
What would you do without your seflies?

Proximity Sensor
This is what keeps you from accidentally pressing buttons with your cheek during calls!

Pedometer
More and more phones are including a fitness element. Experts recommend 10,000 steps a day.

Magnetometer
The magnetometer measures the strength of the magnetic field around the device to determine what direction it is moving.

Light Sensor
Have you ever turned your phone on in the dark and had it been too bright? Your light sensor may have been malfunctioning.

Accelerometer
Have you ever wondered how your phone knows which way you are holding it to display vertically vs. horizantally? The acceleromerter is the answer!

Thermometer
If you've ever left your phone out in the sun you've most likely seen it turn off due to heat. The thermometer is useful to monitor internal operating temperature.

Gyroscope
If you like taking non-blurry photos you have the gyroscope to thank. It helps to correct for camera shake.

Fingerprint Sensor
The new fingerprint sensor adds an extra layer of security to your phone.

Microphone
The oldest sensor on any phone. Microphones make it possible for others to hear what you are saying.

https://amyingramblog.files.wordpress.com/2016/03/screen-shot-2016-02-29-at-9-59-43-pm.png

How are smartphone sensors used?

Accelerometer, gyroscope, and heart rate monitor to track physical activity, monitor workouts, and record health data

Fitness and Health Apps

GPS and compass sensors to provide turn-by-turn directions, real-time traffic updates, and location-based services

Navigation Apps

Camera, accelerometer, and gyroscope sensors to superimpose digital objects onto the real world

Augmented Reality Apps

Barometer sensors to detect atmospheric pressure and provide accurate weather forecasts

Weather Apps

Microphone and audio sensors to detect sound levels and adjust audio output accordingly

Music Apps

The proximity sensor and the camera sensor, to help people with disabilities access their phone's features more easily

Accessibility Apps

Use fingerprint sensors and facial recognition sensors to secure the phone and protect data

Security Apps

How are smartphone sensors used?

This app turns your device into a sound level meter, detects harmful environmental noises, and helps protect your hearing and health.

-Microphone to detect noise levels!

-GPS and compass sensors to provide turn-by-turn directions and location-based services.

-Camera to take pictures of the detected noise sources.

-Accelerometer, gyroscope, and heart rate monitor to track physical activity.

Noise measuring App

Problem formulation

Noise pollution is a serious problem in many cities.

Noise maps

Noise is defined as any unwanted sound in the environment where people live and work, causing an uncomfortable feeling and can adversely affect health.

The main sources of noise in outdoors are traffic, constructional and public work, industry, recreation, sport and entertainment.

Noise maps are representations of the current and anticipated level of noise emissions at all sites within the study area depending on one particular or all sources of noise.

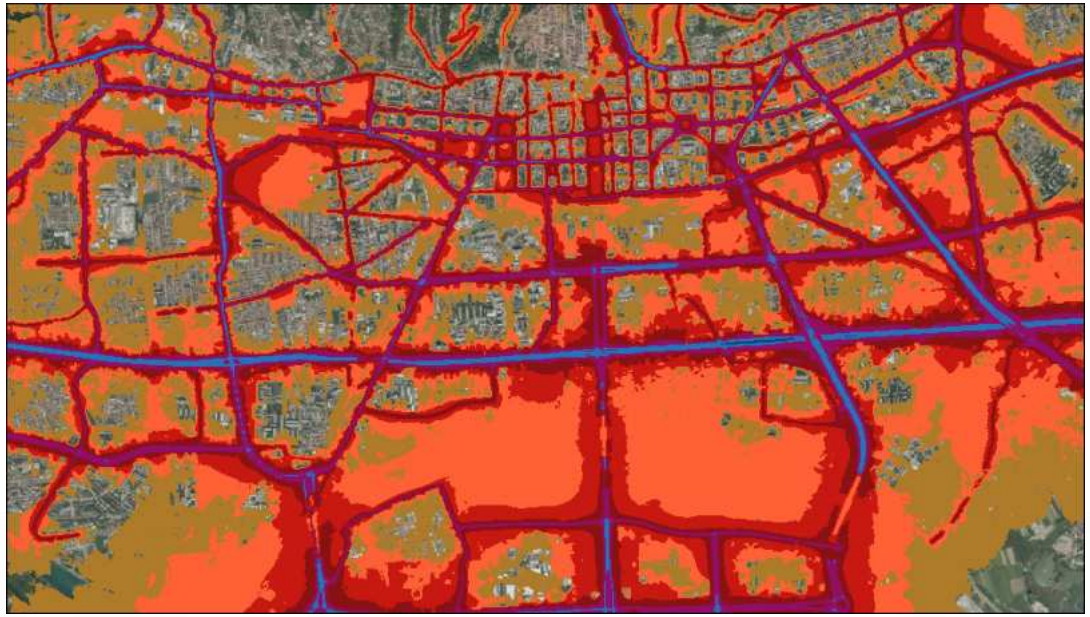
Noise maps

- Law on Noise Protection (Official Gazette 30/09, 55/13, 153/13, 41/06 and 114/18, 14/21) and the Ordinance on the method of preparation and content of noise maps and action plans as well as the methods of calculating permissible noise indicators (Official Gazette 75/09, 60/16 and 117/18).
- Strategic noise maps
- Action plans

Strategic noise maps

- Strategic noise maps - evaluates the population's exposure to traffic and industry noise and are made individually for road, rail, air traffic and industry, including associated infrastructure and facilities for sports and recreation, and especially facilities and areas particularly sensitive to noise (hospitals, schools, kindergartens, quiet areas, etc.).
- They consist of a textual and graphic part and are used primarily as a basis for creating action plans and as a source of data for informing the public.

