



Universidad de
los Andes

CoCo 2o2o: Cosmology in Colombia

The cosmic web through the lens of graph entropy

September 24, 2020

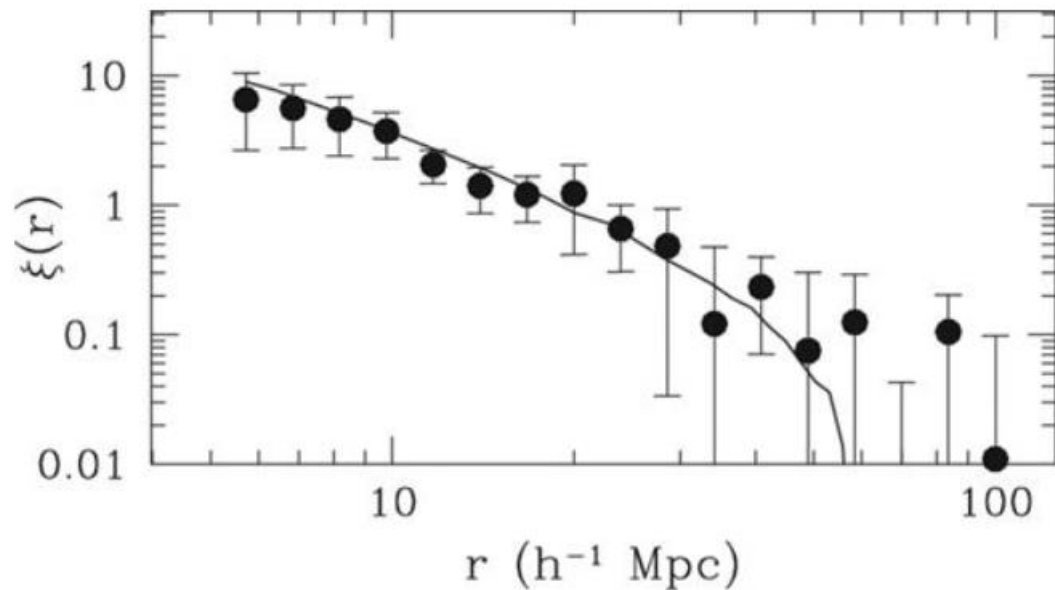
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In collaboration with Jaime Forero-Romero and Xiao-Dong Li

For more detail you can go to: The cosmic web through the lens of graph entropy, MNRAS: Letters, Volume 498, Issue 1, 11 October 2020, Pages L145–L149, 2008.08164

$$1 + \xi(r) = \frac{DD(r)}{RR(r)}$$

Two-Point Correlation Function



Basilakos et al., 2003

Represent the Large Scale Structure as a graph

García-Alvarado et al. (2008:08164)

Probability and Graph Entropy

Probability of having nodes with degree n:

$$Probability (p_n) = \frac{Nc}{Tn}$$

Nc = Number of nodes with n connections
Tn = Total number of nodes

Graph entropy:

$$\sum_{p_n > 0} -p_n \log_2(p_n)$$

β -Skeleton

For a set of dark matter halos:

