BayeHem: Bayesian Optimisation of Genome Assembly

DCSI 2018

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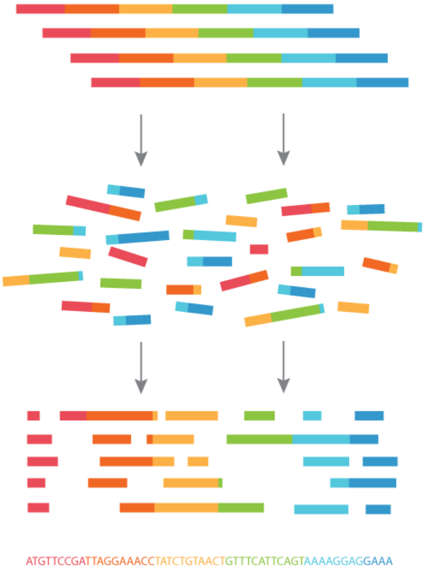
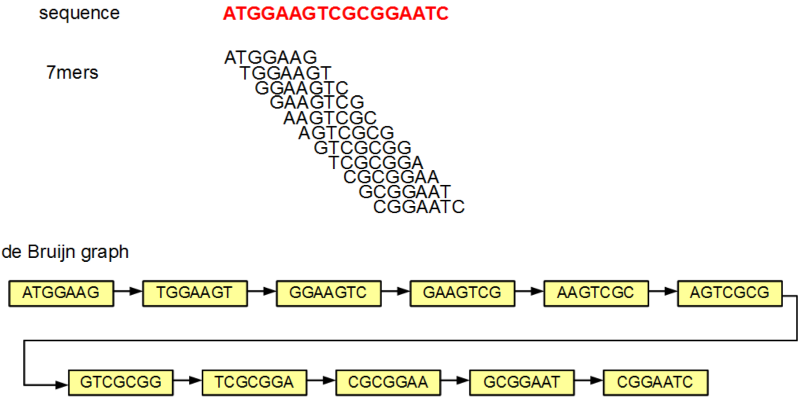
Genome Assembly

2nd Generation Genome Sequencing



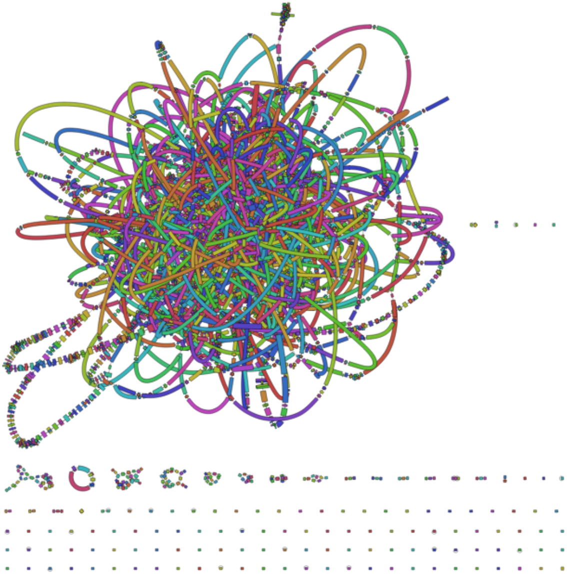
https://www.abmgood.com/marketing/knowledge_base/next_generation_sequencing_data_analysis.php

De Bruijn Graph Assembly



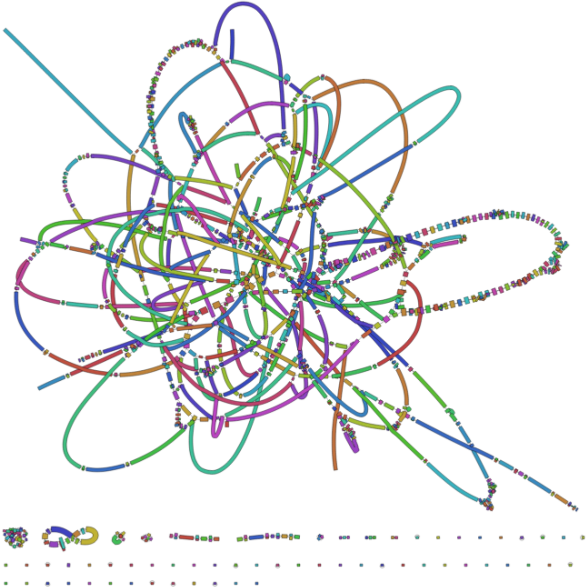
http://www.homolog.us/Tutorials/index.php?p=2.1&s=1

