There will be 8 questions in total, each worth 5 points.

**Question 1** Consider tossing a sequence of coins with probability $p$, and keeping track of the sum $S_n$ (+1 for heads, -1 for tails).

(a) Write down the asymptotically pointwise valid CLT confidence interval for $p$.

(b) Write down any pointwise valid Chernoff-based confidence interval (mention which one you used) for $p$.

(c) Write down a uniformly valid linear confidence sequence (mention which one you used) for $p$.

(d) Write down a uniformly valid curved confidence sequence (mention which one you used) for $p$.

**Question 2** For each of the previous bounds, run a simulation with $10^5$ coins (of any bias you choose) to estimate the probability that the confidence interval for $p$ is wrong at some time between 1 and $10^5$ (repeat a 1000 times to get an accurate estimate of the probability).

**Question 3** Play around with the inverted stitching method to come up with your own unique 1-subGaussian boundary that has crossing probability at most 0.1 before intrinsic time $10^9$.

**Question 4** If you had to use your 1-subGaussian confidence sequence before a finite time, say $10^6$, which of the following would you use? (a) a stitching boundary, (b) a normal mixture boundary, (c) the inverted stitching boundary. Justify your answer.

**Question 5** Consider a series of iid coin tosses (+1 for H with probability $p$, -1 for T with probability $q$), and let $S_n$ be the running sum. Prove that $(q/p)^{S_n}$ is a martingale with respect to the natural filtration. Find the value of $C$ for which $C^n X_{S_n}$ is a martingale, where $X$ is some positive constant.

**Question 6** Prove that for any sum $S_t$ of independent increments with finite variance, we have $\Pr(\exists t \in \mathbb{N} : S_t - t\mu > 1000\sqrt{t}) = 1$. 

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**Question 7**  What is the difference between a p-value and an always-valid p-value? What is the use of the latter and how do you construct it?

**Question 8**  What is the relationship of the normal mixture confidence sequence to the sequential probability ratio test (SPRT)?