A clustering algorithm to organize satellite hotspots data for the purpose of tracking bushfires remotely

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Abstract An abstract of less than 150 words.

Introduction

Bushfires are a major problem for Australia, and many other parts of the globe. There is concern that as the climate becomes hotter, and drier, that the impact of fires becomes much more severe and extensive. In Australia, the 2019-2020 fires were the worst on record causing extensive ecological damage, as well as damage to agricultural resources, properties and infrastructure. The Wollemi pine, rare prehistoric trees, required special forces intervention to prevent the last stands in the world, in remote wilderness areas, from being turned into ash.

Contributing to the problem is that many fires started in very remote areas, locations deep into the temperate forests ignited by lightning, that are virtually impossible to access or to monitor. Satellite data provides a possible solution to this, particularly remotely sensed hot spot data, which may be useful in detecting new ignitions and movements of fires. Understanding fires in remote areas using satellite data may provide some help in developing effective strategies for mitigating bushfire impact.

This work addresses this topic. Using hot spot data, can we cluster in space and time, in order to determine (1) points of ignition and (2) track the movement of bush fires.

This paper is organised as follows. The next section provides an introduction to the literature on spatiotemporal clustering and bush fire modeling and dynamics. Section Algorithm describes the clustering algorithm, and section Application illustrates how the resulting data can be used to study bush fire ignition.

Background

Spatiotemporal clustering

Bushfire modeling

Algorithm

Data pre-processing

Steps

This algorithm runs in a temporal manner. Starting from the first hour of the first day or the bushfire season, hotspots are grouped, and then agglomerated spatially. This proceeds to the next hour.

1. Divide hotspots by hour

Hostpots will first be divided into hours as shown in Figure 2. Notice the unit of time is an arbitrary choice. Theoretically, it can be replaced with any other units not larger than the total length of time and not less than the temporal resolution of the data. It depends on

2. Start from the first hour

Hotspots in the first hour will be filtered out from the data.

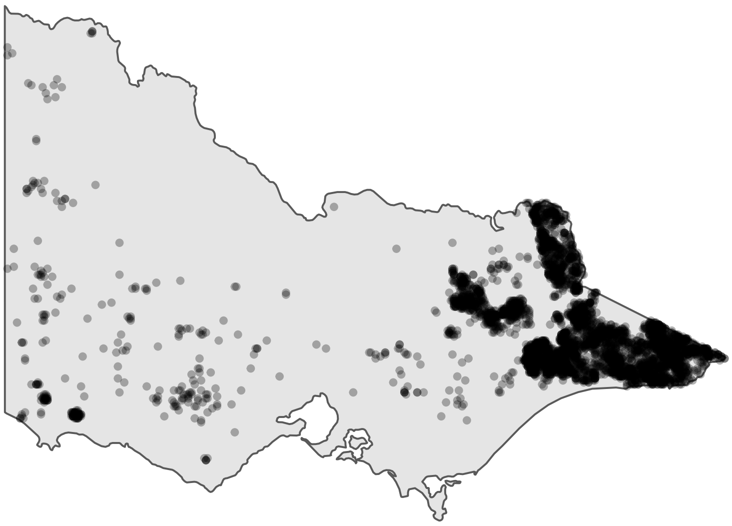


Figure 1: Hotspot locations in Victoria during 2019-2020 season.

