OzTrack: Data Management and Analytics Tools for Australian Animal Tracking

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INTRODUCTION

Studying animal movements is of critical importance when addressing environmental challenges such as invasive species, infectious diseases, climate and land-use change. The number of species tracking projects in Australia is rapidly expanding - due to both the reduction in the cost of tracking devices (radio, acoustic, and satellite) and the need for ecology management communities to study the behaviour of species across taxa, space and time. The high resolution sensor and tracking devices deployed to monitor species typically generate very large datasets which can be difficult to interpret without advanced analytical computing and visualization tools. Much of the animal tracking data collected from within Australia is not analysed or stored in an efficient and systematic manner, and as a direct result data loss and study repetition is common. The aim of the OzTrack project is to develop the critical data management infrastructure needed to support the animal tracking research community. The project is developing three software components that are described in more detail below:

- A central repository for the data and metadata being generated;
- A set of analysis, modeling and visualization services;
- A Web portal interface that enables scientists to search, retrieve, analyse and visualize the data.

ANIMAL TRACKING DATA REPOSITORY

The management of animal tracking data can be extremely onerous: some projects generate millions of observations within relatively short timeframes. Usually each data record includes an animal ID, a geolocation and a timestamp, but can also include sensor data such as animal body temperature, heart rate, altitude/depth, and environmental temperature. The other major challenge is the variety of hardware and software tools used, resulting in a variety of file formats, data types, units and resolutions. Filtering and unit/extent conversion operations are often performed on dates, timestamps, coordinates, and sensor measurements. Not surprisingly, a data management workflow which systematically collects, converts, stores and indexes data (and documents provenance) is a high priority. Figure 1 shows the workflow and overall architecture for the OzTrack system.

OzTrack users firstly provide metadata describing their projects, identify team members and define access rights for data files. User authentication and authorisation is a critical component of OzTrack and has been implemented via the AAF. Once a project exists, team members upload datafiles via a webform. The upload process handles a variety of different date, time and geospatial coordinate formats. After processing and validation, the data is stored in an object relational database (PostgreSQL) with spatial extensions (PostGIS).

ANIMAL TRACKING ANALYTICS

The spatial and temporal complexity of animal tracking data prohibits effective analysis without visualisation tools, but fortunately, many helpful tools are freely available in the open source software domain. Within OzTrack we use:
• GeoServer[1] and OpenLayers[2] to visualize location data for one or more animals.
• Adehabitat [3], an open source package written in R[4] containing commonly used habitat analysis tools. This package is often used in the animal tracking research community, particularly the mcp function which computes a home range size estimation and provides plots and spatial visualisations of the results.
• V-track, a new R package for passive acoustic data analysis currently under development at the UQ EcoLab[5]. Acoustic data requires unique statistical analysis techniques. This package allows analysis of movement data, and discovery of diving, resting, feeding or surfacing events.

**OzTrack Web Portal**

The OzTrack Web application (see Figure 2) provides researchers with data upload, visualisation and analysis tools. Figure 2a shows the Home page and map search and browse interface. Users can search for data associated with particular projects, animals, regions or time periods. Figure 2b shows the user interface for creating a new project. The Java based web application implements Spring MVC and Spring Security running on a Tomcat server backed by PostgreSQL/PostGIS. The database and web application interact with GeoServer and R to provide the mapping and analysis tools.

![Figure 2: OzTrack Screenshots: Home Page and Creating a Project](image)

**DATA SHARING, CONCLUSIONS AND FUTURE WORK**

Experienced animal tracking ecologists[6] within the UQ Eco-Lab[5] have guided development of Oztrack. They are very excited about the ability to archive, analyse and share their animal data through an online authenticated interface. In the longer term, they hope to open the system to other animal tracking researchers, both within Australia and abroad.

Based on advice from the researchers, our approach has been to make only project metadata publicly available (through ANDS RDA [7]). Access to the detailed tracking data is possible at the discretion of project owners. This is ideal for researchers who wish to promote their research and discover similar research (via RDA), whilst still protecting the intellectual property contained within their datasets.

Future work includes: developing more advanced search functionality, animating animal tracks and integrating/overlaying related landuse and climate data.

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**REFERENCES**