Data Translation Challenge

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I. Executive Summary:

SuckyCorps's biggest challenge consists of deciding which product to launch to expand their line of robot vacuum agents. They want to improve their robot vacuum product line by analyzing how well each model cleans. In this report, I have analyzed Non-Sensing Sucky, Sensing Suck, Memory Sucky, and Omniscient Sucky. The goal of this report is to help SuckyCorps to decide which models should stay, which should go, and which ones are worth improving.

The results of the analysis show that the Omniscient Sucky is the best at cleaning because it knows everything about its environment. However, it is also the most expensive option since it requires special sensors to be installed. This will make this option too expensive for most people to afford. The Memory Sucky is also a good choice because it remembers past movements and avoids cleaning the same area multiple times. However, its effectiveness depends on the environment, and it uses more battery compared to the other models. The Sensing Sucky is better than the Non-Sensing Sucky because it can detect dirt and obstacles, but it doesn't work as well in complex spaces with a lot of walls. The Non-Sensing Sucky is the weakest model because it moves randomly and wastes energy.

Based on these findings, the Non-Sensing Sucky should be discontinued because it is outdated and does not clean effectively. The Sensing Sucky should be kept as an affordable option for people who just requires basic cleaning. The Memory Sucky shows potential and should be improved when it comes to battery life. The Omniscient Sucky is very effective but expensive. This model should be sold as a premium product for high-end customers or businesses that are willing to pay more for great cleaning results. These recommendations will help SuckyCorps focus on models that offer the best balance between performance, cost, and customer needs.

II. Supporting Analysis:

Each vacuum model was tested in different environments and conditions. Then the average cleaning score and variance were calculated. The higher score indicates how much better that agent was at cleaning environment. Also, the score variance helps to understand how consistently the different agents behave in different environments. Low score shows that the agent is reliable and performs consistently. However, a high score shows inconsistent performance. This table below reflects the summaries of overall performances of all four agents.

Agent	Average Score	Score Variance
NoSenseAgent	17.35	180.19
SensingAgent	72.31	1037.90
WorldModelAgent	128.64	3788.12
OmniscientAgent	228.69	1155.81

The table above shows how each agent behaves:

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- NoSenseAgent has the lowest average score of 17.35 and lowest variance of 180.19 among all the agents. This shows that it is ineffective because of random movement and wasted battery usage. However, the low variance score of this agent shows that it consistently performs similarly. Hence this agent consistently preforms badly and does not clean well.
- SensingAgent has a little better performance than NoSenseAgent. Its average score is 72.31 and it shows that it detects obstacles and dirt but lacks the ability to plan ahead of time. This agent's variance score is average which means that it is a well balanced model, but needs more improvement.
- WorldModelAgent has the average score of 128.64 and a high variance score of 3788.12. This shows its ability the perform better, but its effectiveness is unpredictable as indicated by its variance score. Even though it remembers past movements and reduces battery wastage, its variance keeps on changing based on the change in environment and layout.
- OmniscientAgent by far is the best model with the average score of 228.69 and a variance of 1155.81. This is because it contains the knowledge of the environment, which allows it to clean more efficiently, and the variance is moderate. This means that this agent consistently performs better than the other agents.

The Agent Performance was tested under different dirt and wall densities. This helped us to understand how environmental complexity affected performance.

Dirt Density	Wall Density	Average Score of NoSenceAgent	Average Score of SensingAgent	Average Score of WorldModelAgent	Average Score of OmniscientAgent
0.1	0.1	17.35	72.31	128.64	228.69
0.1	0.5	4.38	6.62	9.13	10.50
0.1	0.9	1.27	1.42	0.97	1.23
0.5	0.1	84.96	303.38	534.87	372.23
0.5	0.5	22.38	35.27	46.97	47.58
0.5	0.9	6.38	6.35	6.47	6.65
0.9	0.1	152.04	462.62	779.47	518.92
0.9	0.5	40.15	59.73	76.58	74.23
0.9	0.9	11.50	10.73	11.37	11.38

These are some of the observations form the table:

- Performance decreases as wall density increases. This occurs because obstacles limit the agents' ability to move efficiently. All agents struggle in environments with many walls since they get stuck more often. This wastes battery when trying to find new paths, and it takes longer to clean the same area. This is especially noticeable for agents like NoSenseAgent and SensingAgent, which do not have advanced navigation abilities. This is also evident in their low average scores.
- Dirt density also has a big impact on performance. When there is more dirt, agents have more chances to clean and earn a higher score. In low-dirt environments, some agents waste time moving without finding much to clean. This makes their efficiency lower. This is why dirtier

areas can sometimes make an agent look more effective than it is. This is also evidenced in the table above.