Effect of K-mer Size: 51-mer



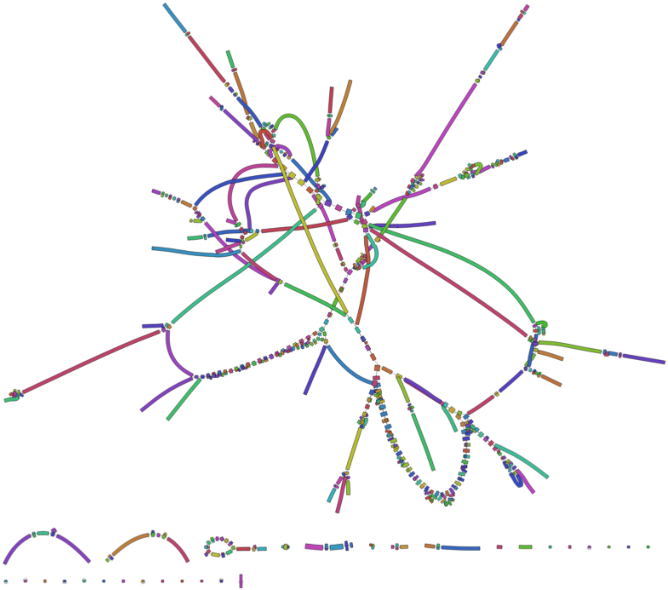
https://github.com/rrwick/Bandage/wiki/Effect-of-kmer-size

Effect of K-mer Size: 61-mer



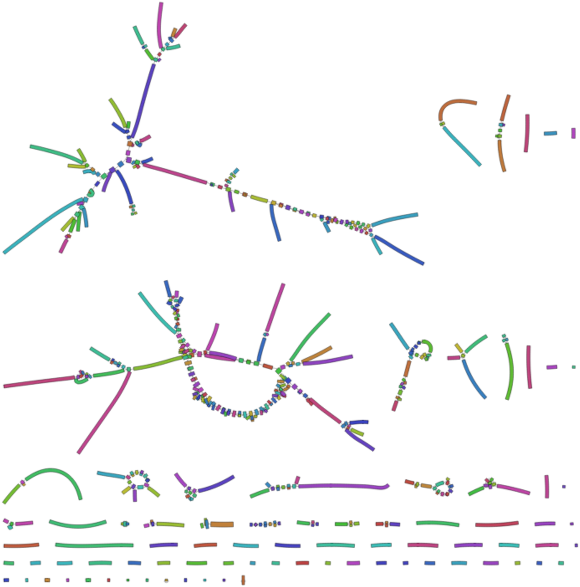
https://github.com/rrwick/Bandage/wiki/Effect-of-kmer-size

Effect of K-mer Size: 71-mer



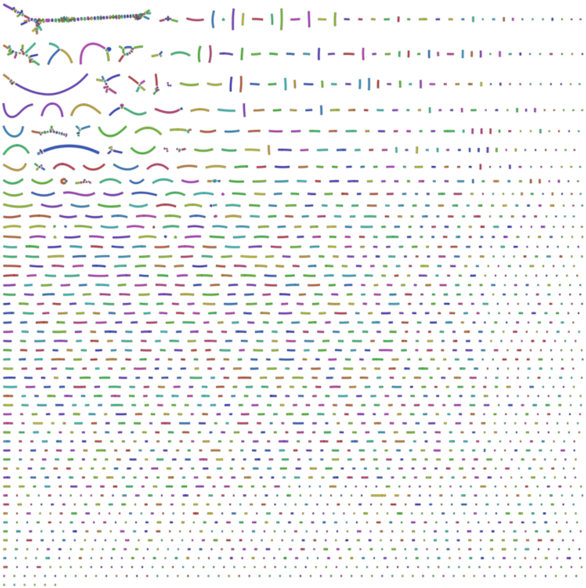
https://github.com/rrwick/Bandage/wiki/Effect-of-kmer-size

