

# The Entropy Universe

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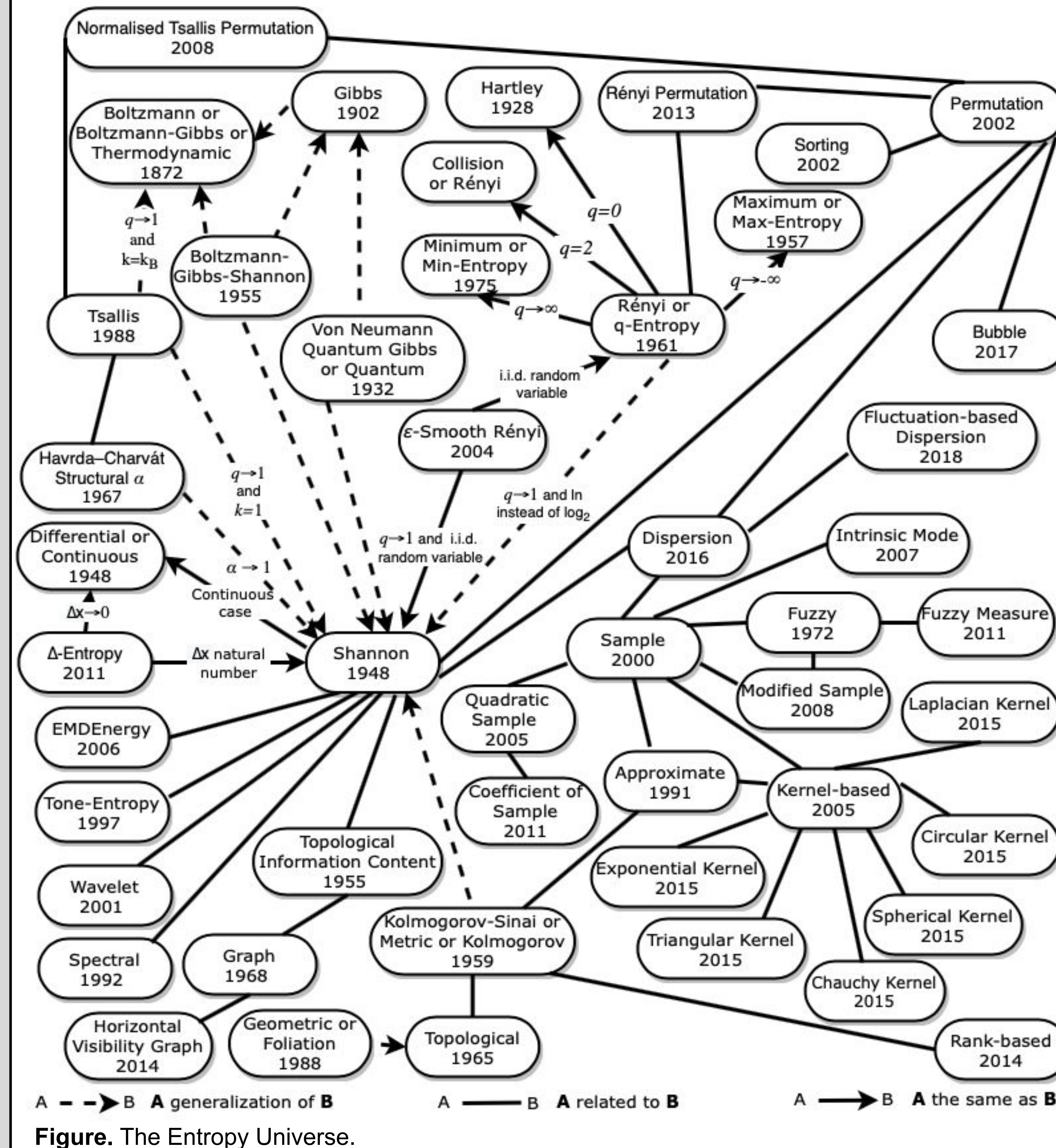