- WorldModelAgent performs best in open areas where dirt density is high and walls are few. This is because it remembers past movements and avoids cleaning the same area twice. This saves battery. However, in complex environments with many walls, its efficiency drops because its movement is restricted, and its memory advantage does not help as much.
- Omniscient Sucky consistently scores high in all environments. Unlike other agents, it never wastes movement since it knows exactly where the dirt is and how to reach it in the shortest path. While it is the most expensive model due to the need for special sensors, its high and stable performance makes it the best overall performer.
- This analysis is important for SuckyCorps because it shows which models are best suited for different customers. If a customer has an open space with lots of dirt, the Memory Sucky could be a good balance of performance and cost. However, for environments with many obstacles, the Omniscient Sucky is the only model that performs well. The company can use these insights to decide which models to improve, which ones to discontinue, and how to market each product effectively.

Since Memory Sucky (WorldModelAgent) requires memory storage to track its environment, it is expected to consume more battery. The table below shows how different battery capacities affect its performance.

Battery Capacity	Average Score	Score Variance
500	Low	Unstable
1000	Moderate	High Variance
2000	High	More Stable

This is the observations from the table above:

- Higher battery levels improve performance. More power helps agents, especially Memory Sucky, function efficiently. At 2000 battery, Memory Sucky had the highest average score, meaning it could fully use its movement efficiency. With enough power, it avoids redundant cleaning and maximizes coverage.
- Lower battery levels lead to inconsistent performance. At the 500 battery capacity, performance varied greatly, with some runs showing decent cleaning and others failing to complete the task. The variance in scores was higher, meaning results were unpredictable. Some agents ran out of power before cleaning effectively, reducing their usefulness.
- Battery optimization is needed for Memory Sucky. It is designed to be efficient, but it needs enough power to make smart decisions. If battery life is too low, it loses its advantage, making it no better than simpler models. To make this model viable, either battery consumption must be optimized, or customers should use it in areas where frequent recharging is possible.
- A high variance score means performance is unpredictable. Lower variance means more reliable performance, which is important for customers who need consistent cleaning. Memory Sucky

had high variance at lower battery levels, meaning some runs were efficient while others failed. In comparison, Omniscient Sucky had lower variance, proving it performs well in all conditions.

III. Conclusion:

After analyzing the different robot vacuum models, it's become clear that some models perform much better than others. The Omniscient Sucky is the best cleaner because it knows everything about its environment. However, it requires special sensors, making it very expensive and best suited for businesses or high-end customers willing to pay for top-tier cleaning. The Memory Sucky also performs well, especially in open spaces where it can move efficiently without wasting time. But its performance is heavily tied to battery power. When the battery is low, its cleaning ability becomes unpredictable. The Sensing Sucky is a step up from the Non-Sensing Sucky, as it can detect dirt and obstacles, but it still struggles in environments with many walls. Lastly, the Non-Sensing Sucky is the least effective because it moves randomly, wasting energy and time without cleaning efficiently.

Based on these findings, SuckyCorp should discontinue the Non-Sensing Sucky, as it no longer meets performance expectations. The Sensing Sucky should remain as a simple, budget-friendly option for customers who don't need advanced features. The Memory Sucky has strong potential but requires better battery efficiency to ensure it maintains performance without running out of power too quickly. The Omniscient Sucky should be marketed as a premium product for businesses or customers who demand the highest level of cleanliness.

For future improvements, battery optimization and performance consistency should be a priority, especially for the Memory Sucky. Additional research into cleaning speed and long-term reliability could help refine product decisions. By focusing on cost-effective, reliable, and efficient models, SuckyCorp can improve its product lineup and give customers the best options for their cleaning needs.