Coding Assignment 1 Write-up

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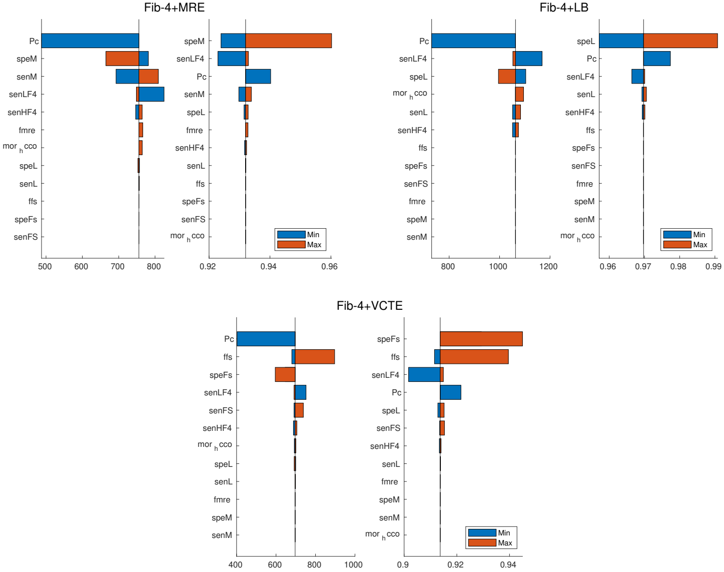
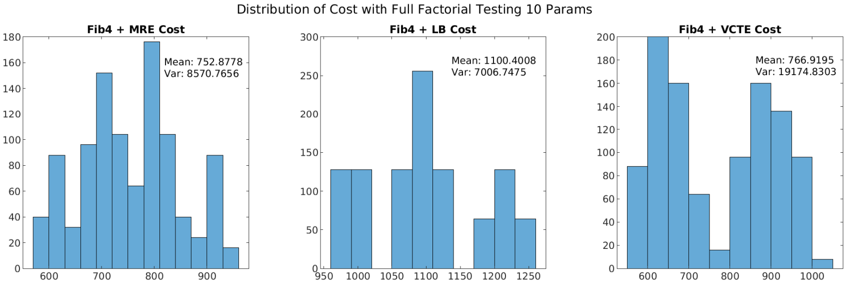
03/20/2021

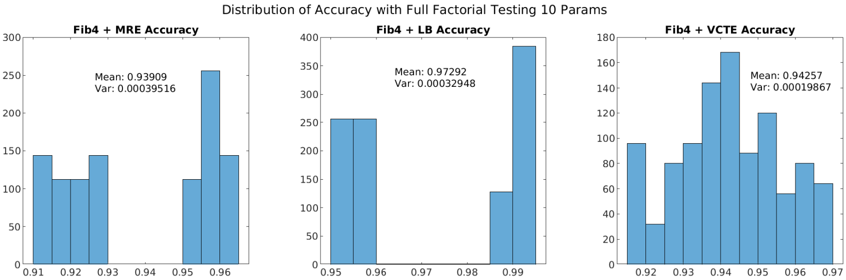
Question 2| One-Way Sensitivity Analysis Tornado Plots

Observations of how sensitive the model output is to the specified parameters.