Strategic noise map of the city of Zagreb (2018)



Zagreb Road trafic Noise Map (day)

Zagreb Road trafic Noise Map (night)

https://geoportal.zagreb.hr/Karta?tk=114

Action plans

- are made based on the results of the strategic noise map and the so-called conflicting noise maps, from which the difference between the existing or predicted state of noise immission and permitted noise levels is visible.

Action plans

- Strategic noise maps and action plans are an integral part of the environmental protection information system of the Republic of Croatia and form an expert basis for the creation of spatial plans and in the process of strategic assessment of the impact of plans and programs on the environment.
- They are permanently adapted to changes in the space and must be renewed every five years.
- Developed strategic noise maps and adopted action plans are submitted to the Ministry of Health and the European Commission.

Crowdsourcing

- Crowdsourcing is an outsourcing process that is traditionally performed by employees and transferred to an undefined group of people in the form of an open call (Howe, 2006).

- Voluntary collection of information about space or the situation in space through citizens represents a significant step forward in the design of management systems and enables the elimination of certain weaknesses of the concept of smart cities.

Crowdsourcing

https://amyingramblog.files.wordpress.com/2016/03/screen-shot-2016-02-29-at-9-59-43-pm.png

Smartphones have taken crowdsourcing to a new level.

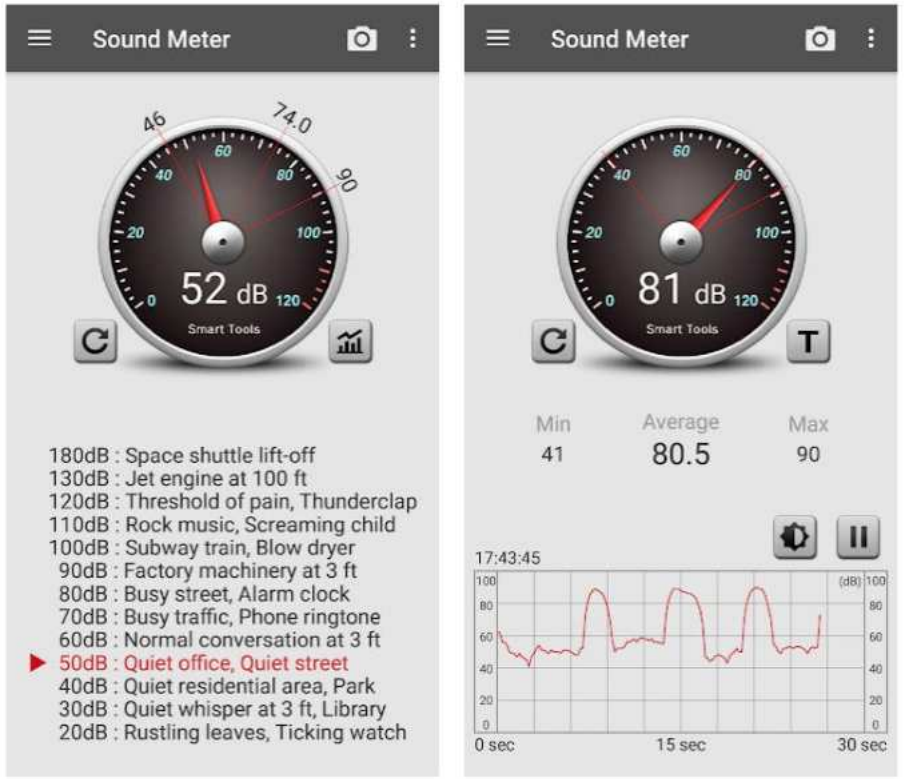
They include many built-in sensors such as camera, GPS receiver, microphone, proximity detecting sensor, compass, accelerometer, gyroscope etc.

Crowdsourcing

Mobile phones as sound measuring device.

Citizens measures noise exposure in their environment.

Participation of citizens in controlling noise pollution.



