exoplanet classification

march 22, 2025

stuff i did

- busy with USA math olympiad, so sorry for the short presentation!!
- went back to the **planetary systems classification** i was doing a few weeks ago
  - did a literature study of a 2023 paper: [Framework for the architecture of exoplanetary systems](#)
    - applying this framework on our dataset

2023 paper defining four different planetary systems

2023 paper defining four different planetary systems

Similar

Anti-ordered

Ordered

Mixed

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Similar – similar regardless of distance

Anti-ordered – as planets further, get smaller

Ordered – as planets further, get larger

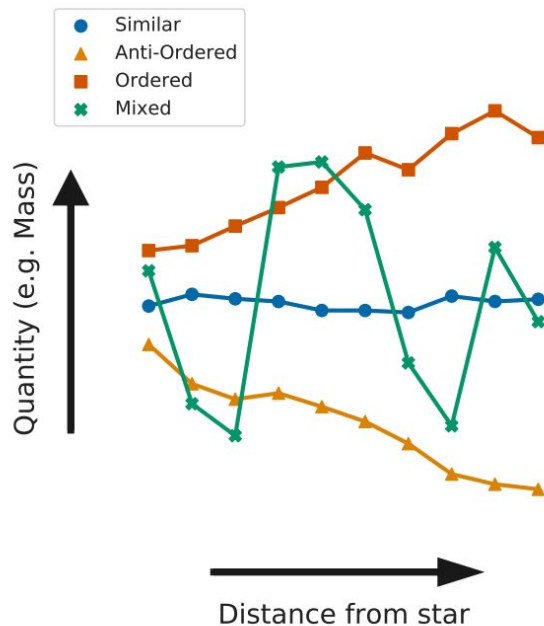**Mixed** – goes back and forth

Fig. 2. Classes of architecture. This schematic diagram shows the four architecture classes: similar, anti-ordered, mixed, and ordered. Depending on how a quantity (e.g. mass or size) varies from one planet to another, the architecture of a system can be identified.

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two ways to determine the planetary system architecture type:

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1. coefficient of similarity – positive for ordered, negative for anti-ordered

$$C_s\left(q\right) = \frac{1}{n-1} \sum_{i=1}^{n-1} \left(\log \frac{q_{i+1}}{q_i} \right)$$

   where q_i is some planetary quantity q (ex. mass, radius, orbital period, etc.) for the ith planet in a system.
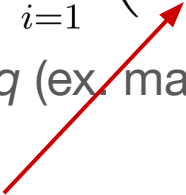
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this is super helpful for distinguishing **ordered** and **anti-ordered** planetary systems

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two ways to determine the planetary system architecture type:

2. coefficient of variation – measure magnitude of variation in a set of numbers

$$C_v\left(q\right) = \frac{\sigma\left(q\right)}{\overline{q}}$$

"while similar systems will have a low value of the coefficient of variation, mixed systems will have a high value of coefficient of variation"

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defining boundaries for different classes based on **planetary mass:**

Architecture class	Condition	
Anti-ordered	$C_S(M) < -0.2$	
Ordered	$C_S(M) > +0.2$	
Similar	$\|C_S(M)\| \leq 0.2$ and $C_V(M) \leq \dfrac{\sqrt{n-1}}{2}$	(3)
Mixed	$\|C_S(M)\| \leq 0.2$ and $C_V(M) > \dfrac{\sqrt{n-1}}{2}$	

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apply to our own dataset!! (joined NASA composite systems data + HWC)

apparently, due to detection bias, anti-ordered planetary systems have not been found in the authors' data sources yet. might be interesting to look into our new data and see if anything about that has changed!!
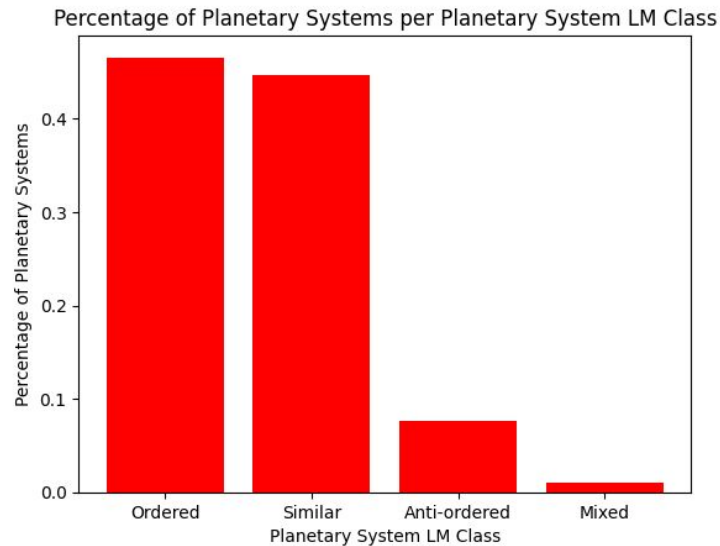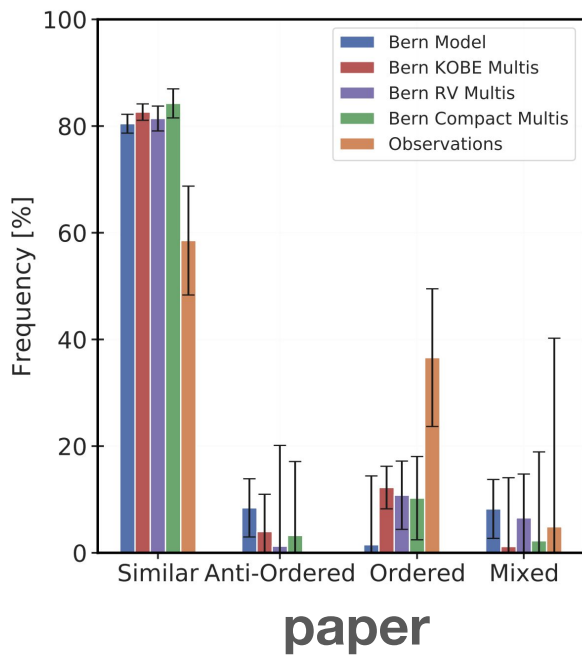