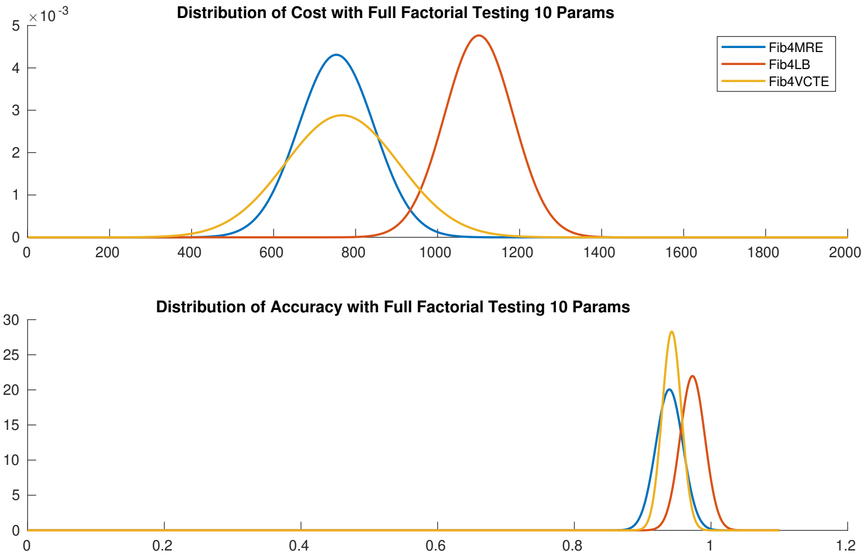


Question 3a| Full-Factorial Histograms





Question 3a| Full-Factorial Fitted Distributions



Question 3b| Full-Factorial Percent ¿ 300 (from Code)

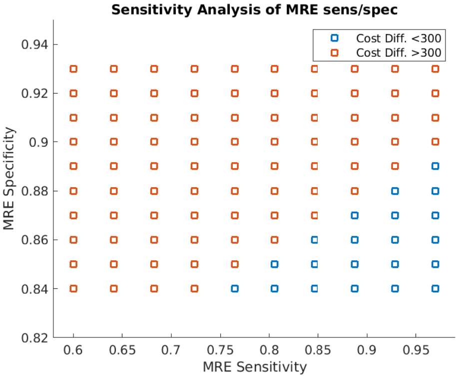
The percent of trials where the difference $|LB_{cost} - MRE_{cost}| > 300$ was 61.7188%

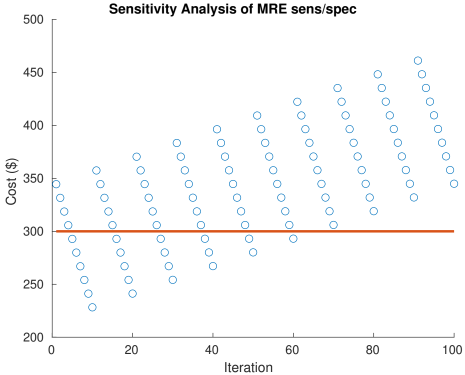
See `q3.m` 252-253:

```
diff = abs(Fib4MRE_cost_out-Fib4LB_cost_out);
percent_greater = sum(diff>300)*100/L;
```

Question 3c| Full-Factorial Sensitivity Analysis on MRE

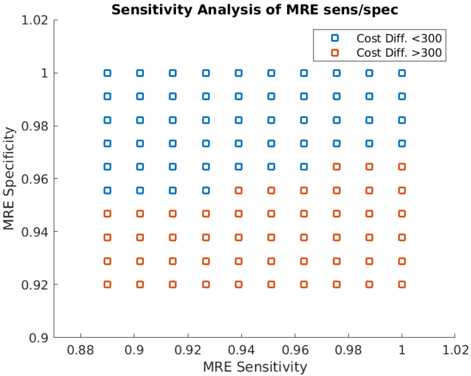
The effect of varying MRE specificity and sensitivity params (`speM` & `senM`) on the cost difference between MRE and LB can be visualized as follows:

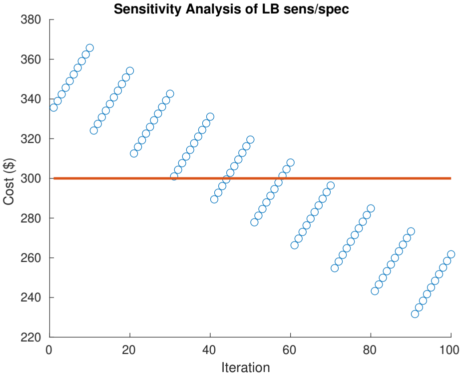




<u>79%</u> of the simulated outputs for cost difference were greater than 300.

