These exercises will be due at the beginning of class on Wednesday, November 23. Please submit a legible hard copy of your solutions at that time.

0. In Scheme, C, or Java, implement a variant of the Knuth–Morris–Pratt algorithm in which a question mark occurring in the pattern string is treated as a wild card that can match any single character in the text string.

1. Instrument your implementation of the algorithm so that it keeps track of the number of comparisons between a character of the pattern string and a character of the test string (counting each wild-card match as a “comparison”) and reports the total.

2. Design a suite of tests for this variant of KMP string matching, apply your implementation to all of the tests, and collect the output, including the comparison counts.

3. What is the worst case for the original KMP algorithm? Express, as a function of \( m \) and \( n \), the number of comparisons that the algorithm make in matching a string of length \( n \) against a pattern of length \( m \) in the worst case.

4. What is the worst case for the variant of the KMP algorithm that includes single-character wild-card matching? Justify your answer.