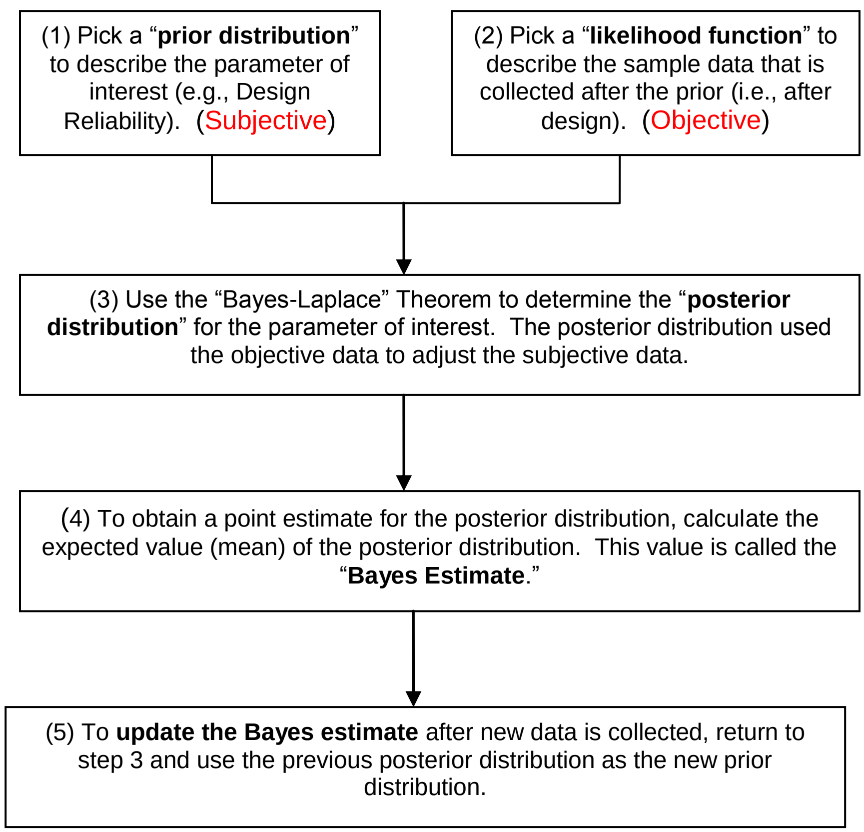
Bayesian Statistics: Concept, Process, & Comparison

How can predicted-mission reliability be updated with each demonstration of mission success or failure?

What is the difference between Classical Statistics and the Bayesian Statistics?

1. Predicted mission reliability can be updated using Classical Statistics, Bayesian Statistics, or both for comparison purposes. **Classical (Frequentist) Statistics** uses only historical or demonstrated data to determine a probability distribution, point estimate, and interval estimate (confidence limits). **Bayesian Statistics** uses new demonstration data in the form of a probability distribution to update a subjective probability distribution. This subjective probability distribution describes a "degree of belief" in a proposition (predicted mission reliability) and is established prior to and independent of the new demonstration data.
2. Bayesian Statistics is preferred when the data set (e.g., launch count) is small. Regardless, as launch count increases, both methods will converge on the true value (i.e., end of program demonstrated mission reliability). See illustrative comparison on the next page.
3. The Bayesian Statistics method follows this process:



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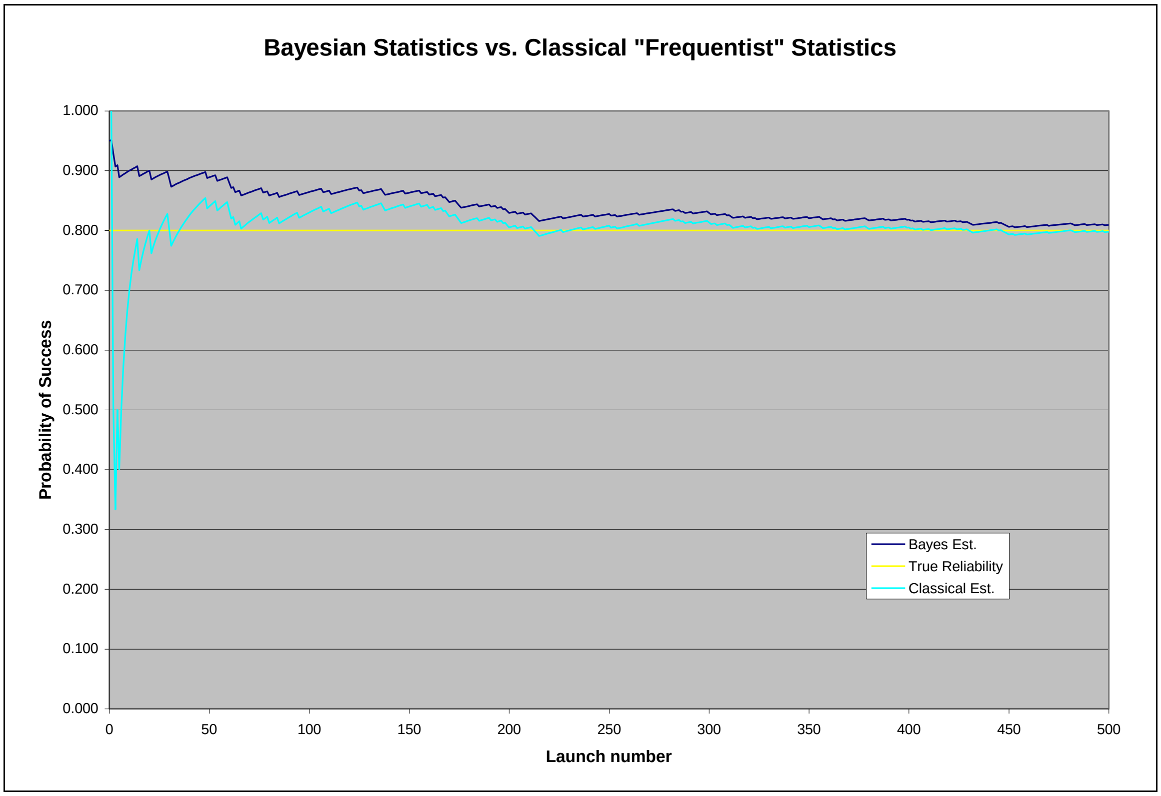
<u>Comparison</u>: Bayesian Statistics vs. Classical Statistics For Reliability Field Data Based on Trials and Not Clock Time



0 = F 1 = S	Launch Number	Bayes Est.	True Reliability	Classical Est.
	0	0.950	0.8	
1	1	0.951	0.8	1.000
0	2	0.929	0.8	0.500
0	3	0.907	0.8	0.333
1	4	0.909	0.8	0.500
0	5	0.889	0.8	0.400
1	6	0.891	0.8	0.500
1	7	0.894	0.8	0.571
1	8	0.896	0.8	0.625
1	9	0.898	0.8	0.667
1	10	0.900	0.8	0.700
1	11	0.902	0.8	0.727
1	12	0.904	0.8	0.750
1	13	0.906	0.8	0.769
1	14	0.907	0.8	0.786
0	15	0.891	0.8	0.733
1	16	0.893	0.8	0.750
1	17	0.895	0.8	0.765
1	18	0.897	0.8	0.778
1	19	0.898	0.8	0.789
1	20	0.900	0.8	0.800

<u>Summary</u>

1. Assume the vendor's mission reliability at the *start* of the program is believed (predicted) to be 0.95.
2. Assume the true (demonstrated) reliability at the *end* of the program is 0.80.
3. For this scenario of 500 launches, the failure (F) or success (S) outcome for each launch was assigned randomly and not from any actual flight history.
4. The random assignment of failure and success is shown for the first 20 of the 500 launches.
5. It is coincidental that the classical approach produced the "true value" on the 20th mission.
6. As shown, as launch count increases, both methods converge on the true value.

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