The effect of varying LB specificity and sensitivity params (`speM` & `senM`) on the cost difference between MRE and LB can be visualized as follows:

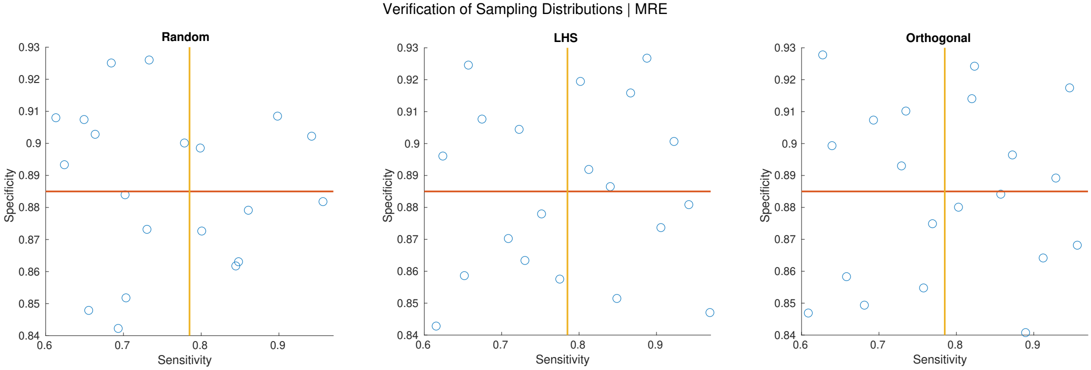




49% of the simulated outputs for cost difference were greater than 300.

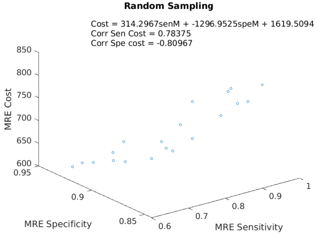
Sample-Based Sensitivity Analysis

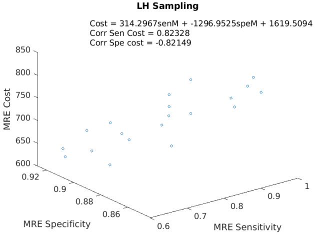
Here is a verification that my sampling was done correctly. I created a brute-force method for orthogonal sampling, `orth_samples.m`.

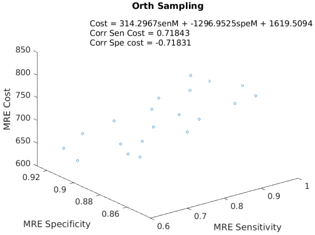


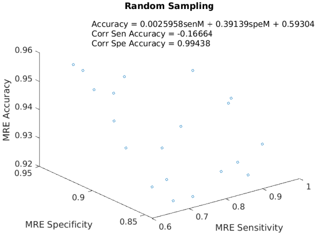
Question 3e | Sample-Based Sensitivity Analysis for MRE

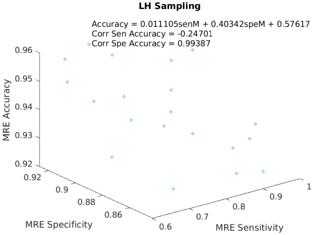
Here are the 3D plots, regression equations and Pearson's correlation coefficients for the MRE sample-based Sensitivity Analysis.

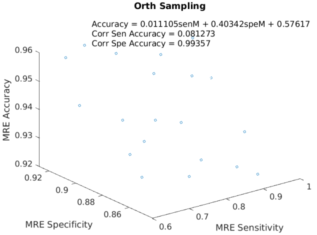






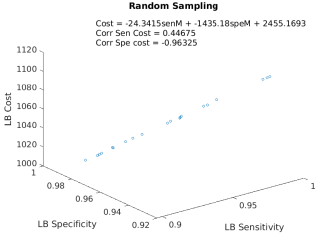


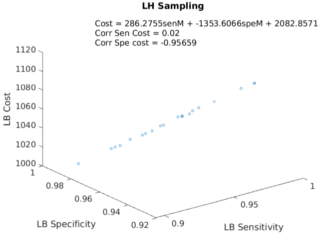


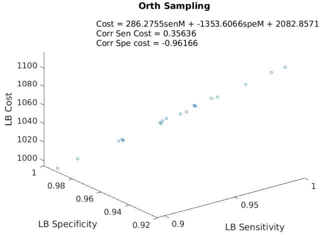


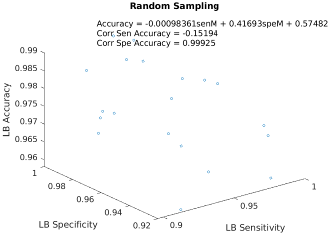
Question 3f | Sample-Based Sensitivity Analysis for LB

