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The Nine Axes of Merit

One framework for prioritizing technosignature searches

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Bridging Multi-Messenger Astronomy and SETI Workshop

Why do we need to compare different technosignature searches?

- In a perfect world, we would just have infinite funding…
  - Still **useful to compare new studies with previous ones** (esp. if **null results**)
  - We live in a different world, with finite funding — need to **prioritize funding for most meritorious projects**
- **Figures of Merit:** In radio SETI, equations to evaluate the efficacy / efficiency / scientific importance of individual studies
- Dearth of Figures of Merit for non-radio technosignatures, cross-wavelength approaches, or non-communicative methodologies…

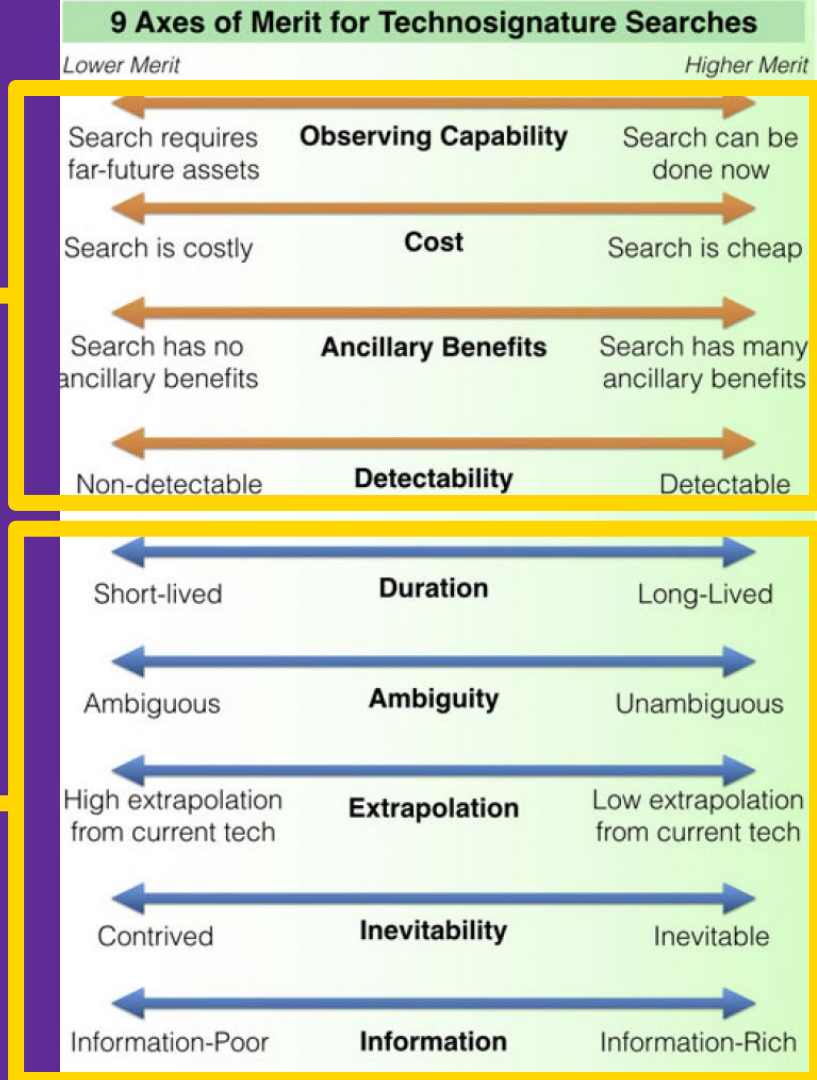
$$CWTFM = \zeta_{\mathrm{AO}} \frac{\mathrm{EIRP}}{N_{stars}\ \nu_{\mathrm{rel}}}$$