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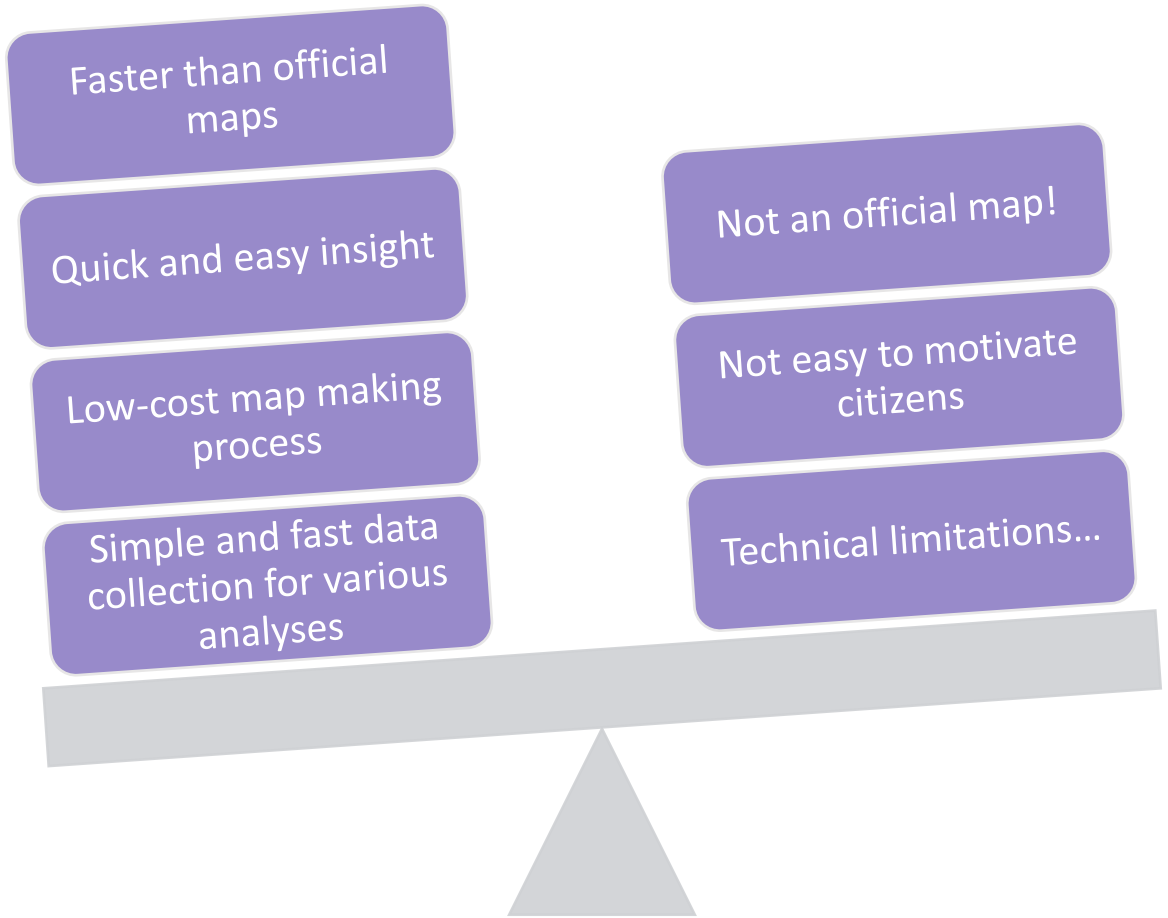
Positive

Negative



Thank you for your attention!

Questions?

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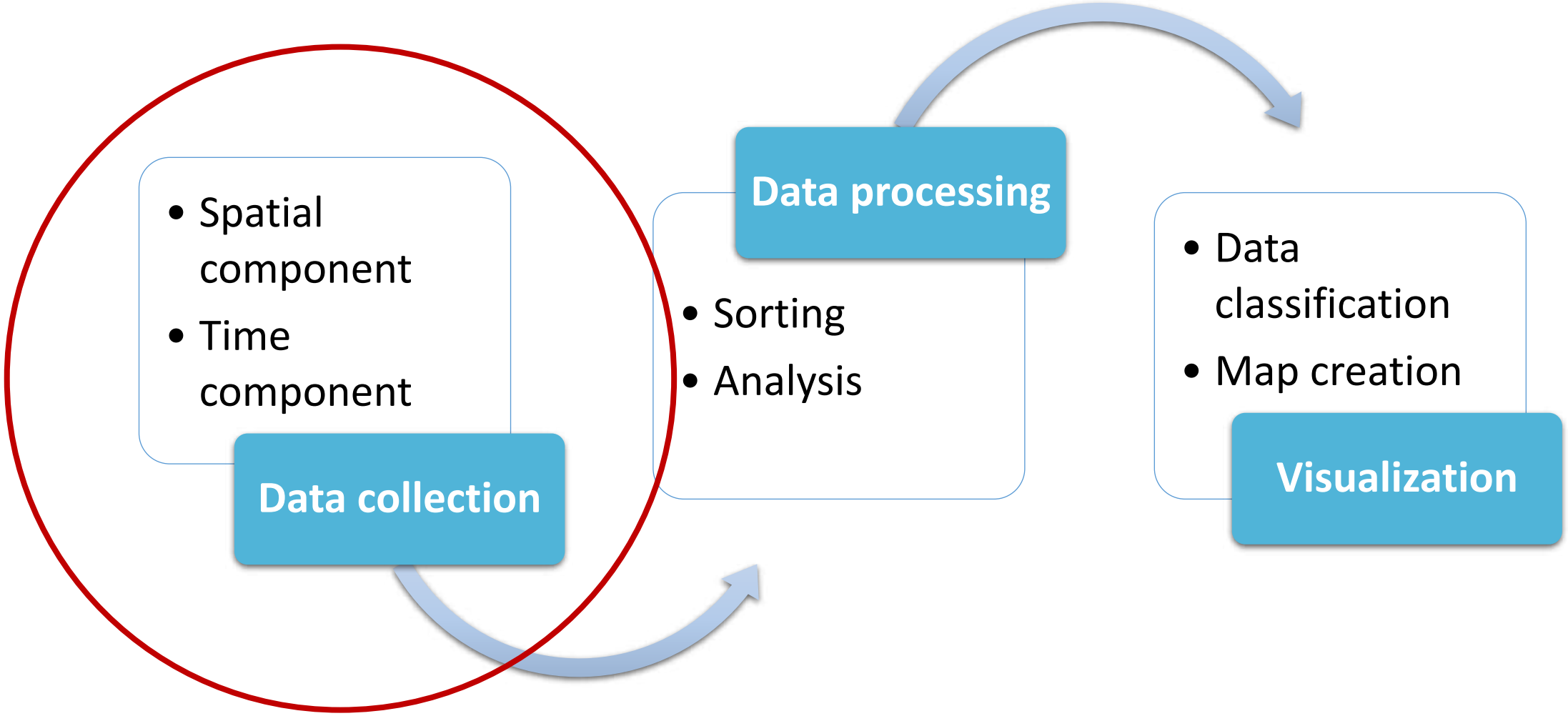
Noise maps are representations of the current and anticipated level of noise emissions at all sites within the study area depending on one particular or all sources of noise.