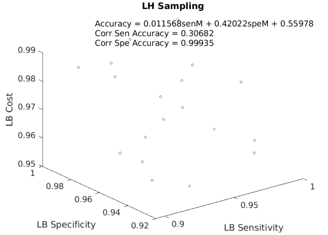
Here are the 3D plots, regression equations and Pearson's correlation coefficients for the LB sample-based Sensitivity Analysis.

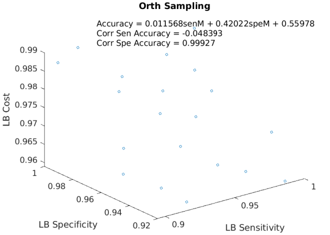












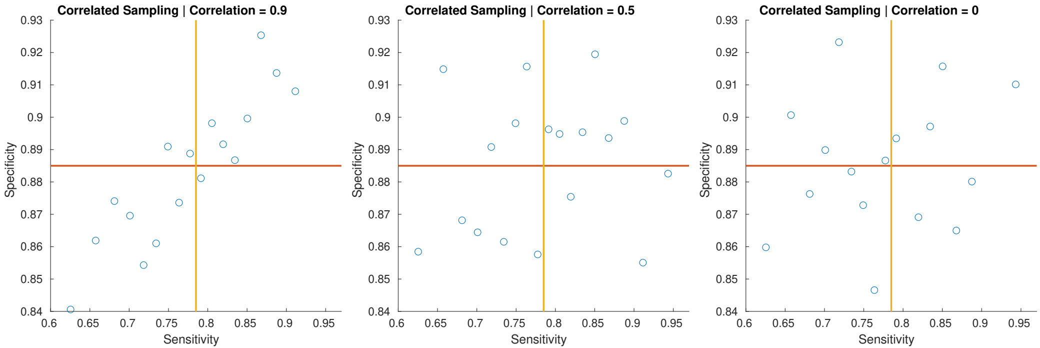
Question 3g | Rank/Statistical Tests

Rank transformations may be useful for particular sensitivity analyses, but depend on the type of data and sample selection. In grid-based techniques, the model outputs may have a sort of distribution or cluster of interest. With a rank transformation, visualizing this will be difficult, since the data is transformed to a uniform distribution.

Similarly, statistical tests may be employed when proper assumptions hold true. In this model, the outputs may not be normally distributed (as in the Fib + MRE/LB Accuracy full-factorial experiment).

Question 3h | Inducing Correlation in Sampling

Here is a verification that my sampling correlation was induced properly:



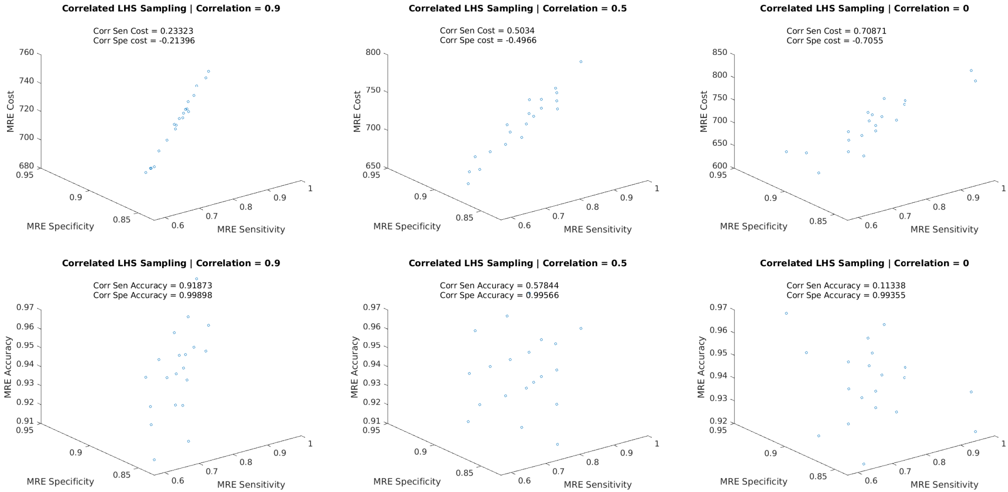
I chose these sampling correlations since there should in theory be a fairly strong correlation between sensitivity and specificity for a good clinical test. However, in some cases, they may not have as much correlation or be weakly correlated. I also assumed a normal distribution of sampling, since these test results are likely also normally distributed.