Enriquez et al. 2017

Enter: The Nine Axes of Merit

Logistical Axes

Scientific Axes



Logistical Axes

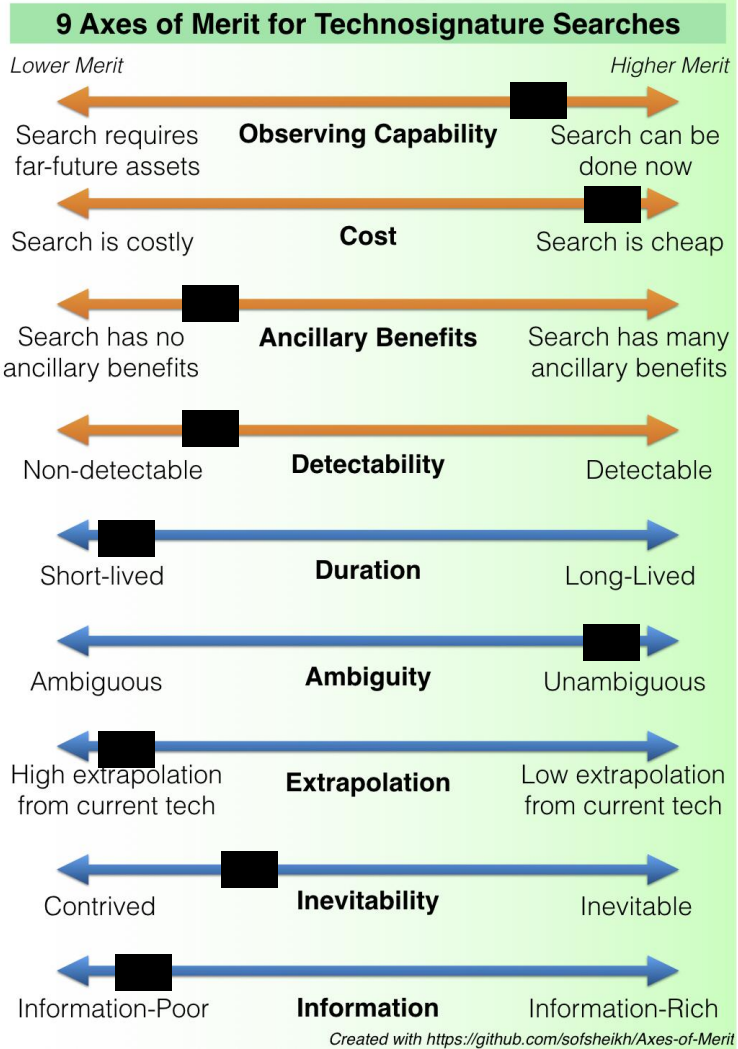
- More meritorious searches…
  - Can be **performed easily with current technological capabilities**, without years of additional development of astronomical instrumentation (Observing Capability)
  - Will be **cheaper in money, resources, or time** (Cost)
  - **Can also be used for advancement in other sub-fields** e.g., astrophysics, social sciences, education, etc. (Ancillary Benefits)
  - **Produces a strong signal** compared to the background noise (Detectability)

Scientific Axes

- More meritorious technosignatures…
  - Persist for a **long time** and/or have a high duty cycle (Duration)
  - Have very **few natural confounders** from astrophysical phenomena (Ambiguity)
  - Require **minimal extrapolation beyond known human technologies** or modern physics (Extrapolation)
  - **Commonly result from technological development**, without assuming a particular societal trajectory (Inevitability)
  - Contain **significant information content** that can be further studied and analyzed (Information)

Case Study: Gravitational Wave Technosignatures

Smithsonian



Caveats about using the Nine Axes

- **The axes are not fully orthogonal** (e.g., detectability and cost)
- **Don’t try to make them quantitative!** Use them as a framework for what a good technosignature proposal should address, or to identify the strengths and weaknesses of an approach
- Overlap with high-energy/multi-messenger (my brainstorm):
  - Leverage low Cost, high Ancillary Benefits
  - Need to justify Extrapolation, Duration