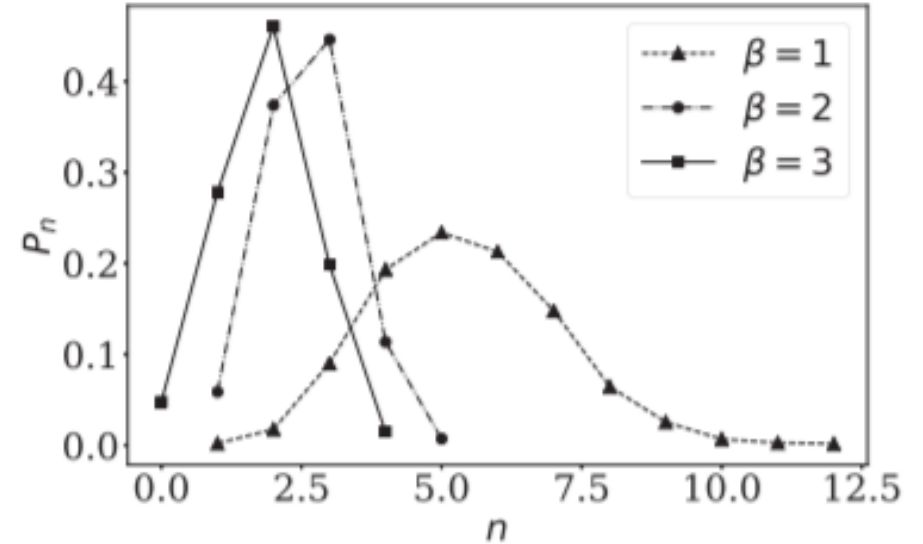
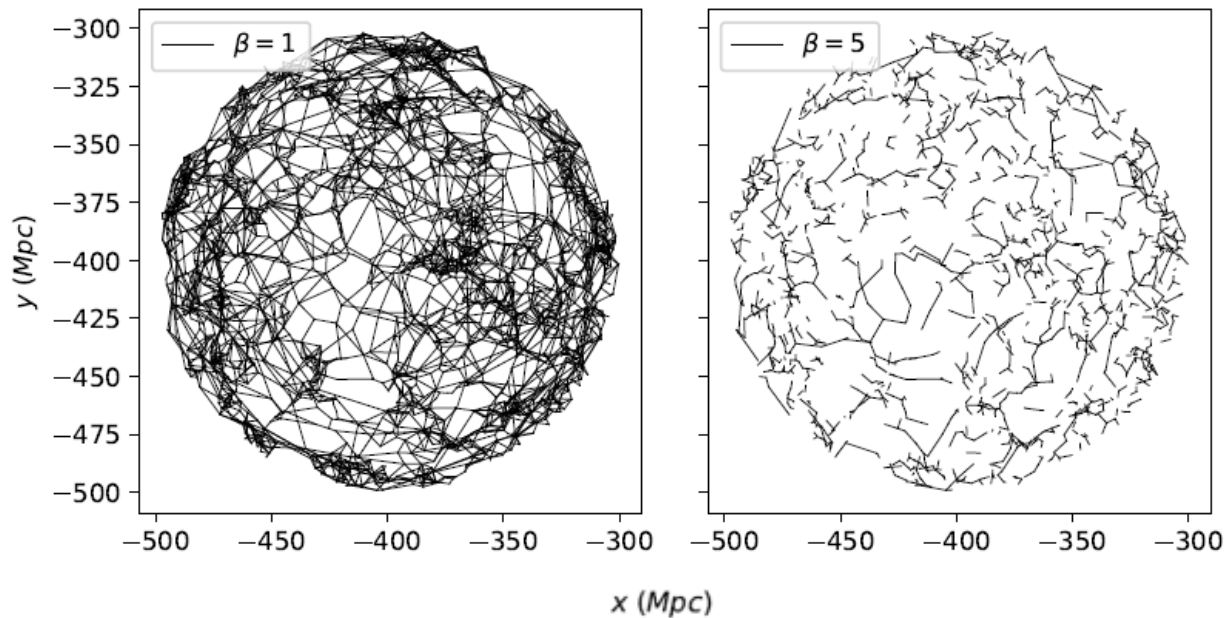


Figure 2. Probabilities of having n connections, P_n , for three different values of β . The graph entropy summarizes the changes in the P_n distribution as a function of β .