Effect of K-mer Size: 81-mer



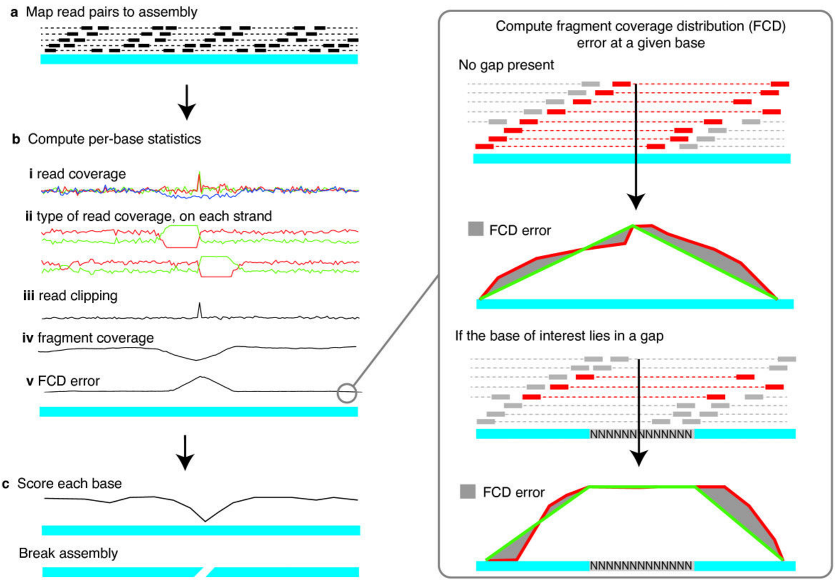
https://github.com/rrwick/Bandage/wiki/Effect-of-kmer-size

Effect of K-mer Size: 91-mer



https://github.com/rrwick/Bandage/wiki/Effect-of-kmer-size

Assessing Assemblies



[2]

Bayesian Optimisation

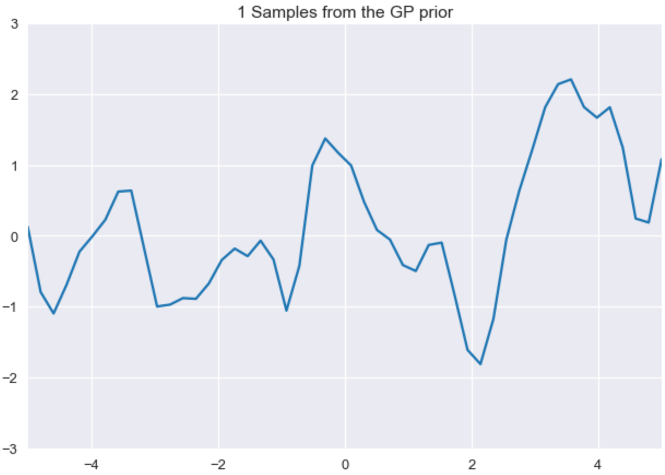
Gaussian Processes

- Form of functional regression.
- Powerful base for Sequential Model Based Optimisation [6].
- Every draw is a multivariate Gaussian random variable.