Correction!

In reality there is more often a trade-off between sensitivity and specificity (not all clinical tests are perfect). Would have been more realistic to have shifted sampling to more properly represent ROC curve!

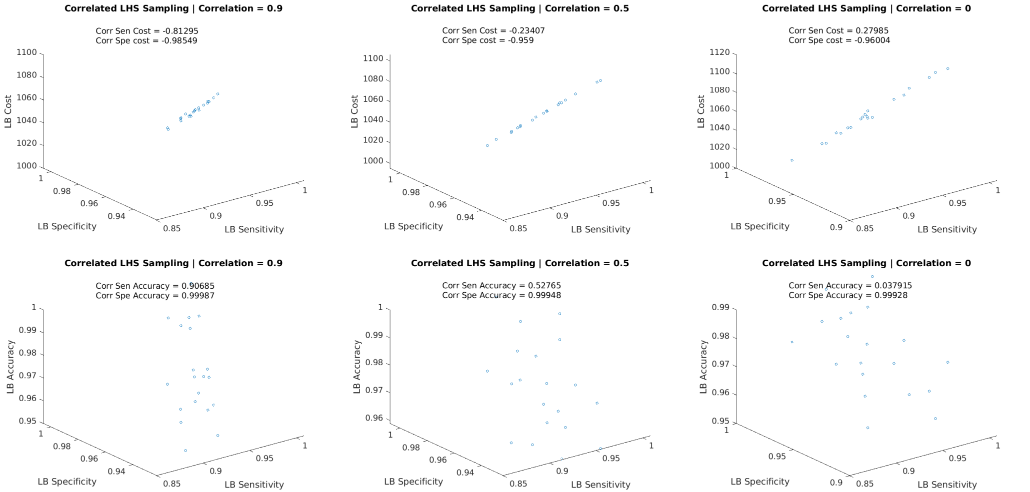
Question 3h | Inducing Correlation in Sampling - MRE

Here are the results with correlated sampling for MRE sens/spec. Correlation decreases from left to right.



Question 3h | Inducing Correlation in Sampling - LB

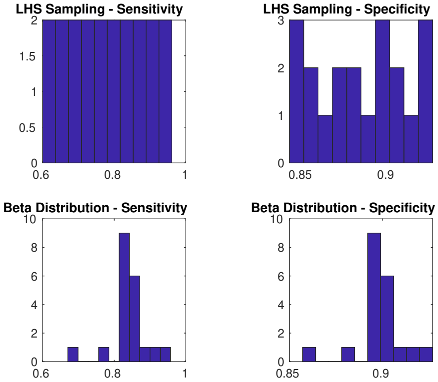
Here are the results with correlated sampling for LB sens/spec. Correlation decreases from left to right.



Question 3i | Importance Sampling

I changed my sampling distribution from uniform (as in random, lhs, orthogonal sampling). I used a Beta(α, β) distribution with $\alpha = 5$ and $\beta = 2$ for both MRE specificity and senstivity to simulate a more optimistic sampling distribution. This beta distribution implies that the model output means are representative of samples with left-skewed sensitivity and specificity.

The distributions compared to the uniform distribution found in the LHS sampling technique



Question 3i | Importance Sampling

The output averages were as follows:

	Parameter Varied	
	MRE Sens	**MRE Spec**
Cost	767.0697	706.8664
Accuracy	0.9324	0.9471

As sensitivity is skewed left, the accuracy decreases and cost increases. Conversely, as specificity is skewed left, the accuracy increases, and the cost decreases. This could be because a higher positive test rate (true in screening tests with higher sensitivity) results in a required confirmatory test with another method with additional costs. A more specific test means less false positives, which prevents decreases the likelihood of this added cost.