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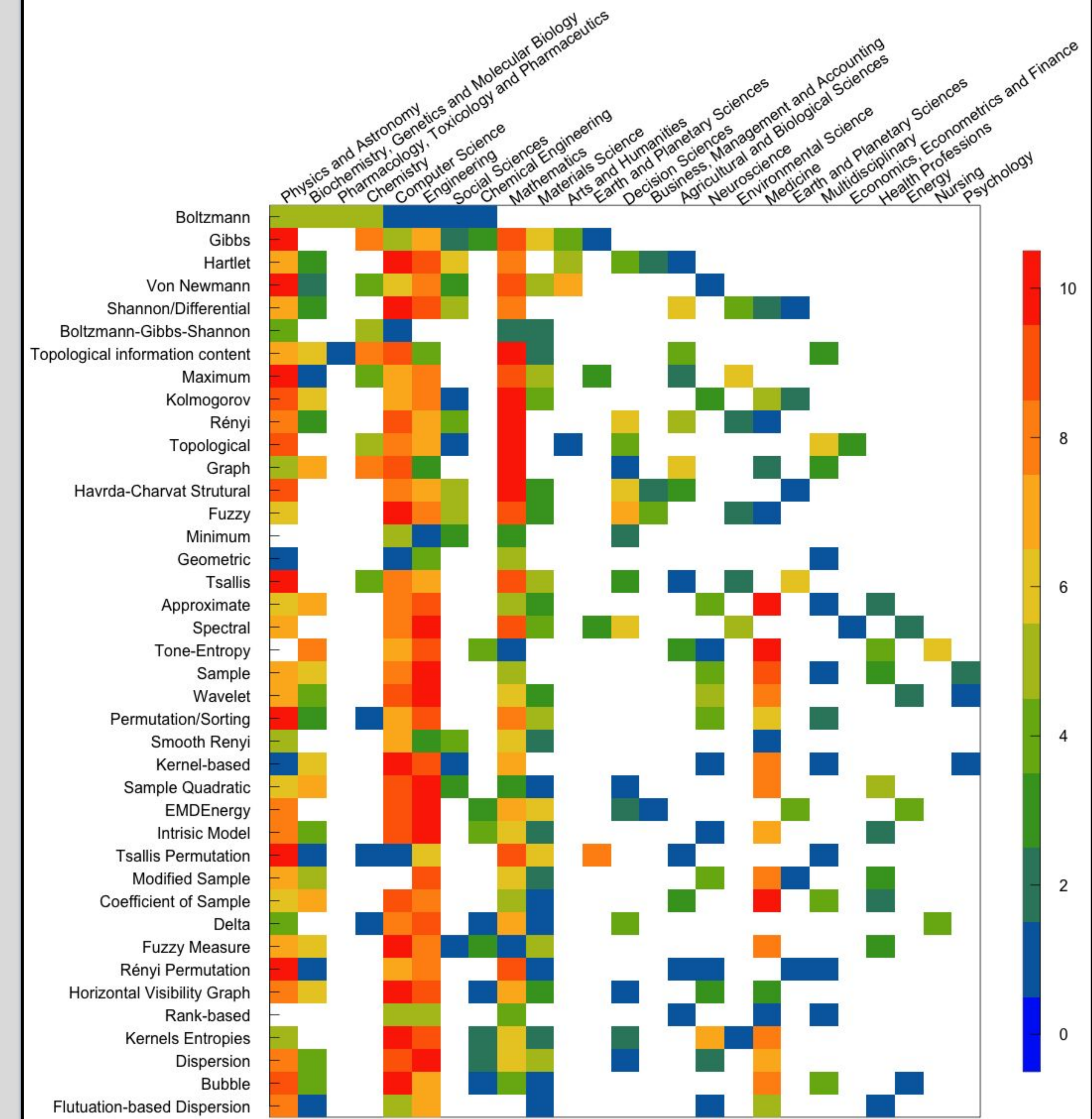
## Introduction