$$f \sim GP(0, K)$$

$$K \sim k(x_i, x_j) = exp(-\frac{1}{2}d(x_i/l, x_j/l)^2)$$

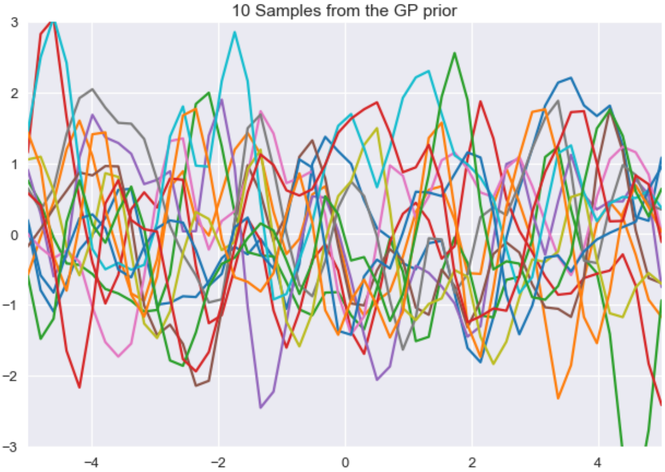
Gaussian Process Prior



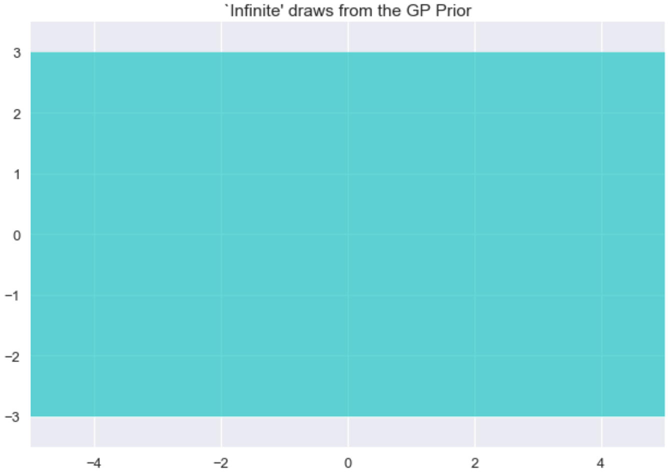
Visualisation code modified from `http://katbailey.github.io/post/gaussian-processes-for-dummies`

