BAMBI: Resurrection

Blind Accelerated Multimodal Bayesian Inference

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Nov 13, 2018

Outline

Background

- Key papers in historical order:

MultiNest	arXiv:0809.3437
BAMBI	arXiv:1110.2997
SkyNet	arXiv:1309.0790
PolyChord	arXiv:1506.00171

- First widely-successful nested sampling algorithm MultiNest.
- BAMBI aims to speed up MultiNest using neural networks.
- Neural network approach is developed into stand-alone code SkyNet.
- MultiNest is updated from version 1 to version 3.
- Higher-dimensional nested sampling available in PolyChord.

Nested Sampling

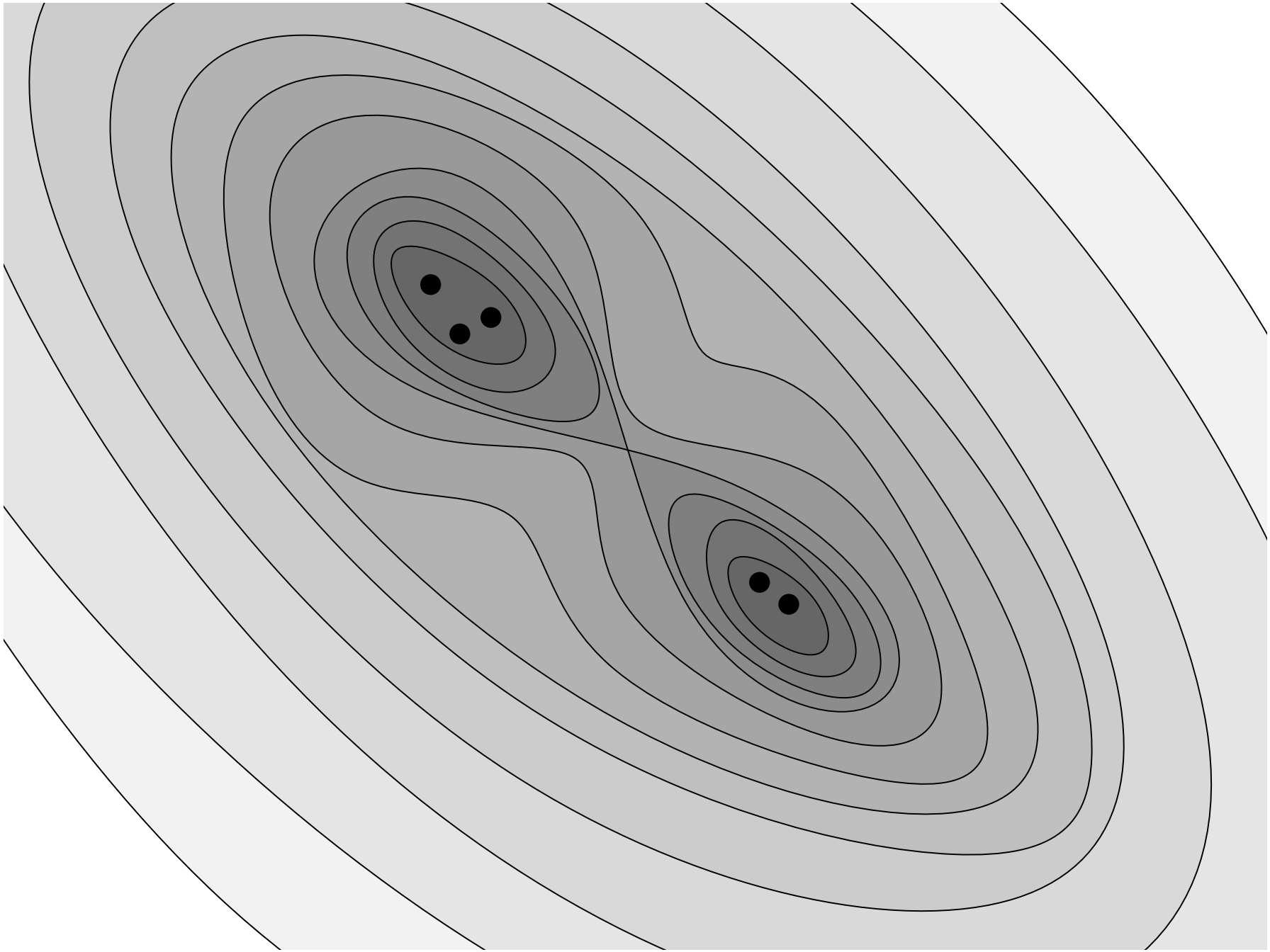
- Completely new approach to sampling:

  Maintain a set S of n samples, which are sequentially updated:

  S_0: Generate n samples uniformly over the space.

