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I collaborated with Yug Jarodiya.

Problem 1

The language consisting of strings of the form $a^i b^j$ where $i \neq j$ requires the grammar to capture the imbalance between the number of a 's and b 's.

We will re-write $i \neq j$ as $i < j$ or $i > j$.

$$L = \{a^i b^j ; i < j \text{ or } i > j\}$$

$$S \rightarrow A_{i < j} \mid A_{i > j}$$

$$A_{i < j} \rightarrow aA_{i < j}b \mid bB$$

$$B \rightarrow bB \mid \epsilon$$

$$A_{i > j} \rightarrow aA_{i > j}b \mid aX$$

$$X \rightarrow aX \mid \epsilon$$

Problem 2

Problem 3

Problem 4