Task for today

Using a noise level measurement application installed on mobile phone, measure and collect data of noise in the selected area and create a noise map based on this data.


Data collection
• Spatial component
• Time component
Data processing
• Sorting
• Analysis
Visualization
• Data classification
• Map creation

Noise Capture

Android application only!

The application record:

- decibel level dB(A),
- coordinates (WGS84),
- date and time.

*The application registers the measurement every 1 second.

Collected measurements are saved in local memory of a mobile phone in .JSON format.

Data collection

Before using the application for the first time, enable access to the device's memory, access to the microphone and location. During the measurement, the mobile device must have an Internet connection and location services turned on. Calibrate the application manually if possible.

Hold the phone in front of you pointing "away" with as little movement and shaking as possible.

Start walking immediately after pressing the recording icon and record for 10-15 minutes, stop the recording, save it to the mobile device and start a new session/measurement.

Maintain a constant, natural walking speed during track recording. Never walk too fast, run or cycle with the intention of saving time.

GIS Software for tomorow

1. QGIS – „professional GIS application that is built on top of and proud to be itself Free and Open-Source Software (FOSS)”

2. ArcGIS Online – „content management system comprised of applications and templates for creating interactive maps”

Download QGIS

Account Login - ArcGIS Online

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Thank you for your attention!

Questions?

LET'S MEASURE SOME NOISE!

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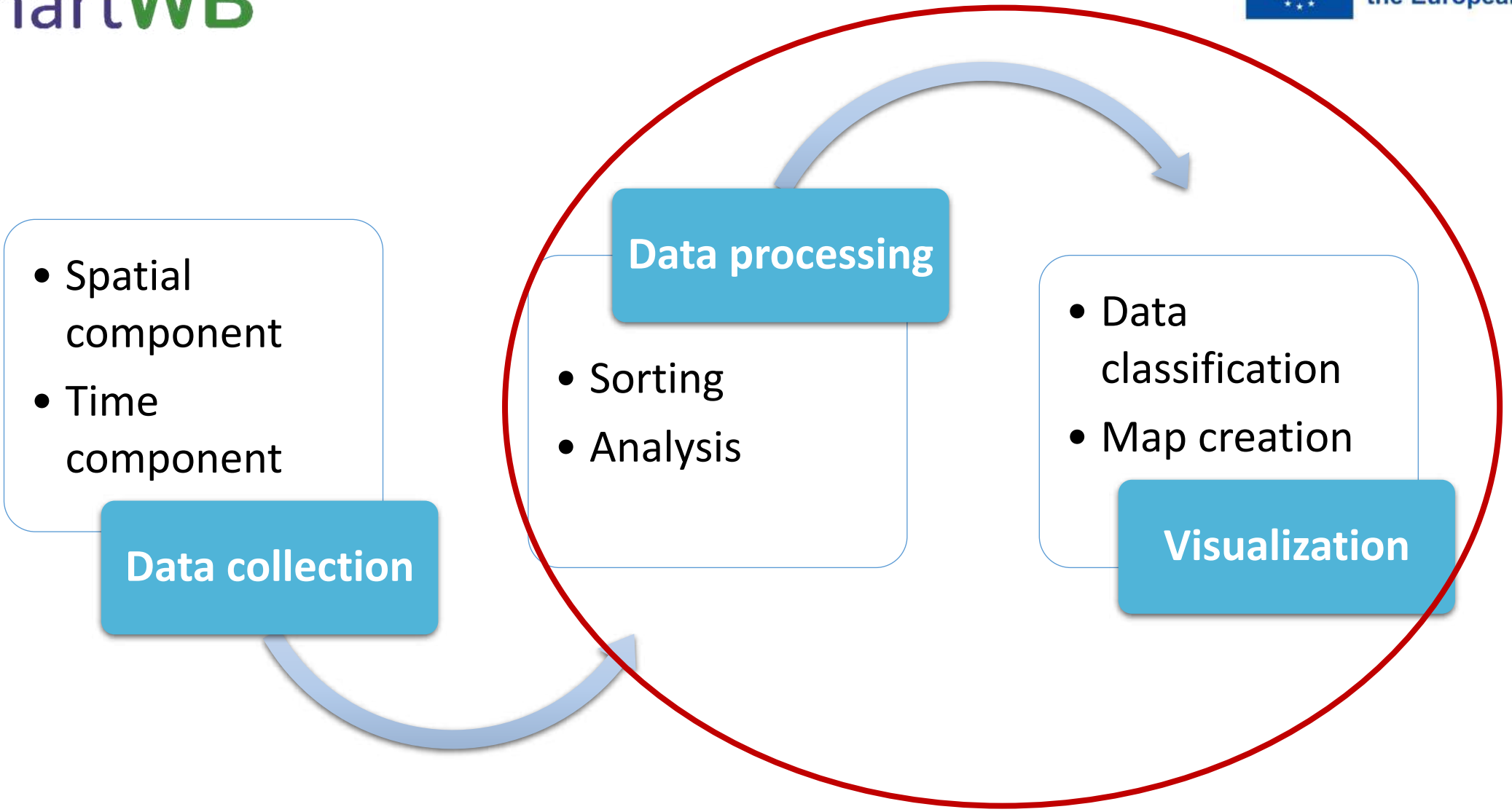
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Download QGIS

