

CS486C – Senior Capstone Design in Computer Science

Project Description

Data integrity and abuse prevention to enable equity in community science for conservation



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Project Overview:

1 – Context

In December 2022, 188 governments of the world agreed to conserve 30% of the land and sea globally by 2030. This agreement, the Kunming-Montreal Global Biodiversity Framework, or 30x30, came as a new addition to the Convention on Biological Diversity (CBD). This is an ambitious step for the international community and local populations across the globe. While being a major progress towards the preservation of biodiversity, and the ecosystem services it provides, it comes with multiple challenges. Equity and inclusivity are major concerns for populations directly impacted and engaged in conservation areas, as conservation has a challenging history in this regard¹. Ensuring the achievement of conservation targets requires intensive monitoring of essential biodiversity variables.



Citizen scientists contribute valuable data for academic research and conservation. Enhancing equity and inclusivity can expand its reach and value.

2 – Our team work

In a recent paper², we proposed to answer both concerns by turning them into an opportunity for populations directly impacted by conservation. Specifically, we advocate for advancing the monitoring of biodiversity for conservation targets by relying on equitable and inclusive citizen science (also known as community science). Citizen science is the method by which non-academic persons can contribute to the advancement of science and knowledge by their observations. By pairing remote sensing with citizen science, we can ground-truth satellite data more accurately and

1 Blanc, Guillaume. *The invention of green colonialism*. John Wiley & Sons, 2022.

2 <https://doi.org/10.1038/s41893-024-01309-7>

3 <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0226534>

4 <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0295298>

5 <https://www.mdpi.com/1424-2818/16/1/42>

expand the use of these products. Citizen science observations can also provide information about parameters not observable with remote sensing.

3 – Key concerns

Several citizen science apps have been deployed, such as eBird, iNaturalist and Globe. While they are formidable tools in their own regard, we identify two components which could enhance their contribution to achieving the 30x30 conservation targets. First, their reliability is still debated and could be improved^{3,4,5}. For example, they might be mismatched with other sources of data, e.g. satellites, which is a challenge for validation. Second, citizen scientists are not incentivized to contribute to standardized biodiversity monitoring through these apps. Though experiments are being conducted on this question, it will raise specific concerns (see below).

4 – Broader Solution

This second item is critical to engage citizen scientists and to promote equity and inclusivity in conservation at the global scale. We are developing an initiative that will ultimately transfer payment to citizen scientists for participation in biodiversity monitoring. While it is already possible for citizen scientists to contribute for free to existing apps, providing payment introduces critical changes and challenges. Addressing them is necessary to ensure the reliability of such feature. A first challenge is to ensure that community science collected is verifiable and trust-worthy. This implies to ensure that contributed data points are not fabricated or that the app system can be abused. This can be dealt with similarly to other apps for which security is a concern and specifically tailored for the nature of these data.

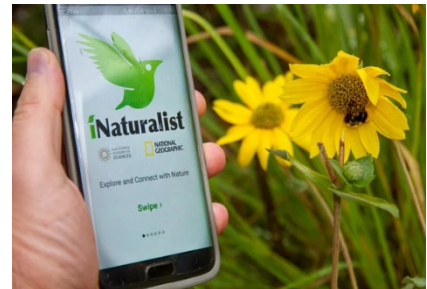
5 – Key features

This project will build a module that can plug into any citizen science app to address the necessary verification concerns for data collected and uploaded.

This project will focus on the following key features. First, it will be able to verify time and coordinate of acquired data, able to function offline. Second, it will include a data authenticity feature, ensuring that the data and metadata were not forged, duplicated or modified in any way. This includes protection against tempering with the data as well as with the app itself. These should allow for sorting out pseudo-duplicate (e.g. photography of a single sample from different angles with slight time variation).

6 – Overall Impact

With this plug-in ready module, we will be able to implement a pilot citizen science project to evaluate the feasibility of verifying contributed data and metadata, based on existing or newly developed apps. Successful outcomes will enable the mainstreaming of payment and verification in citizen science apps. By deploying, at global scale, our proposed solution for monitoring essential biodiversity variables, and engaging local populations as citizen scientists for conservation, we will foster equity and inclusivity towards global conservation targets.



Citizen science apps have relatively low security concerns. However, adding payment for data contribution will introduce new risks and of higher concern.

Some of the key functions supported by this product should include:

- Minimum Viable Product: A module/extension to an existing citizen science app or an independent software ready to be plugged in any citizen science app; coded for either iOS or Android.
 - This product will be able to track the acquisition of data with a smartphone, online or offline (i.e. out of network/signal), as well as its metadata in terms of time (smartphone internal clock) and location (smartphone GPS).
 - The module will ensure that the uploaded data points have not been tampered with or abused by either digital or physical methods.
 - Digital: Avoid data duplicates, reuse of data, tempering with data or app, fabricating data.

- Physical: Avoid multiple uploads of the same data points by multiple users or by repeated submissions from the same user (e.g. a person taking pictures of the same plant from different angles at different time of the day).
- Complete Product: In addition to the above functionality the final product should integrate:
 - A quality check feature: Recorded data can be corrupted or of poor quality or associated to incorrect metadata. Such issues should be automatically accounted for, to ensure both the citizen scientist fair recognition of contribution, and the scientific validity and usefulness of the data.
- Stretch Goals: Additional features would take this software/module to the next step. *These are shared across two projects and should be synergized*:
 - A point system: Users are awarded points for their data contributions. These points are based on a variety of criteria which will be supplied by the client (e.g. rarity of the data point, place, time, species or quality of the data point). The product will internally aggregate the points awarded per user. It will also be able to export the points per user to be used by a different entity (accredited institution).
 - Pairing app with relevant satellite tracks (recorded or anticipated), to optimize the match between remote sensing and ground observation. This would improve the monitoring of essential biodiversity variables for conservation and could contribute to shape the points system.
 - Porting the app to iOS if developed on Android, or to Android if developed on iOS.
 - Some of the app's components will ideally be developed in coordination with the Capstone working group "Automatic data verification for community science contribution to conservation monitoring". If possible, this will be associated to a point system rewarding users for specific contributions (relatively to time and space or species), which could be redeemed for payment down the line (coordinated with associated working group).

A note on not reinventing the wheel... To our knowledge there is no available tool providing all the outlined elements in a similarly comprehensive package. What is unique about this project is none of its sub-components, but their integration and their function and goal. Thus, we encourage you to use existing code and can provide support from developers of existing citizen science apps.

Knowledge, skills, and expertise required for this project:

- This project is to be developed in coordination with another project "Automatic data verification for community science contribution to conservation monitoring"
- Skills/knowledge in software/hardware integration, low-level mobile security (e.g. to make sure that users do not temper with mobile GPS outside of the app to abuse the app)
- Skills/knowledge in data security
- Skills/knowledge in mobile app development (iOS or Android)
- Coding language can be flexible

Equipment Requirements:

- No specialized software or equipment should be required for this project, beyond a standard software development stations and free IDEs, frameworks, and other tools.
- Obviously, smartphones with data recording capabilities (camera) are required to test the software.