Heirarchical Resolution

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Lightning Talk

Nicolai Meinshausen, Peter Bickel, and John Rice. *Efficient Blind Search: Optimal Power of Detection under Computational Cost Constraints*[*ANNALS OF APPLIED STATISTICS, Vol. 3, No. 1, 38-60, 2009*

Search Space

•Consider no drift. Good frequency resolution depends on matching phase of photons at beginning and end of the record. If true frequency is f_0, the number of cycles in time T is T/f_0, so if the hypothesized frequency is $f = f_0 + \delta f$, δf should be $o(T^{-1})$ in order for a photon at the end of the record to be in phase with one at the beginning. The phase error at the end of the record is $T\delta f$.

•10 days = 864,000 sec,- $\delta f = T^{-1}$. If a 40 Hz range has to be searched, a minimum of 40 x 864000 = 34,560,000 possible frequencies must be examined.

•Similarly, drift must be resolved within $o(T^{-2})$. To search the interval of possible frequency derivatives at this resolution, about 400-500 values must be examined.

•Consequence is that a test statistic must be evaluated ~10^9 values of frequency and its derivative.

Power Versus Computational Cost: Blocking

Power $\propto \theta^2 T$

f resolution $\propto T^{-1}$

$\dot{f}$ resolution $\propto T^{-2}$

Calculation of statistic for a single $(f, \dot{f}) \propto T$

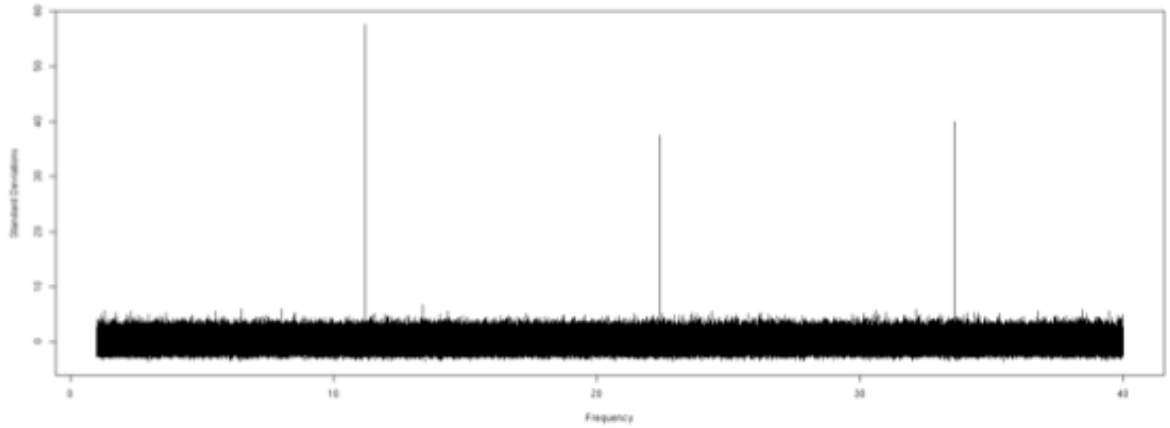
FLOPS $\propto T^4$

Partition T into B blocks, compute statistic in each block and average:

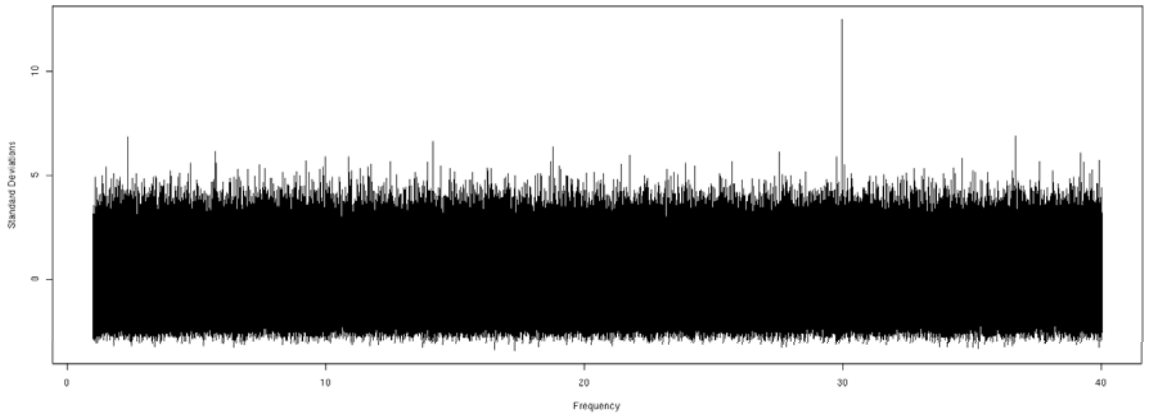
Power $\propto \frac{\theta^2 T}{\sqrt{B}}$