Account Login - ArcGIS Online

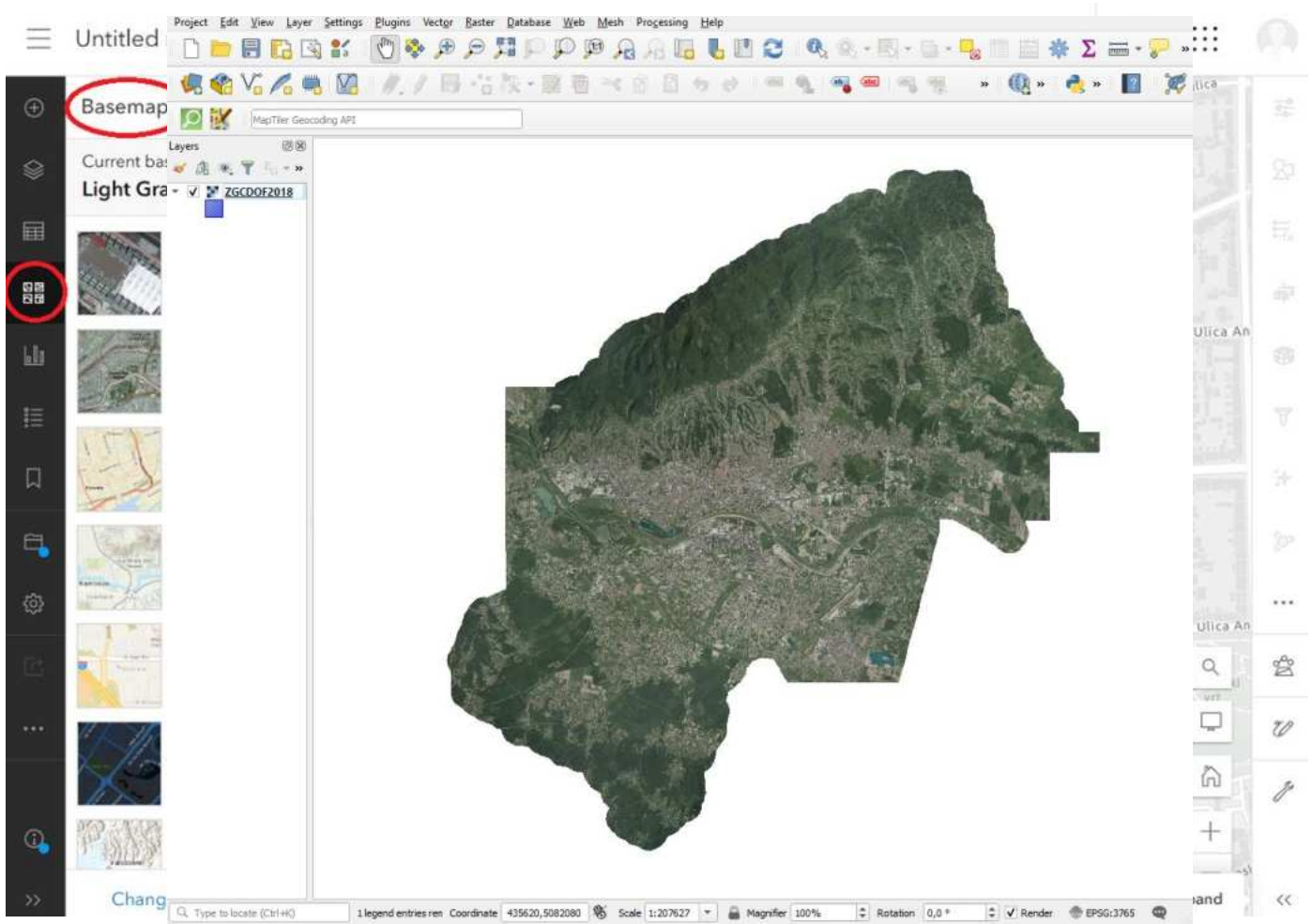
1. Basemap

ArcGIS Online:

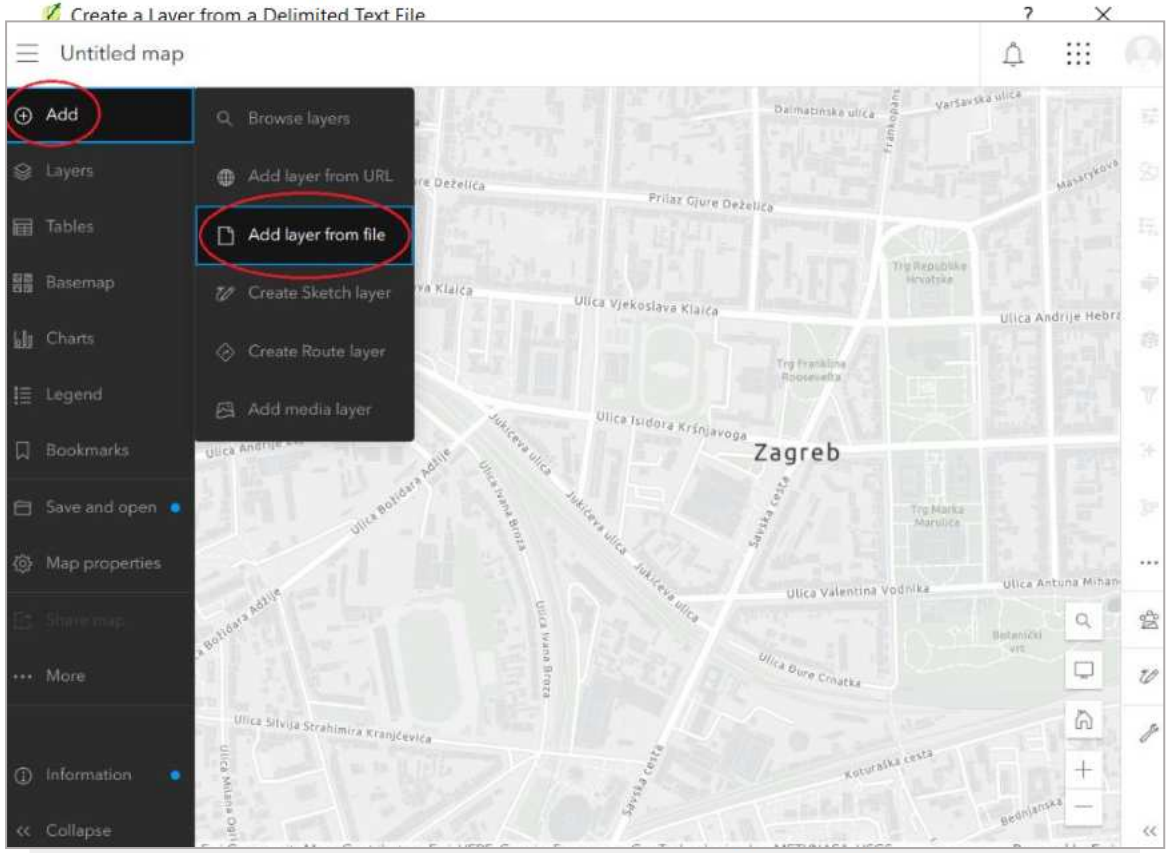
Basemap

QGIS:

Layer→Add layer→Add WMS layer



2. Upload measurement



ArcGIS Online:

Add →Add Layer From File

QGIS:

Layer→Add layer→AddDelimitedTextLayer

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Data downloaded in GeoJSON format needs to be converted to .shp format.

Note: If invalid measurements appear in the data set, they must be dropped before entering them in the program (eg no coordinates are recorded, an extremely high db value is recorded, etc.).

Data processing

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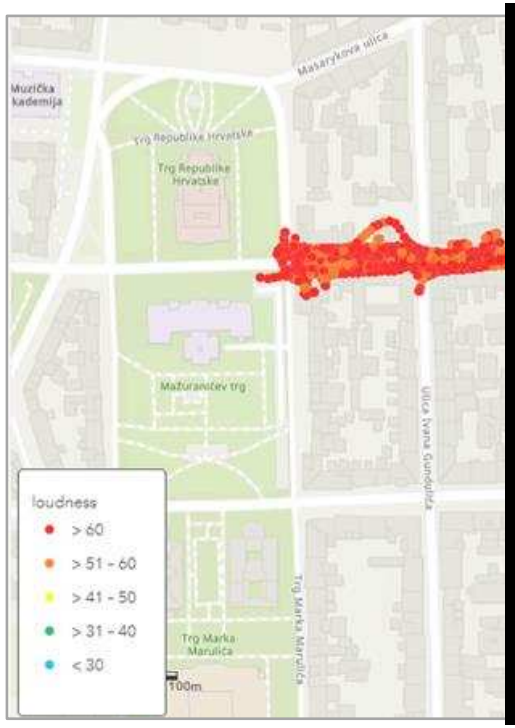
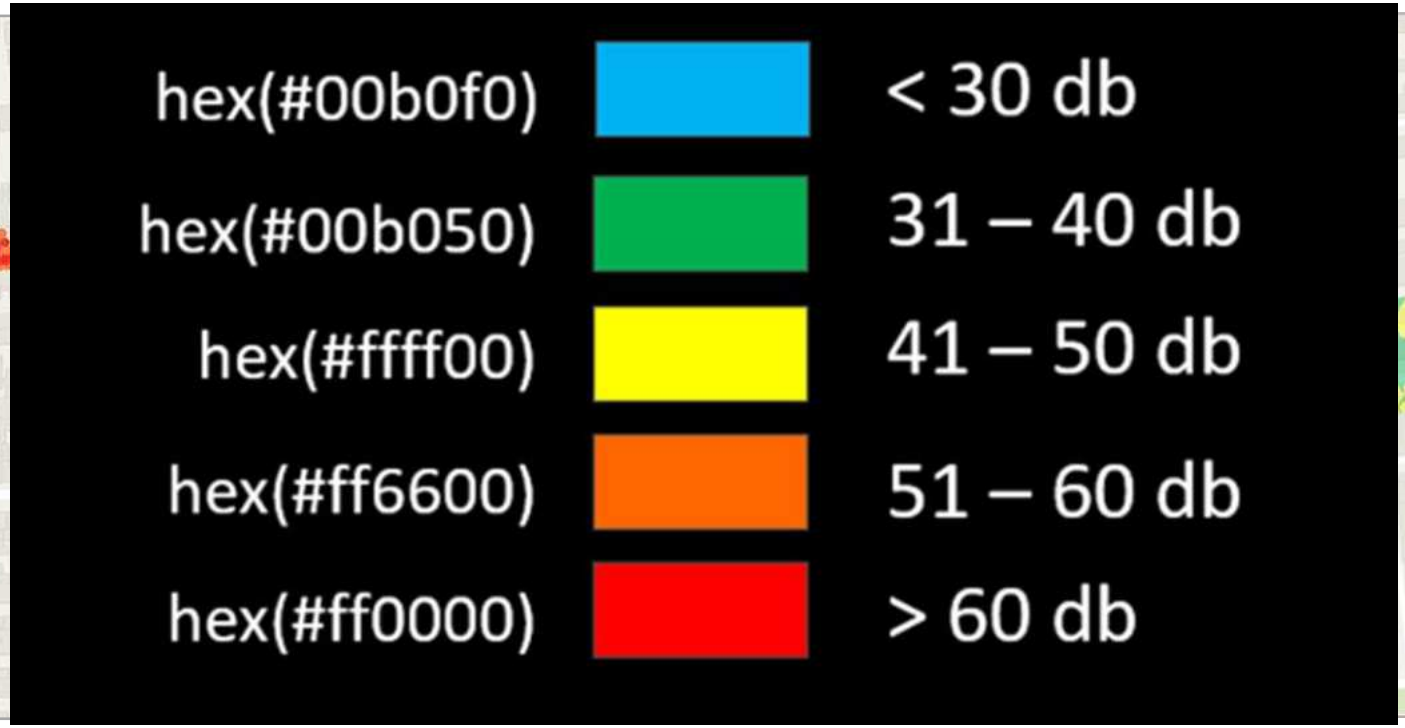
Spatial interpolation is the process of using points with known values to estimate values at other unknown points.

