Speeding up the Bayesian inference pipeline for the detection of nHz SGWB

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Spoke 3 General Meeting, Elba 5-9 / 05, 2024

Scientific Rationale

- **Pulsar Timing Arrays collaborations reported evidence for the presence of a stochastic Gravitational Wave Background (SGWB) at nHz frequencies**
  - **- constrain properties of the astrophysical sources**
  - **- probe potential cosmological sources**

- **Current EPTA dataset: 25 pulsars, 61k ToA measurements, ~28-50 parameters per pulsar**

≥ 2 WEEKS FOR A FULL BAYESIAN INFERENCE!

- **Future IPTA dataset: 100+ pulsars, 1M+ ToA measurements, 50+ parameters per pulsar**

SPEEDING UP BAYESIAN INFERENCE!

The SGWB Bayesian inference is a complex endeavor consisting of many stages..

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Technical Objectives, Methodologies and Solutions

TO DATE, LIKELIHOOD EVALUATION TAKES ~80% OF THE ENTIRE WALLTIME!

IT IS WORTH FOCUSING ON THE LIKELIHOOD..

- Reformulate the likelihood function currently written in ENTERPRISE - the PTA Bayesian inference pipeline - to speed it up

- Use efficient multi-(CPU) core and GPU based techniques for faster calculations

- Implement/apply ML techniques e.g. for the likelihood marginalization

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Timescale, Milestones and KPIs

- ➤ **0 - 3 months : Literature review, state of the art in likelihood formulation**

- **4 - 10 months : Rewriting the likelihood function**

- **11 - 14 months : Coding / Refactoring ENTERPRISE likelihood function**

- **15 - 16 months : Testing and benchmarking with simulated and real datasets**

- **17 - 18 months : Product delivery to users and testing with users**

TARGETS: one publication and code implementation on ENTERPRISE

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Accomplished Work, Results: in progress...

Focus on:

- **Exploit the Hellings & Downs correlation of the SGWB signal to rewrite the likelihood**

- **Parallelize the inversion of the covariance matrix**

- **More efficient marginalization of the pulsar ToA parameters**

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Next Steps and Expected Results: too soon..

THANK YOU!!