  S_{n+1}: Delete the lowest probability sample in S_n, and replace it with a new sample with higher probability

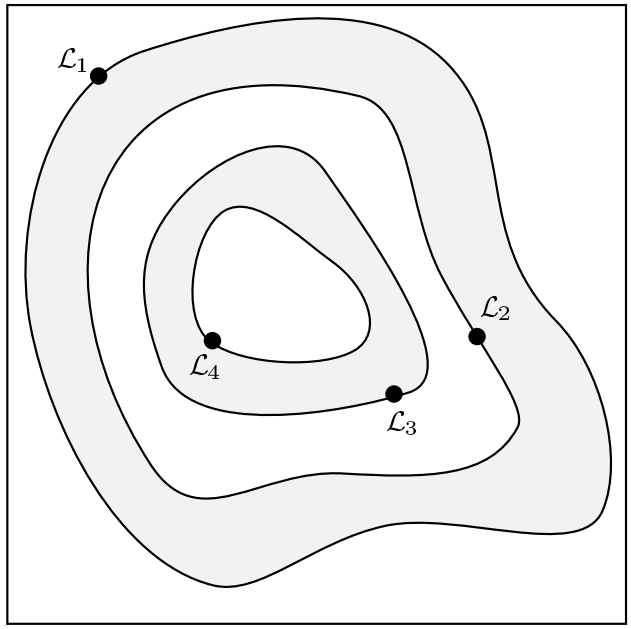
- This generates a *run* of discarded points.
- $n \sim \mathcal{O}(10s - 1000s)$
- Requires one to be able to uniformly within a region, subject to a *hard probability constraint*.
- John Skilling's original paper: euclid.ba/1340370944



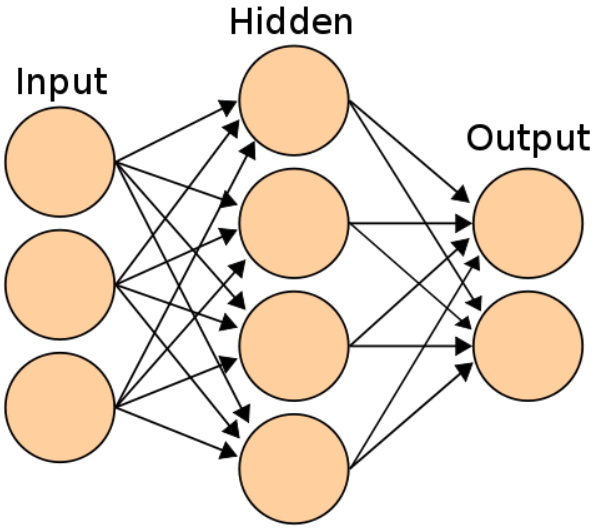
How is Nested Sampling used?

- Nested sampling generates a *run* of discarded points
- These points can be weighted in post-processing to give:
  - Posterior samples
  - Bayesian Evidence (marginal likelihoods)
  - Kullback Liebler divergence
  - Partition function
- This is possible because the nested sampling scheme is a probabilistic integrator, allowing one to estimate the *density of states*.

Neural networks to speed up likelihood calls



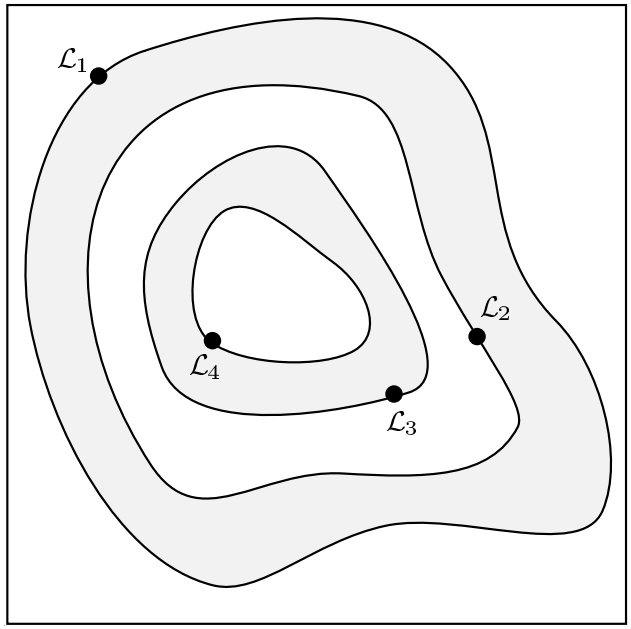
- Likelihood calls can often be slow (seconds to minutes in cosmology and particle physics).
- Use trained neural network as fast proxy for the likelihood