3. Classification





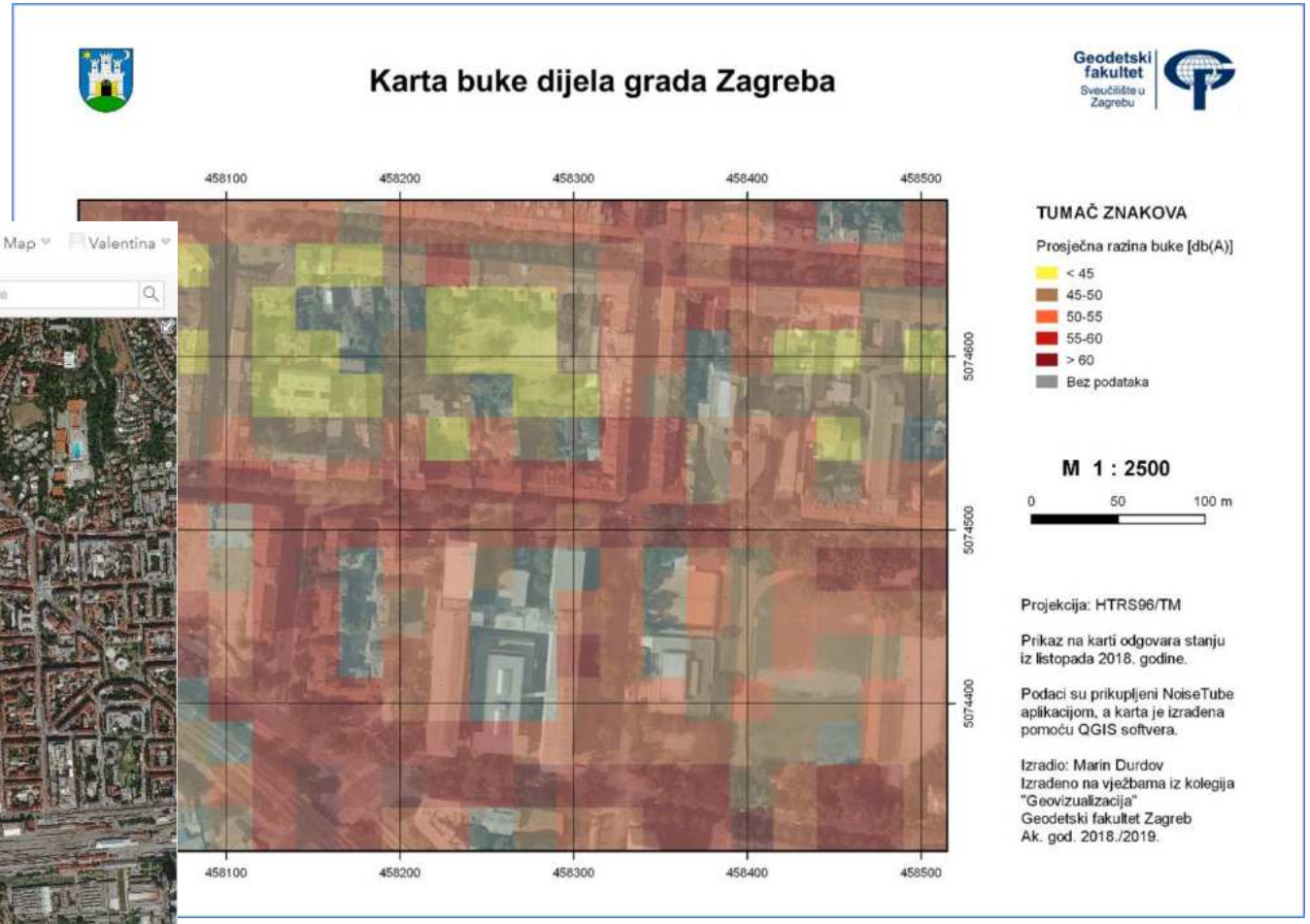
4. Interpolation

Classification rules

1. All values must be included within the classification.
2. Classes must not overlap, and there must not be empty classes.
3. The number of classes must be such as to maintain the accuracy with which the collected data provide some information.
4. If possible, the classification method should be based on some mathematical model.

The Basics of Data Classification, link
Data Classification in Mapping, link

Final result



Conclusion

The described noise map was made by open-source application for the noise measurement, a open-source programme for data processing, and on the mobile device.