Number of Planetary Systems per Planetary System LM Class
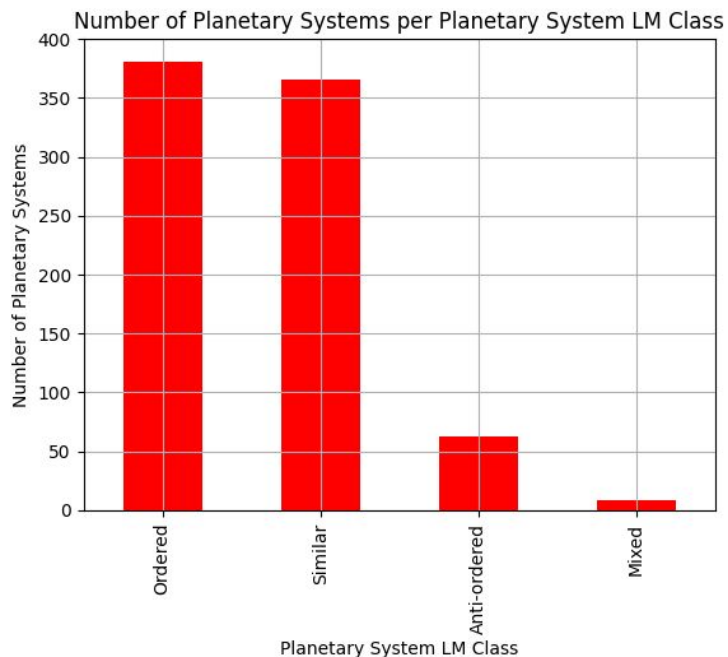
pl_lm_class	count
Ordered	381
Similar	366
Anti-ordered	63
Mixed	8

dtype: int64

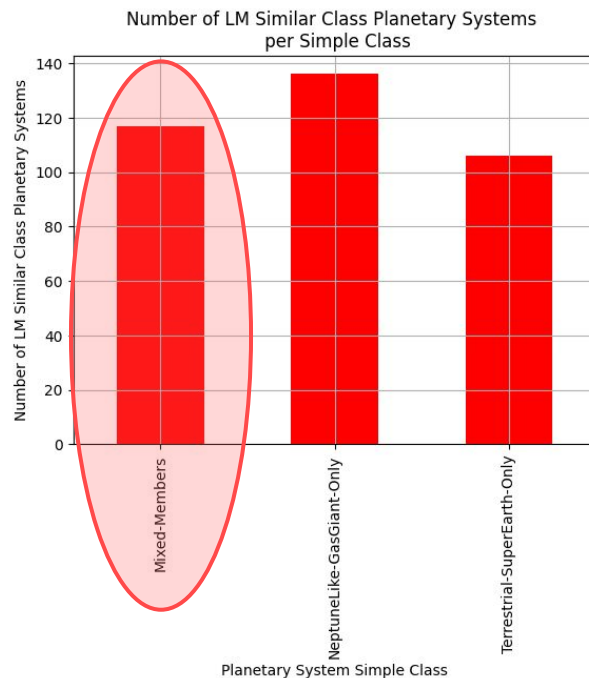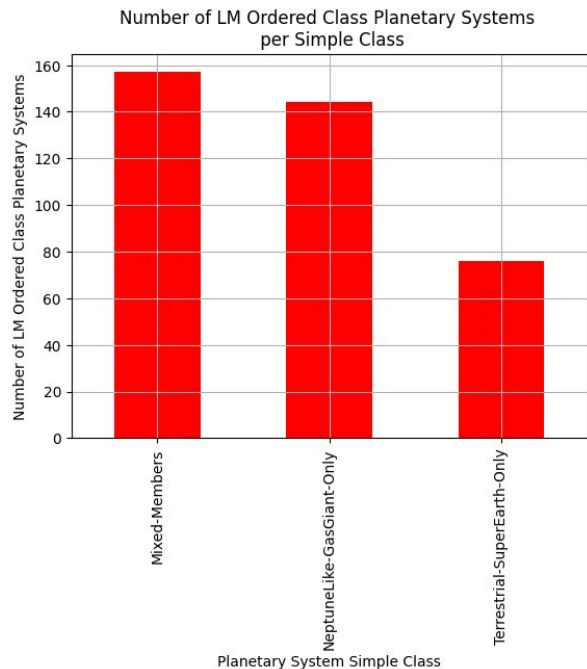# 2023 paper defining four different planetary systems

our data actually shows different trends than the discussed in the paper…

paper

our data

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compared to my old classification:

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