Interactive 3D visualizations of environmental data using the terrainr R package

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# 1 Introduction

Environmental decision making is a complex process, requiring stakeholders of varying educational and professional backgrounds to communicate and negotiate about differing environmental value systems to determine a mutually-agreeable course of action. One of the key challenges in this process is the translation of background knowledge and expertise between stakeholders, particularly as members of the public become increasingly involved in making landscape management decisions. For this reason, visualizations have often been described as a “common language” which may help stakeholders understand one another more effectively, allowing stakeholder values, background knowledge, and statistical information to be communicated in a more intuitively understandable format (Nicholson-Cole 2005). In particular, interactive visualizations may allow stakeholders with less formal training more agency to explore data and simulations on their own, potentially identifying preferred alternatives or problematic assumptions baked into the presented analysis. To this end, interactive simulations have been used for engaging the public to great effect in domains such as transportation policy (Lovelace, Parkin, and Cohen 2020) and urban planning (Pettit et al. 2015).

However, many environmental problems don’t lend themselves to the types of interactive graphics that have flourished elsewhere While some metrics may be easily plotted, others (such as visual impact, ecological integrity, or land management histories) require more context than can be communicated through standard visualizations. While interactive 2D maps are able to provide some spatial context to data, they often still require users to think about a landscape in a highly abstract way, attempting to match colors on a map to regions of a color key located elsewhere, match symbols to values in a legend (or to values implicitly assumed to be understood), and to convert pixel distances and areas into their real world equivalents. This level of abstraction can make maps rather difficult to understand, limiting their value as a translational tool (Ottosson 1988).

This limitation may be overcome by creating more true-to-life renderings of an area of interest, visualizing landscapes more similarly to how they might appear in the real world. TK ALREADY DONE FOR VISUAL RESOURCES TK. These visualizations are more effective when produced at higher resolutions, with increased realism and visual fidelity (Appleton and Lovett 2003); however, producing these highly realistic renderings typically requires more computational power and technical knowledge than more abstract 2D maps.

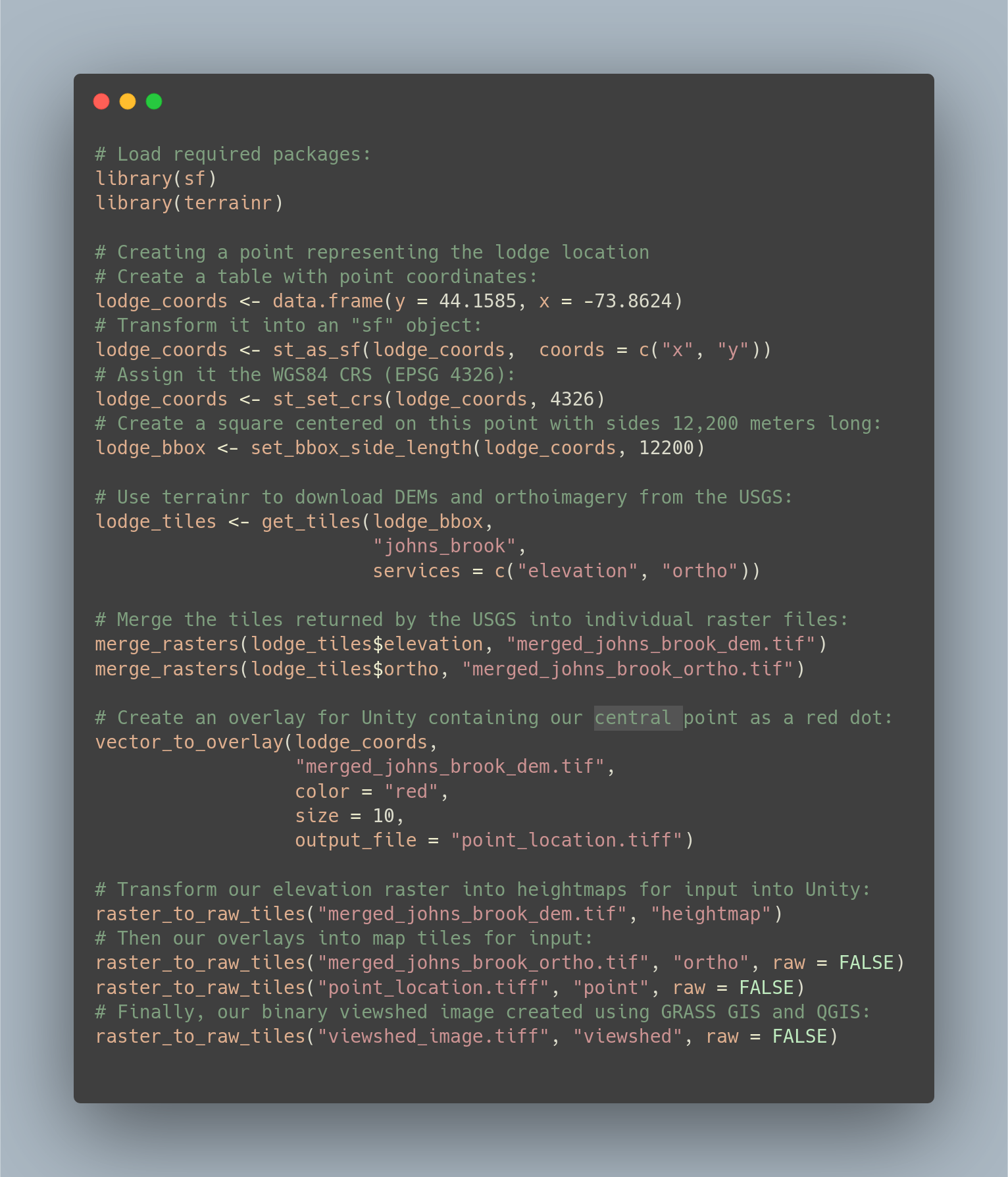
Game engines have been proposed as a potential solution for the demanding requirements of producing these renderings (Herwig and Paar 2002). These programs, specifically tuned to render terrain at high resolutions quickly enough so that players in a video game won’t notice any computation lag, can simulate large-scale landscapes using mass market computer equipment. The most popular of these engines, the Unity real-time development platform (Unity Technologies 2020), has been used to produce 3D landscape visualizations since at least 2010 (Wang et al. 2010). However, while Unity solves many of the computational obstacles to the use of large-scale 3D renderings, it still demands a high level of skill and familiarity for users to produce landscape visualizations. Perhaps for this reason, Unity is still under-utilized as a tool for 3D landscape visualization.

This paper describes the terrainr package (Mahoney 2021), an extension for the open source R programming language (R Core Team 2020) which assists users in retrieving, manipulating, and transforming spatial data for importing to Unity, and illustrates how this package may be used as part of a workflow for visualizing visual impacts and viewsheds. By depicting landscapes in a more concrete form than typical 2D maps, this workflow produces renderings that may be more intuitively understandable for a generalist audience, serving as an effective tool for translating between stakeholders in an environmental decision making process.

# 2 The terrainr R package

# 3 Viewshed Analyses with terrainr

To illustrate how these features may be applied to visual resources stewardship, we will walk through visualizing an example viewshed analysis using terrainr and Unity. All the code involved in this process has been included as Figure @ref(fig:code\_required).



(#fig:code\_required)All the R code required for the visualizations incorporated in this paper. In addition, viewshed calculation was done using GRASS GIS version 7.8, with the outputs saved as an image using QGIS. Descriptions of functions and their arguments is available online at <https://docs.ropensci.org/terrainr/>

# 4 Discussion

# 5 Conclusion

# References

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