Gaussian Process Prior

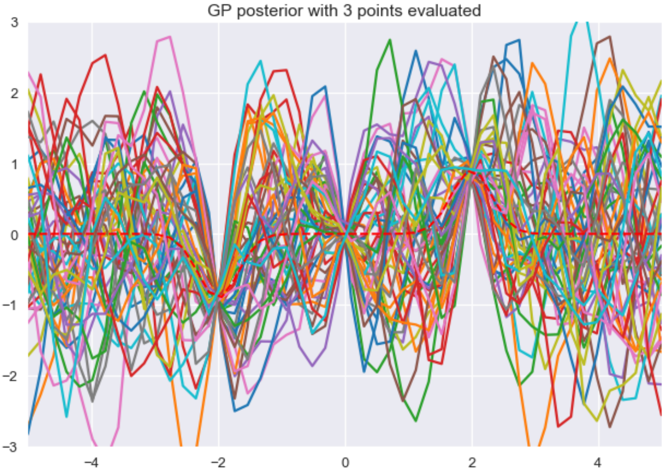
Gaussian Process Prior



Gaussian Process Prior

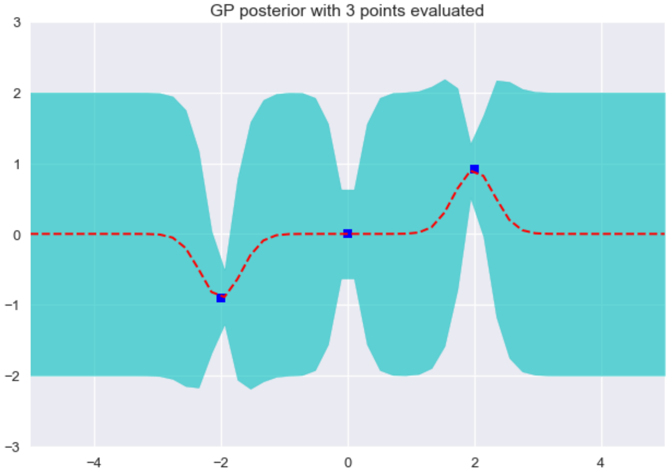


Gaussian Process Posterior

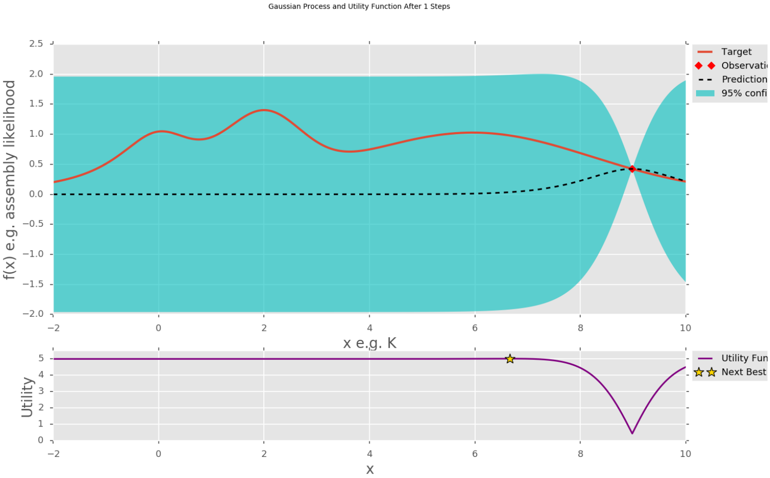


Gaussian Process Posterior

Gaussian Process Posterior

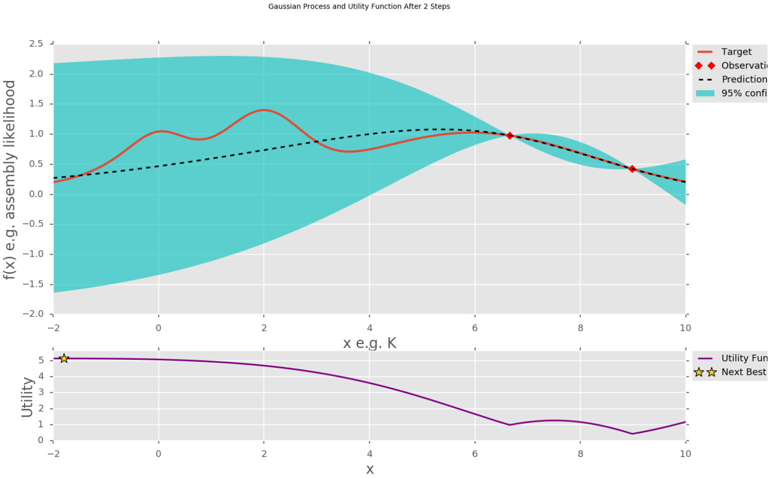


Acquistion Function

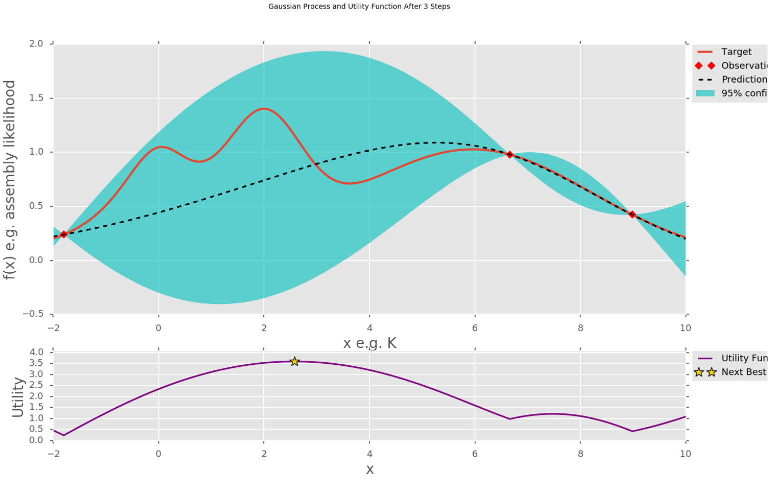


Adapted from code found here: `https://github.com/fmfn/BayesianOptimization`