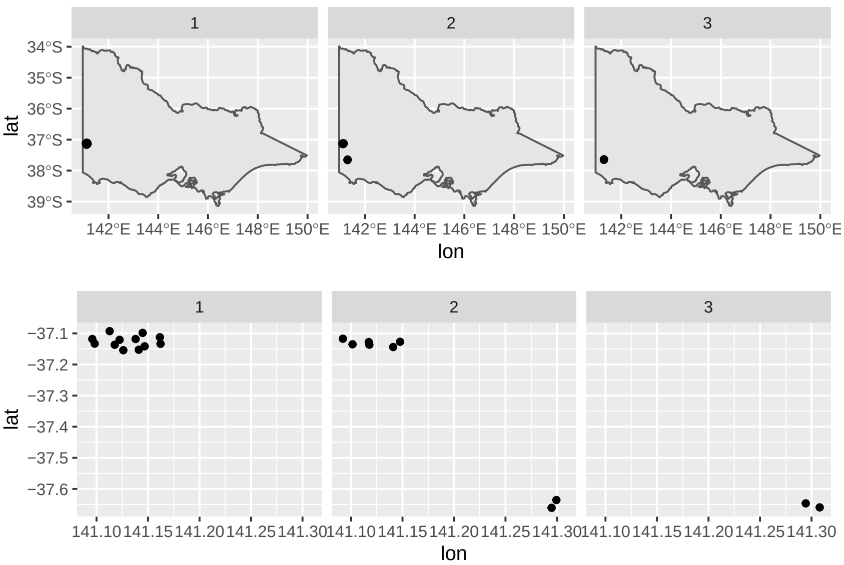
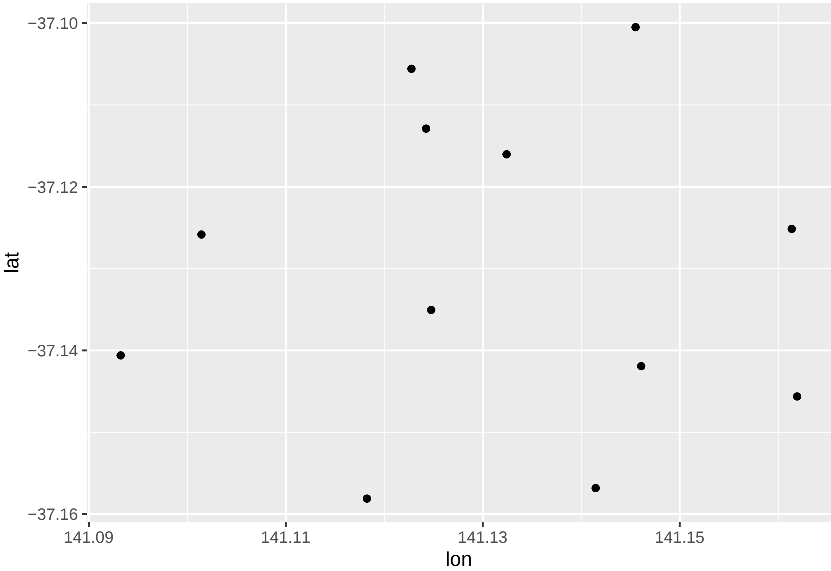


Figure 2: Hotspots in the first 3 hours.



3. Connect reachable hotspots

We try to formalize the meaning of "cluster" to better illustrate the connection between

Definition 1 (directly reachable) *A point p is directly reachable from a point q with respect to AdjDist, if the distance between point p and q is less or equal to AdjDist*

Definition 2 (reachable) *A point p is reachable from a point q with respect to AdjDist, if there is a chain of points* p_1, p_2, ..., p_n, $p_1 = p$, $P_n = q$ *such that* P_n *is directly reachable from* p_{n-1}