García-Alvarado et al., 2020

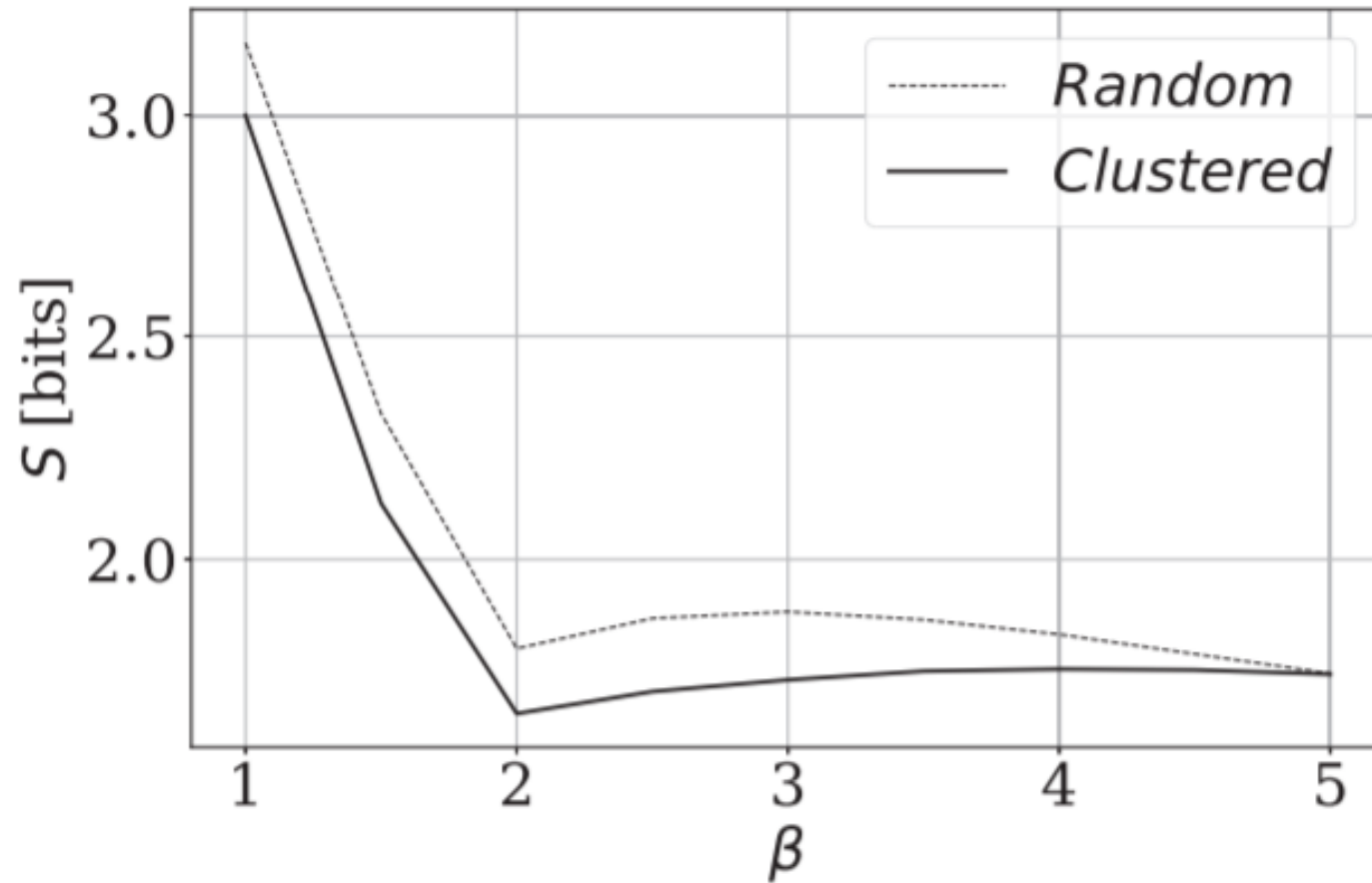


Figure 3. Graph entropy as a function of the parameter β for clustered and random points distributed inside a sphere.

