A collection of my interview problems

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1 CTC quant researcher

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1. Discuss my research project
2. We want to make change for S cents, and we have infinite supply of each coin in the set Coins $= \{v_0, v_1, ..., v_n\}$, where v_i is the value of the $i-$th coin. Find the number of methods to reach value S?

We can start by drawing a decision tree for simple cases. Then we need to design a dynamic programming algorithm.
Suppose there are $z(S, n)$ methods to reach value S use the n coins.

Subproblem: find $z(T, i)$, the number of methods to reach value $T < S$ use the first i coins. Considering the two options, use the i-th coin or not, we have the recurrence relation:

$$z(T, i) = z(T - v_i, i) + z(T, i - 1).$$

```
class Solution:
    def change(self, amount: int, coins: List[int]) -> int:

        memo = {}
        def helper(amount, i):

            if amount < 0:
                return 0
            if amount == 0:
                return 1
            if i < 0:
                return 0

            if (amount, i) not in memo:
```

```
                ans = helper(amount - coins[i], i) + helper(
                                                amount, i-1)
                memo[(amount,i)] = ans

            return memo[(amount,i)]

        return helper(amount,len(coins)-1)
```

3. You can take two trains, train A or train B, to go to work. The waiting time of train A follows a uniform distribution between 0 and 5, and the waiting time of train B follows a uniform distribution between 0 and 10. What is your expected waiting time to take a train to work?

$X_1 \sim U(0,5)$, $X_2 \sim U(0,10)$. My waiting time $X = \min(X_1, X_2)$.

$$\begin{aligned}
E[X] &= \int_0^{10}\int_0^5 \min(x_1,x_2)\frac{1}{50}dx_1dx_2 \\
&= \frac{1}{50}\int_0^{10}\int_0^5 \min(x_1,x_2)dx_1dx_2 \\
&= \frac{1}{50}\left(\int_0^5\int_0^{x_1} x_2dx_2dx_1 + \int_0^5\int_{x_1}^{10} x_1dx_2dx_1\right) \\
&= ...
\end{aligned}$$