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Establishing the Integrated Science of Movement: bringing together concepts and methods from animal and human movement analysis

Supplementary information 2 - Open data and open software

In this document we provide a 2020 snapshot of availability of open data and open software for movement research.

Open data can take many forms. Data can either be made available as supplementary information or placed in an archive with a stable DOI. For animal movement data, one of the most popular and largest open archives is *Movebank.org*, which allows publication of movement data from any species and any sensor type. Other archives specialise in specific taxa or species, such as for example *Eurodeer.org* and *Euromammals.org*. There is an increasing number of other broader archives, which are not limited to movement data. For example, *Lifewatch.be* allows any type of ecological data. On human side movement data are available through open repositories (e.g. *Crowdad.org* for mainly Eulerian data from wireless networks and *Chorochronos.org* for various movement data) and through governmental data centres which provide open movement data for research purposes (e.g. the Urban Big Data Centre at the University of Glasgow, *ubdc.ac.uk*, provides to researchers at UK universities GPS trajectories of a sample of Glaswegians). Other data sources include specific data sets, collected by companies for various purposes and made freely available online (e.g. the *GeoLife* GPS trajectories, NYC Taxi and Uber Trips) and crowdsourced data (e.g. GPS tracks from *OpenStreetMap.org* and from *envirocar.org*). Further, there are general archives that are open to any kind of data, such as *figshare.org* and *zenodo.org*, but which also host various movement data sets. A further development that movement analysis is benefiting from is that the open data trend is becoming ubiquitous for environmental data, such as satellite remote sensing data (Turner et al. 2015).

The provision of Free and Open Source Software (FOSS) has grown rapidly across most movement disciplines. In ecology, the most popular option for releasing analytical software is the *R Computing Environment* and there are many R packages for movement available either through the official CRAN archive or in online code repositories, such as *github.com*. A recent review finds 58 R packages for movement analysis in ecology (Joo et al. 2019). There are several other R packages that are specifically developed for analysing movement data in specific application areas (see for example *stplanr*, *trajectories*, etc.). At the same time the *Python Programming Language* is increasingly popular in GIScience and other data focused disciplines and there now exists specific packages developed for movement data (e.g. *MovingPandas* (Graser 2019a)). Outside of these two core programming languages, many examples of bespoke free (and often open source) programs for analysing and visualising movement are being developed by researchers and released through their own websites and or various other repositories (for example, *DynamoVis* (Dodge et al. 2018)). R packages for movement visualisation are *moveVis* (Schwalb-Willmann 2017) and *anipaths* (Scharf 2018), and the equivalent Python package is called *trackanimation* (Martin Miralles 2017).

References

- Dodge S, Xavier G and Wong WY, 2018, *DynamoVis - Dynamic Visualization of Animal Movement Data*. Retrieved from the Data Repository for the University of Minnesota, <https://doi.org/10.13020/D6PH49>
- Graser A, 2019a. *MovingPandas: Efficient Structures for Movement Data in Python*. *GI_Forum*, 1:54-68. https://doi.org/10.1553/giscience2019_01_s54
- Joo R, Boone ME, Clay TA, Patrick SC, Clusella-trullas S and Basille M, 2019. Navigating through the R packages for movement. *Journal of Animal Ecology*, <https://doi.org/10.1111/1365-2656.13116>
- Martín Miralles JJ, 2017. *Librería de Python para el trazamiento y la animación de trayectorias de GPS almacenadas en ficheros con formato GPX*. Bachelor thesis, Universitat de les illes Balears, Palma. Available from <https://pypi.org/project/trackanimation/>

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- Scharf H, 2018, anipaths: Animation of Observed Trajectories Using Spline-Based Interpolation. *CRAN R package*, <https://CRAN.R-project.org/package=anipaths>.
- Schwalb-Willmann J, 2017, moveVIS: Movement Data Visualization. *CRAN R package*, <https://CRAN.R-project.org/package=moveVis>.
- Turner W, Rondinini C, Pettorelli N, Mora B, Leidner AK, Szantoi Z, Buchanan G, Dech S, Dwyer J, Herold M, Koh LP, Leimgruber P, Taubenboeck H, Wegmann M, Wikelski M and Woodcock C, 2015. Free and open-access satellite data are key to biodiversity conservation. *Biological Conservation*, 182:173-176. <https://doi.org/10.1016/j.biocon.2014.11.048>

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