

Lecture 23 - Debugging Story

DSE 512

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From Last Time

- Homework 4
 - Assigned
 - Due April 30
 - Extensions very unlikely

Story Time



Cholesky

$$A_{n \times n} = L_{n \times n} L_{n \times n}^T = U_{n \times n}^T U_{n \times n}$$

Revisiting Cholesky

A random draw from a multivariate normal distribution can be obtained using the Cholesky decomposition of Σ and a vector of univariate normal draws. The Cholesky decomposition of Σ produces a lower-triangular matrix A (the ‘Cholesky factor’) for which $AA^T = \Sigma$. If $z = (z_1, \dots, z_d)$ are d independent standard normal random variables, then $\theta = \mu + Az$ is a random draw from the multivariate normal distribution with covariance matrix Σ .

Gelman, A., Carlin, J.B., Stern, H.S. and Rubin, D.B., 1995. Bayesian data analysis. Chapman and Hall/CRC.

Building a Matrix

$$a_{ij} = \exp\left(-\frac{i+j}{ij}\right)$$

An Interesting Puzzle

- Goal
 - build the covariance matrix
 - compute its Cholesky factor
- Works fine
 - on my laptop
 - on my EC2 box
 - on several other EC2 boxes
 - in a container
 - outside the container
- Where it doesn't work
 - Exactly one runtime environment



What Actually Goes Wrong

```
Error in chol.default(x) :  
  the leading minor of order 19 is not positive definite
```

Problem: can't access the data!

An Idea

From <https://nhigham.com/2021/02/16/diagonally-perturbing-a-symmetric-matrix-to-make-it-positive-definite/>

```
jitter = abs(min(eigen(cov_mat, only.values=TRUE)$values))  
diag(cov_mat) = diag(cov_mat) + jitter
```

Problem:

- My machine: `jitter = 5.23178e-14`
- The problem machine: `jitter = 47.50922`

Comparing Draws

My Machine

Min. : -2.48445
1st Qu.: -1.02584
Median : -0.66874
Mean : -0.49502
3rd Qu.: -0.03763
Max. : 1.34634

Problem Machine

Min. : -23.5999
1st Qu.: -5.1117
Median : -0.5249
Mean : -0.5053
3rd Qu.: 3.9693
Max. : 21.8226

Solution

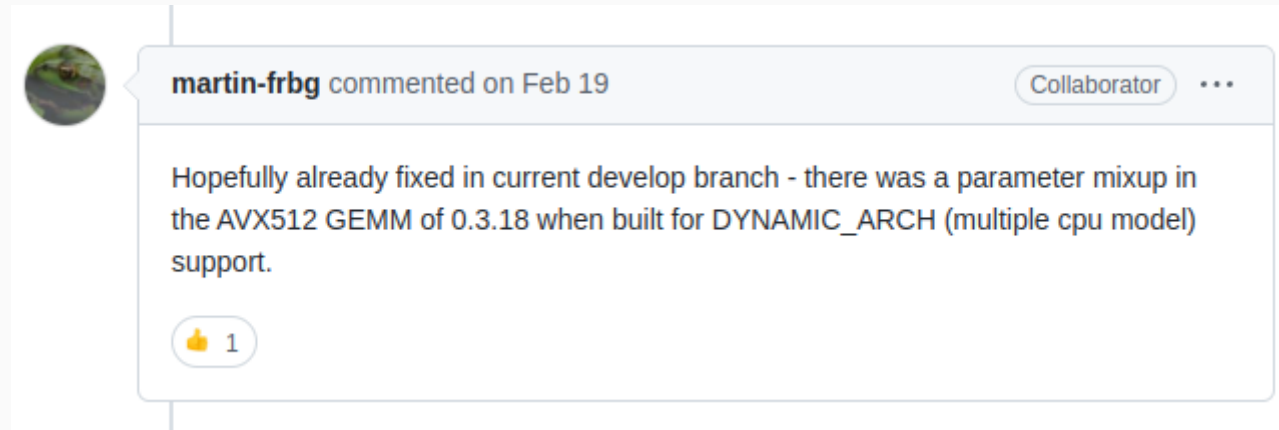
- Give up
- Get the data
- **Discover the data is the same!**

Another Idea

Check the CPU

```
readLines("/proc/cpuinfo")
```

Hardware Has AVX-512



Solution:

```
update-alternatives --set libblas.so-x86_64-linux-gnu /usr/lib/x86_64-linux-gnu/blas/libblas.so
```

That's it for today!