FLOPS $\propto \frac{T^4}{B^3}$

Blocking Vela and Crab



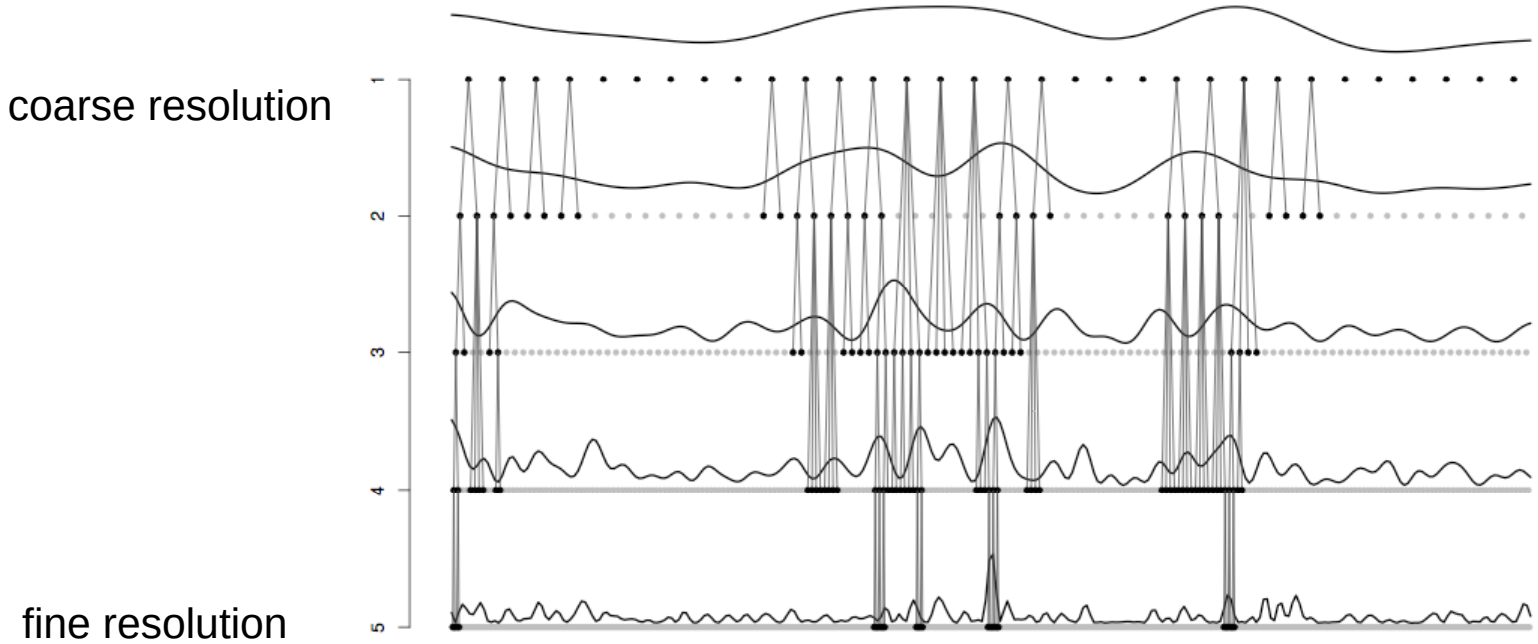
Vela: 318 blocks



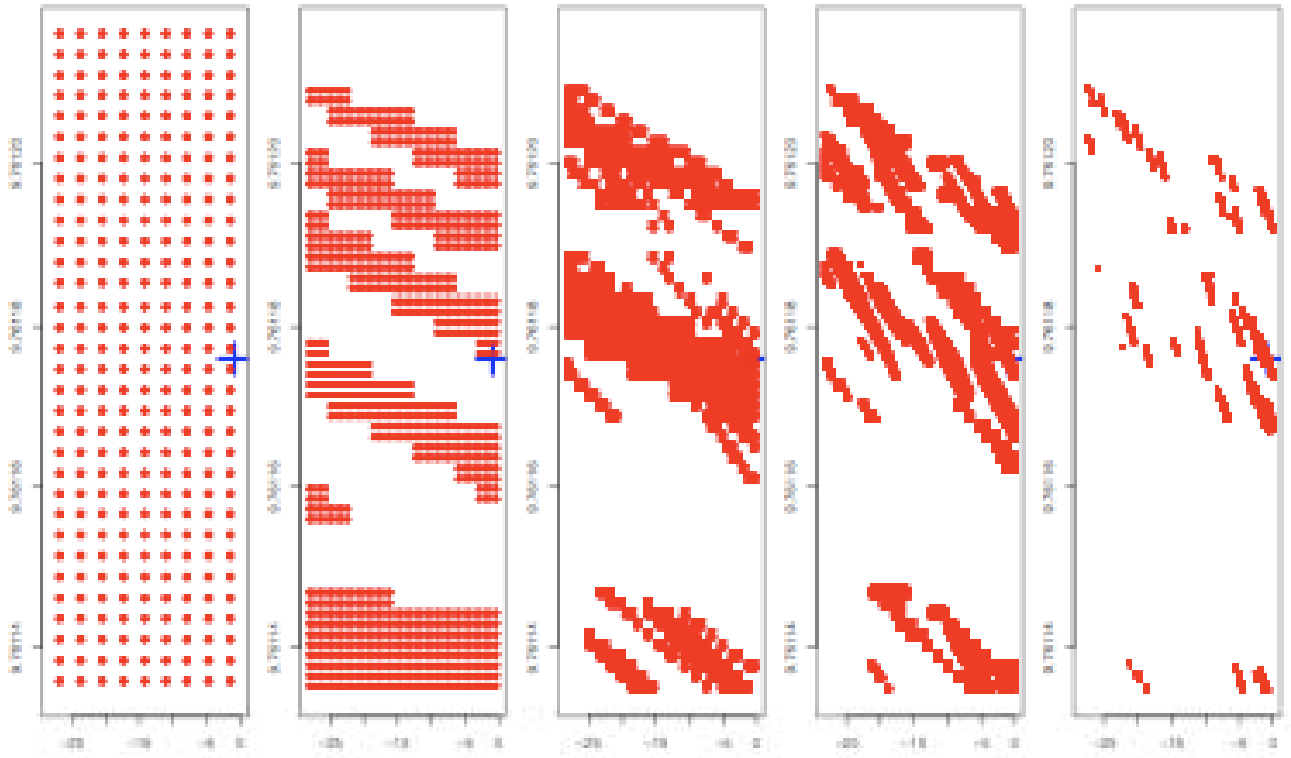
Crab: 25 blocks

Hierarchical Search

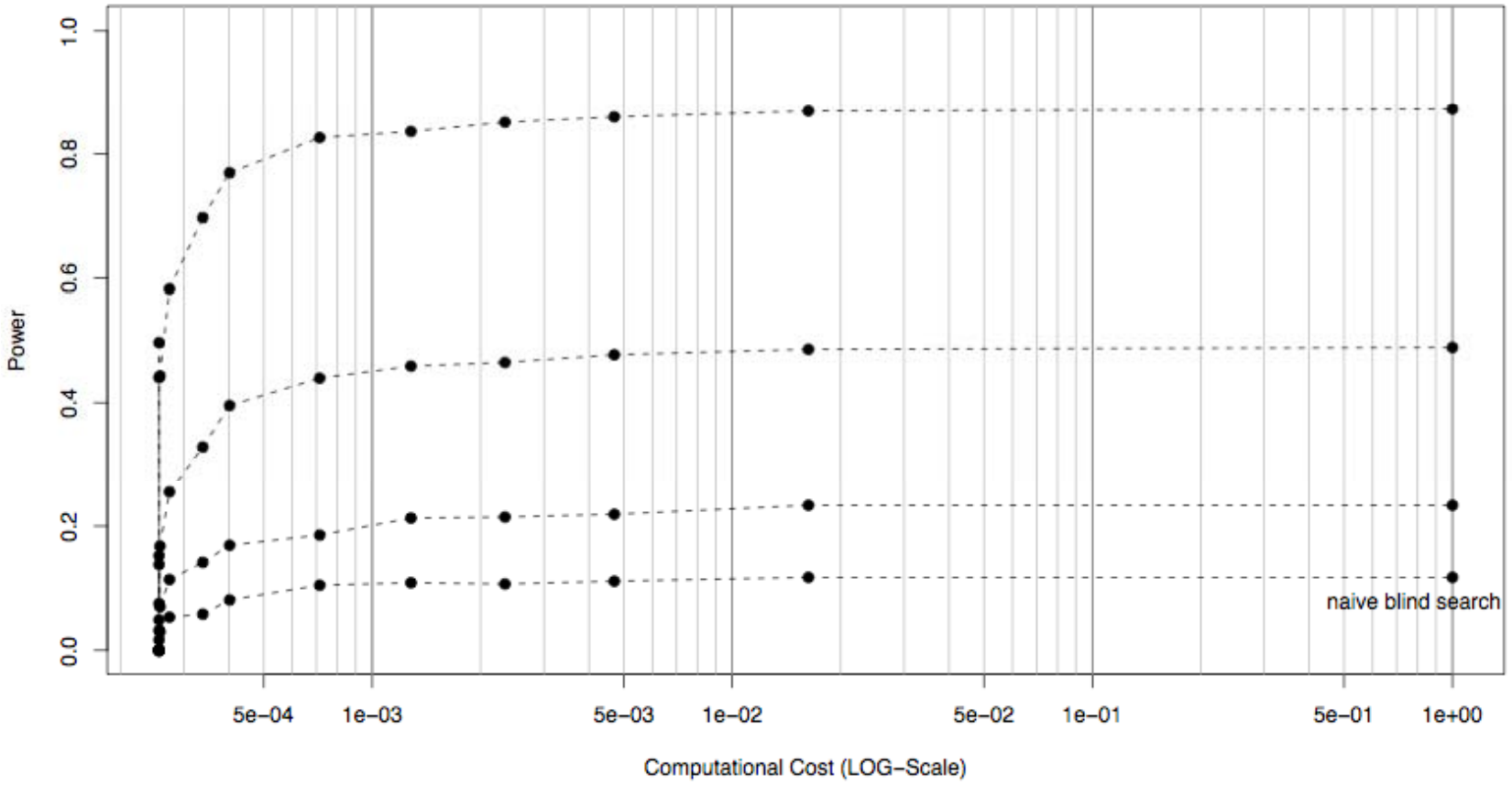
Maximize power subject to computational constraint. Optimal paths through resolution levels found by dynamic programming.



Refinement of search space (local)



Power versus cost



Simulation with 4 different signal strengths