García-Alvarado et al., 2020

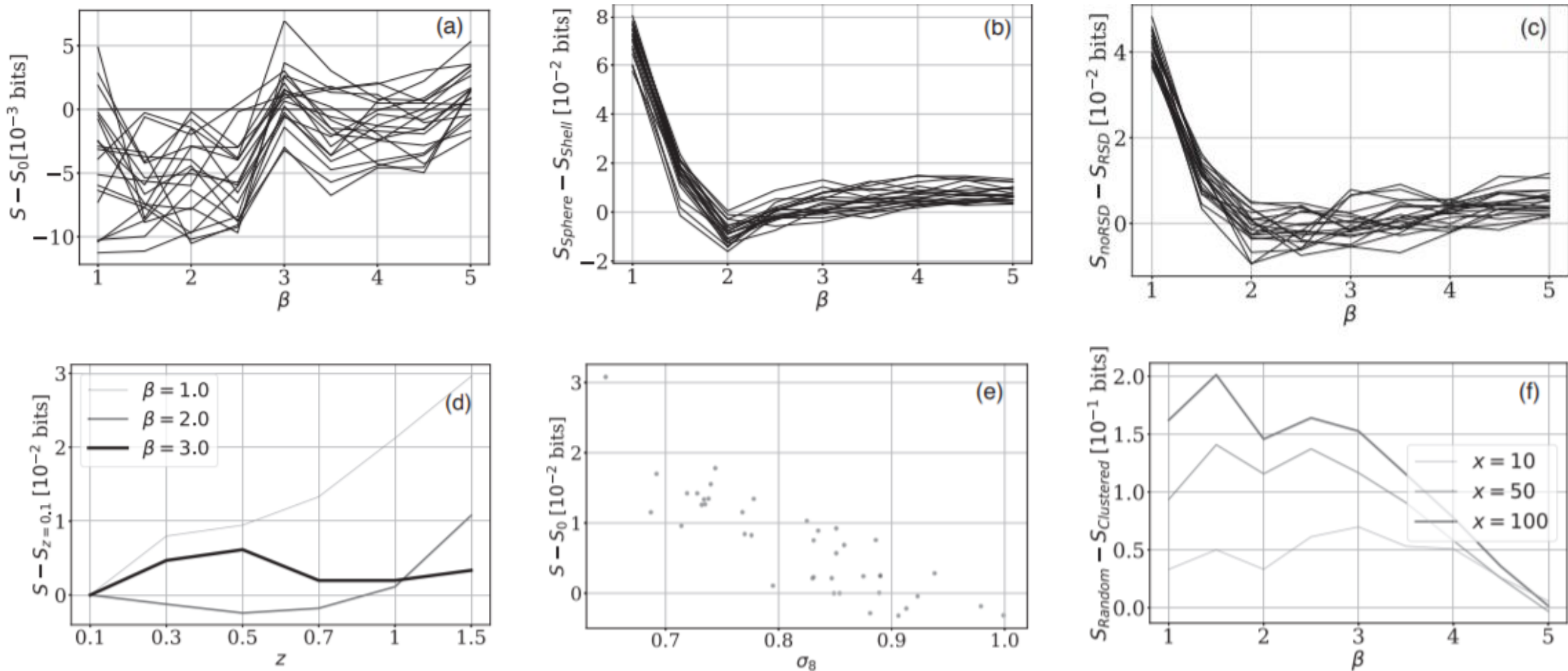


Figure 4. Influence of different effects on the graph entropy. In all cases, we report the changes in entropy from a reference value. Details are explained in the Section 4. (a) Cosmic variance. (b) Survey geometry. (c) Redshift space distortions (RSD). (d) Redshift evolution. (e) Cosmological parameters. We only show the results for σ_8 , the parameter that shows the strongest correlation with the graph entropy. The plot corresponds to the entropy computed for the 1-skeleton at $z = 0.1$. (f) Number density. This calculation is performed on 20 different spheres at $z = 0.1$. A different percentage (shown in the caption) of these points are sampled. We show the difference with respect to the entropy measured on the spheres of sampled random points.

Conclusions

- Graph Entropy analysis allows us to distinguish between random and clustered points.
- The strongest influence on graph entropy comes from clustered points with different number densities.
- Further applications can be:
 - Measuring the entropy from different parts of the sky to check for isotropy.
 - Building graphs from other quantities (i.e. features in the cosmic microwave background, weak lensing peaks) to quantify its connectivity properties.
 - Tests for the applicability on observational data.

Thank you!