About 160 years ago, the concept of entropy was introduced in thermodynamics by Rudolf Clausius. Since then, it has been continually extended, interpreted, and applied by researchers in many scientific fields, such as general physics information theory, chaos theory, data mining, and mathematical linguistics. Based on the original concept of entropy, many variants have been proposed. This poster presents a universe of entropies, which aims to review the entropies that have been applied to time series. The purpose is to answer important open research questions such as: When and How did each entropy emerge? What is the mathematical definition of each variant of entropy? How are entropies related to each other? What are the most applied scientific fields for each entropy? Answering these questions, we describe in-depth the relationship between the most applied entropies in time series for different scientific fields establishing bases for researchers to properly choose the variant of entropy most suitable for their data.

## How are entropies related to each other?



## What are the most applied scientific fields for each entropy?

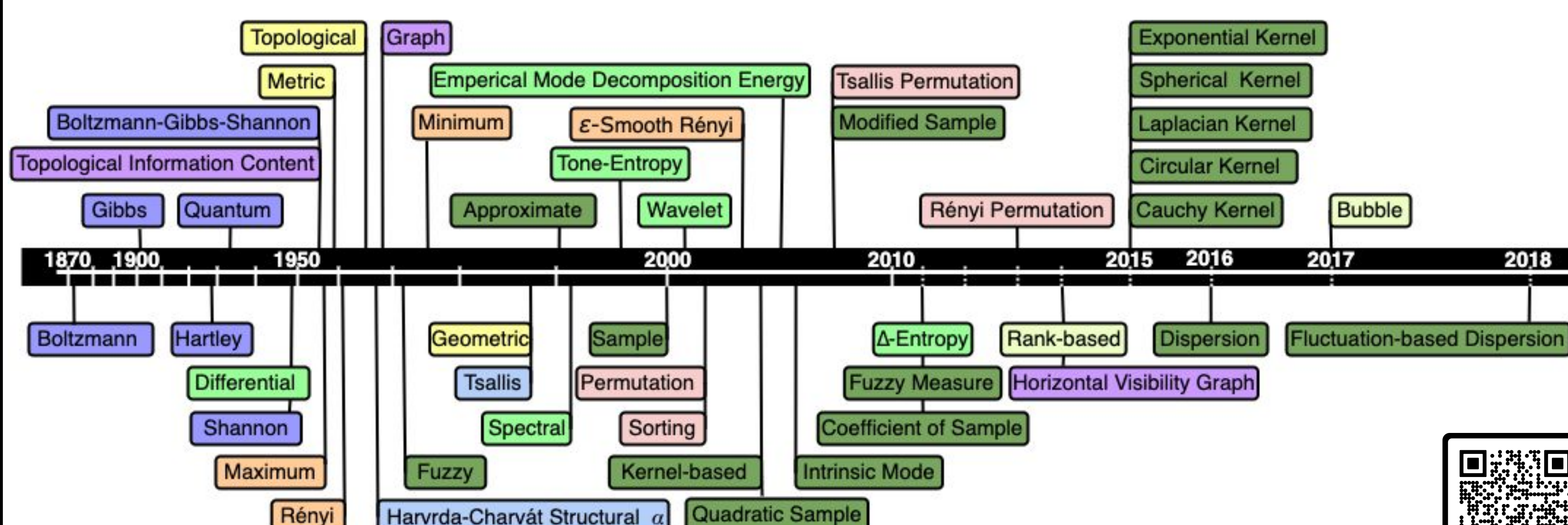


**Figure.** The ten areas of most cited papers that introduced entropies according to the *Documents by subject area* of the Scopus. Legend: range 0 (research-area least cited) - 10 (research-area most cited).

## How did each entropy emerge? What is the mathematical definition of each variant of entropy?

In paper [1] the authors of this poster describe, in detail, how our universe of entropies was built, the entropies' mathematical definitions, their respective origin, and the relationship between each other. *The Entropy Universe* Figure summarizes our Universe.

## When did each entropy emerge?



**Figure.** Timeline of the universe of entropies discussed in this poster.

## Conclusions

We introduce *The Entropy Universe*. The number of citations over the past sixteen years of each paper proposing a new entropy was also accessed. The Shannon/differential, the Tsallis, the sample, the permutation, and the approximate entropies were the most cited ones. Based on the ten research areas with the most significant number of records obtained in the Scopus, the areas in which the entropies are more applied are computer science, physics, mathematics, and engineering.

## Reference

[1] Ribeiro, M.; Henriques, T.; Castro, L.; Souto, A.; Antunes, L.; Costa-Santos, C.; Teixeira, A. *The Entropy Universe*. *Entropy* 2021, 23, 222. <https://doi.org/10.3390/e23020222>

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