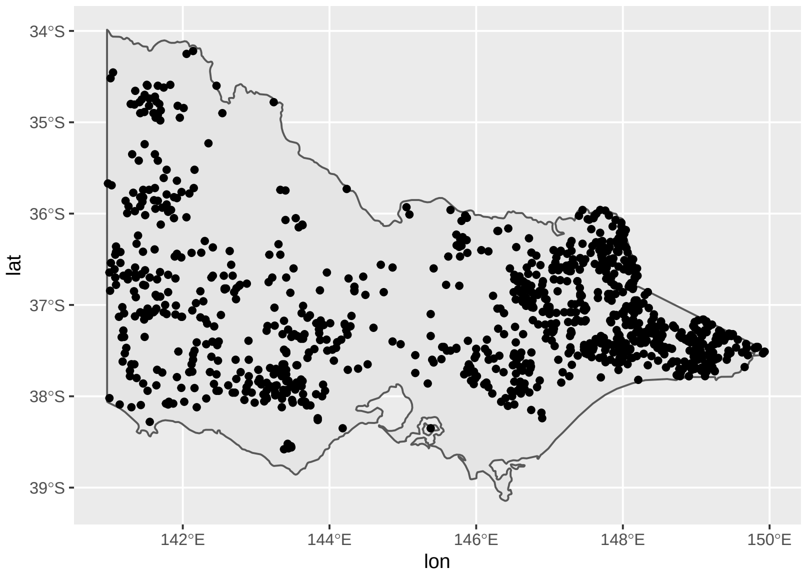
Effects of parameter choices

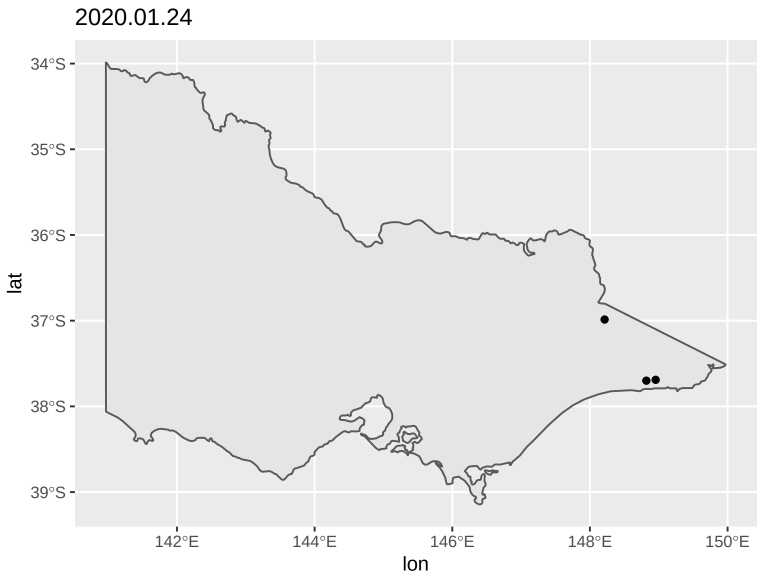
There are two parameters that can be tuned in this algorithm. They are `adj_dist`, which is the density distance and `active_time`, which is the .

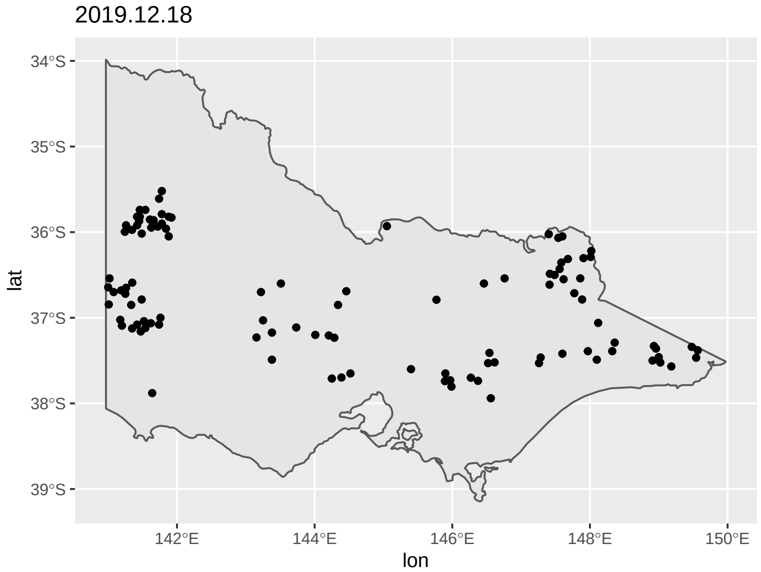
Application

Determining the ignition point and time for individual fires

Show ignition points for a particularly heavy day and another for a particularly light day







Tracking fire movement

Display showing how a fire moves over time, maybe two or more fires

Allocating resources for future fire prevention

Merging data with camp sites, CFA, roads, . . .

Summary

Acknowledgements

- The code and files to reproduce this work are at XXX
- Data on hotspots can be downloaded from XXX

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