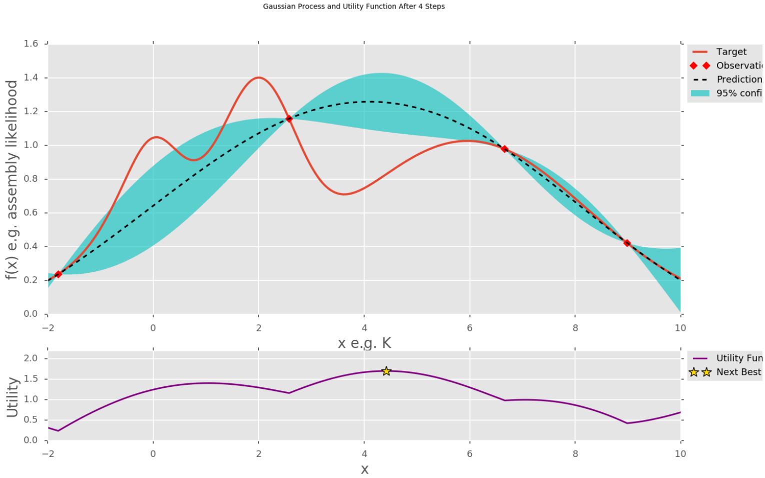
Acquistion Function



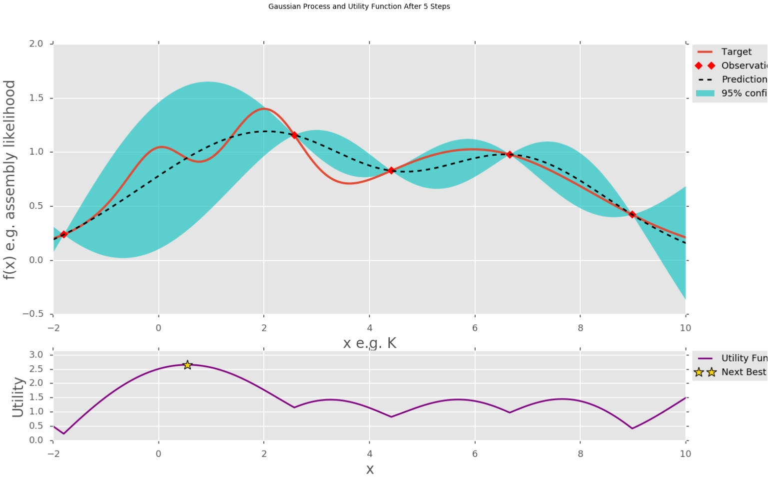
Acquistion Function



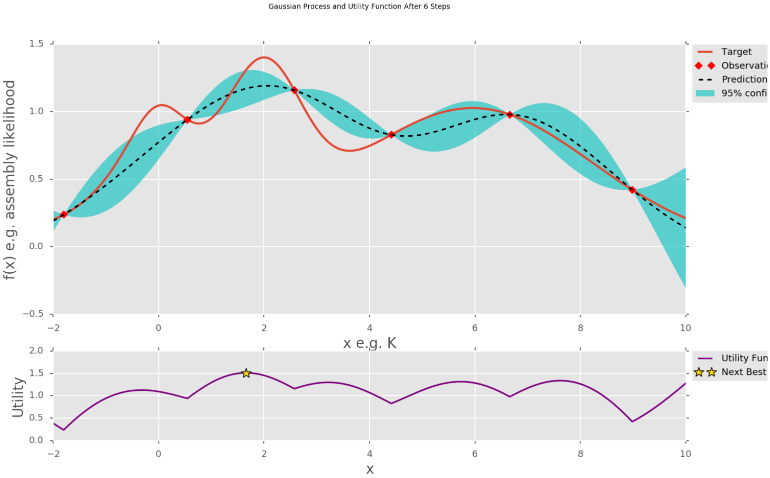
Acquistion Function



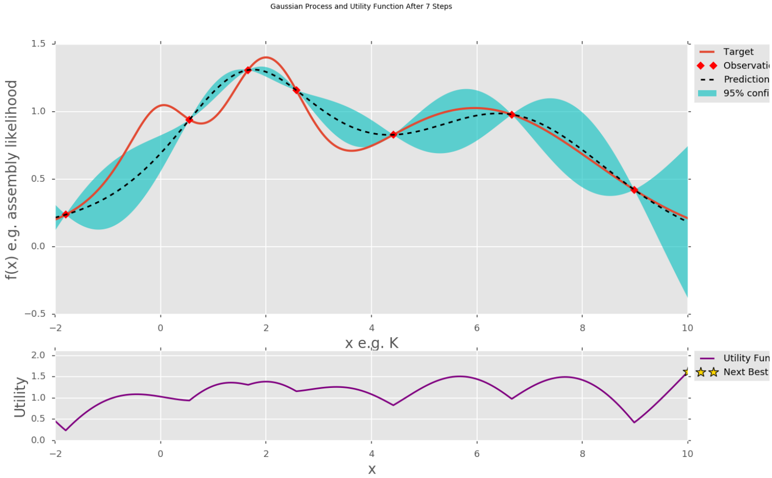
Acquistion Function



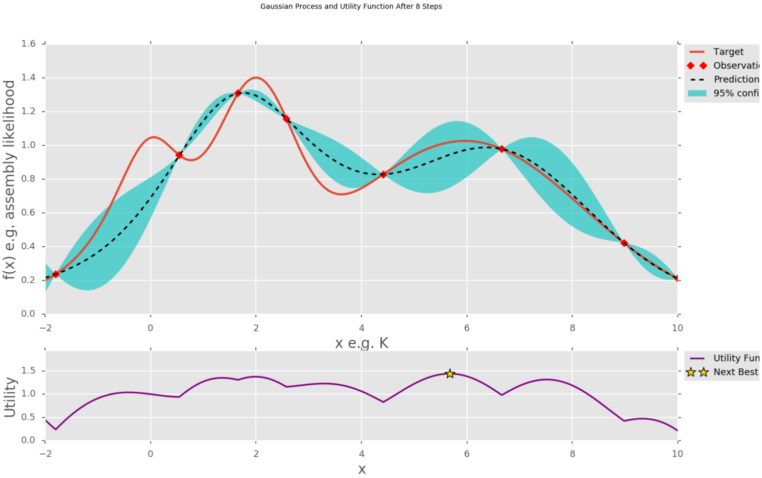
Acquistion Function



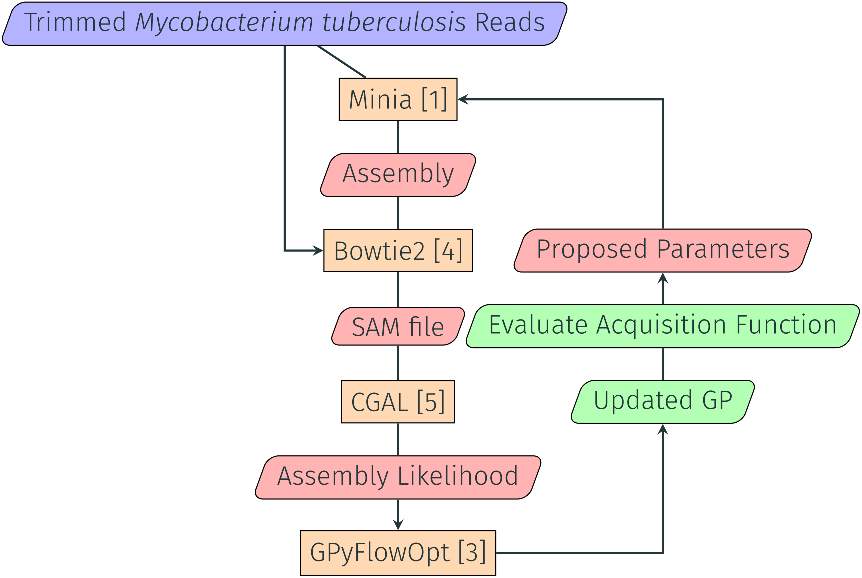
Acquistion Function