The greatest advantage of the described model:

- obtained presentation offers a real and comprehensive illustration of the noise pollution in the area (with the reference to all noise sources),
- map can be made by engaging the community, when necessary,
- simply making general conclusions about the noise in the environment and
- can indicate newly created environmental noise pollution.

Conclusion

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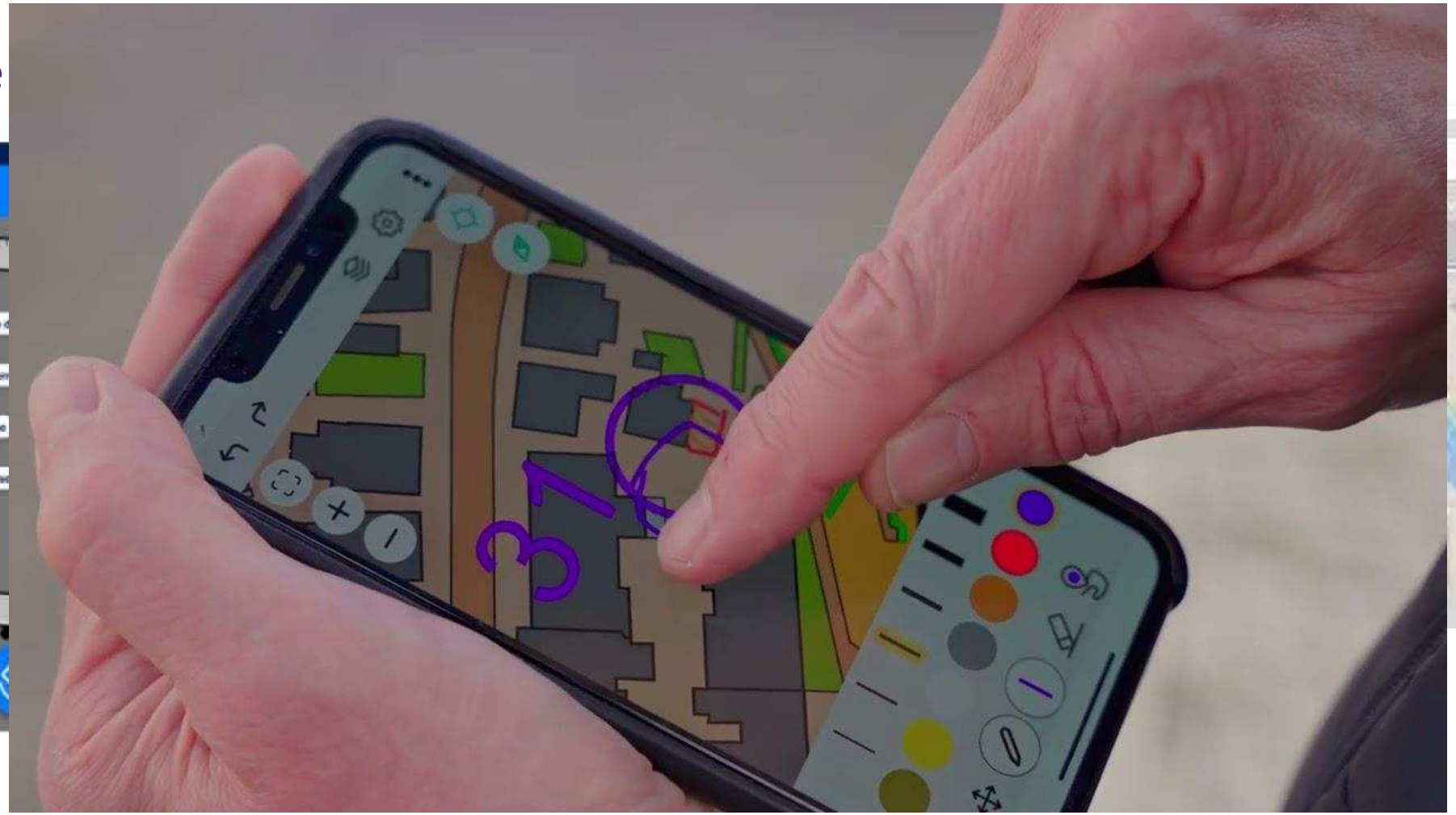
Mobile



Conclusion

SCIENCE

Mobile sensors such as the accelerometer, gyroscope, and magnetometer can be used to teach physics and astronomy concepts such as motion, gravity, and magnetic fields. For example, students can use a smartphone app that displays data from these sensors in real-time to visualize the behavior of objects in motion or explore the properties of magnetic fields

GEOGRAPHY

GPS sensors can be used to teach geography concepts such as latitude and longitude, distance, and direction. Students can use a smartphone app that displays their location on a map and provides information about nearby landmarks, natural features, and cultural sites

ENVIRONMENTAL SCIENCE

Sensors such as the barometer and thermometer can be used to teach environmental science concepts such as weather patterns, climate change, and atmospheric pressure. Students can use a smartphone app that displays data from these sensors to track weather patterns, measure temperature changes, and explore the impact of human activity on the environment

HEALTH

Sensors such as the heart rate monitor and pedometer can be used to teach health and fitness concepts such as cardiovascular health, physical activity, and nutrition. Students can use a smartphone app that tracks their physical activity and provides feedback on their progress towards fitness goals

ENGINEERING

Sensors such as the camera and microphone can be used to teach engineering concepts such as signal processing, computer vision, and image analysis. For example, students can use a smartphone app that analyzes sound waves to study acoustic patterns or a camera app that uses image recognition to identify objects and patterns.

Thank you for your attention!

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