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Cluster Analysis of Planetary Systems

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Abstract

Cluster analysis segregates data into groups such that objects in one group are similar to each other and dissimilar to objects in a different group. Clustering on Planetary Systems (PS) has the potential to provide insights, which could allow a quantitative comparison of PS to be established. Clusters obtained via such an analysis can serve different purposes depending on their nature: theoretically meaningful clusters could foster new perspectives on the formation and evolution of planets and possibly link proto-planetary disks with PS, whereas observationally useful clusters may lead to new predictions based on existing data. Together, clustering could lead to a classification scheme for PS.

A quantitative comparison of PS remains a non-trivial problem for several reasons. There is the curse of dimensionality (multiple features per planet and several planets per system) which complicates the notion of distinguishing two PS. Additionally, the minimum number of features necessary to identify (thereby distinguish) one PS from another is not intuitively obvious. Earlier, a new "distance" in the space of PS was proposed [1].

In this work, various possibilities of metrics in the space of PS are explored. These "distances" are used to analyse clustering on the New Generation Population Synthesis data from the Bern Model. A comparison of the various "distances" and the several clustering algorithms (which were used) is presented. Finally, a metric to compare PS is proposed.

References

[1] Alibert, Y. New metric to quantify the similarity between planetary systems: application to dimensionality reduction using t-sne. *A&A*, 624:A45, 2019.