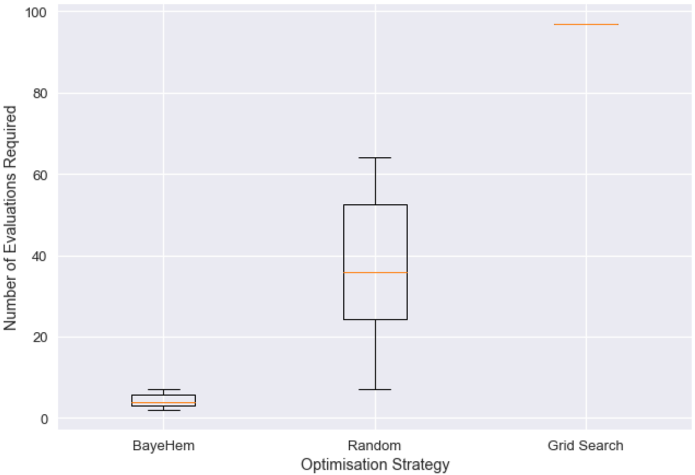
Acquistion Function



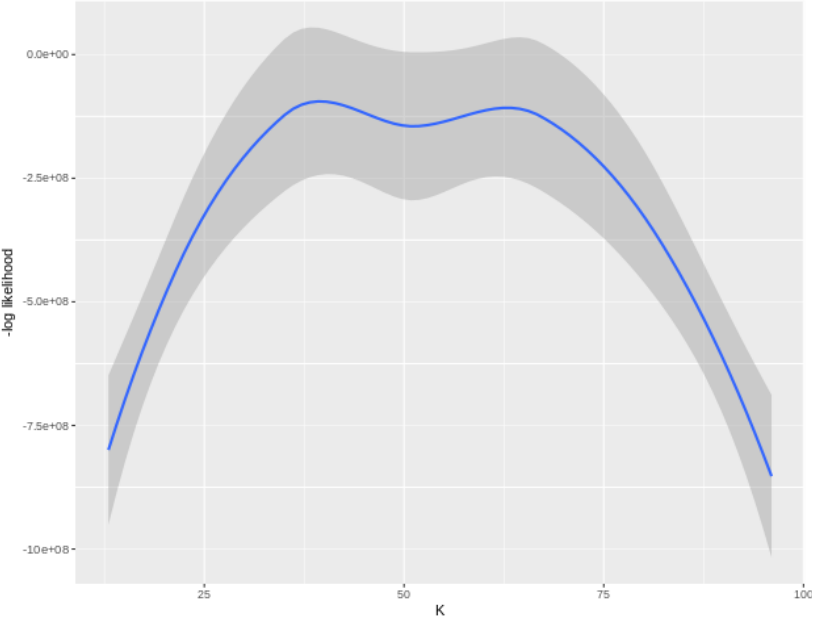
BayeHem


Trimmed *Mycobacterium tuberculosis* Reads
Minia [1]
Assembly
Bowtie2 [4]
SAM file
CGAL [5]
Assembly Likelihood
GPyFlowOpt [3]
Updated GP
Evaluate Acquisition Function
Proposed Parameters

BayeHem Proves Very Efficient



K Likelihood Surface



Limitations and Future Work

- Alternative GP covariance kernels
- Tuning acquisition (and parametrisation)
- Expand to other parameters in assembly pipelines
- Potentially flawed objective function.
- Multi-objective optimisation possible solution.

Conclusion

Summary

- Proof of concept for effectiveness of BayeHem.
- Assemblies are difficult to evaluate by a single metric.
- Large scope for improvement and development of this approach.

Questions?

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