Understanding the Problem and RL Proposition

My recent capstone idea focuses on reducing the 56% tomato loss in Rwanda's supply chain from Farm to Collection Point, then to Wholesale, and finally to Retail. The goal is to minimize loss and boost profit. I had the intuition to use a Reinforcement Learning (RL) algorithm, which could learn the most effective ways to manage tomatoes based on the current state, including factors like location, weather, ripeness, and more. These are just a few of the variables I've been exploring. I believe RL could enhance the supply chain by identifying patterns of loss from actions being taken and preventing them. RL might suggest context-aware actions, but I suspect it needs help in understanding the root causes of losses, which is where Hidden Markov Models (HMMs) could assist.

Applying HMM to Support RL

I envisioned using HMMs to analyze loss percentages between transitions (e.g., [25%, 10%, 5%], where 25% is lost from Farm to Collection Point) to uncover hidden patterns to help us understand the causes of these losses which could be various factors but in the form of probabilities . With the Baum-Welch algorithm, HMMs could link these losses to hidden states such as "Intact" (low loss, e.g., 5%), "At Risk" (moderate, e.g., 10%), and "Compromised" (high, e.g., 25%). Research shows that factors like weather, ripeness, storage, and handling contribute to loss variability, factors that a human might overlook. I believe the HMM-RL combination enhances human decision-making: HMMs detect underlying patterns and predict upcoming losses (e.g., 5% after a 10% loss), while RL proposes tailored actions. For instance, if HMM infers a "Compromised" state with a 25% loss due to early damage, RL could recommend actions appropriate from the Farm stage which would help maximize rewards. I think this collaborative approach could significantly reduce the 56% loss rate.

- **Farm to Collection Point:** Actions are guided by RL based on HMM insights.
- **Collection Point to Wholesale:** Actions are adjusted by RL using HMM insights.
- **Wholesale to Retail:** Actions are informed by RL with support from HMM insights.

Answering the Question: HMM Problem and Details

- **Observations:** The observed data consists of loss percentages (e.g., 25%, 10%) representing tomato losses at each supply chain transition.
- **Type of HMM Problem:** Since the hidden states ("Intact," "At Risk," "Compromised"), and the model parameters are not known beforehand and must be inferred from data, this is a **Baum-Welch problem**.
- **Algorithm to Train HMM:** The **Baum-Welch algorithm** is used to train the HMM based on the observed loss data.
- **Known Values:** The known values are the observed losses at each stage in the supply chain.
- **Unknown Values:** The unknowns include the hidden states and the predicted future losses, and the probabilities, which are learned over time.
- **Parameters Updated:** Parameters such as transition probabilities (between hidden states), emission probabilities (likelihood of observed losses given a state), and initial state probabilities are updated during training.