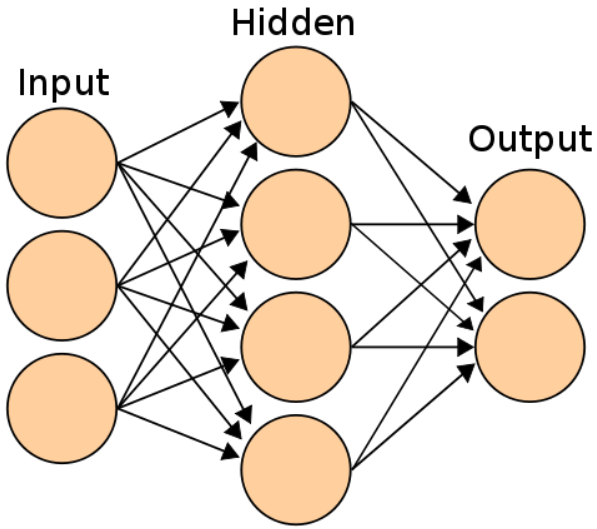


BAMBI

1. Every `updInt/2` iterations, use the last `updInt` discarded points to train a neural network
2. Split points 80 : 20 training:validation
3. If accurate network is obtained, replace log-likelihood with NN.
4. Periodically check whether NN remains accurate, and re-train if necesssary

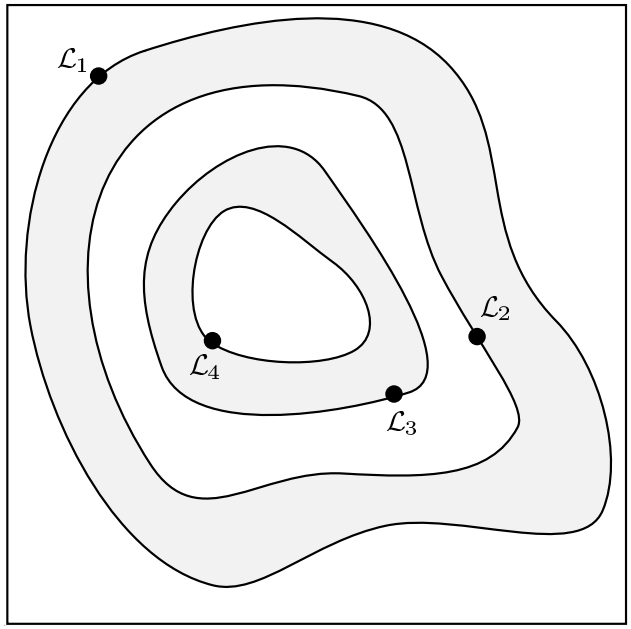
- Do not use NN in place of likelihood if outside range of training data.
- Re-train if most new samples outside 95% central percentile of training data likelihoods.

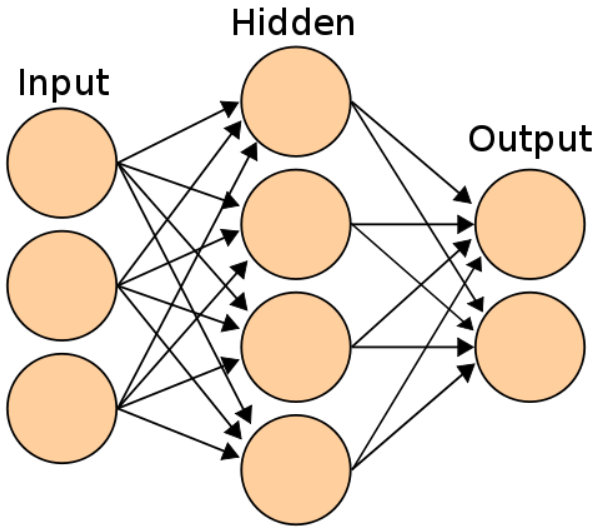




BAMBI: good ideas

- At end of procedure, one is left with a set of overlapping NNs.
- Each NN capable of predicting the log-likelihood across a certain range.
- NNs can be used for further analyses
- set of NNs are particularly well-suited to describing posterior peak





Problems with current BAMBI code

- Out-of-date:
- Hard-coded into old MultiNest (v1).
- NN training technology has advanced since 2013.
- MultiNest will not be suitable for high-dimensional problems, even with fast NN-proxy likelihoods.

PyBAMBI

- Use latest advances in neural networks.
- Use latest versions of PyMultiNest and PyPolyChord.
- Use dumper functions to keep everything in python.
- Use Keras, TensorFlow and Theano for NN framework.