# What a Waste - Food and A.I.

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We all need food to survive. Unfortunately, not all of us can have this most primitive need met. This is, in large part, due to our wastefulness of food. While this is a problem throughout the world, it seems particularly prevalent in the first world. For example, according to the NRDC, the United States is consuming only two thirds of its food, while ⅛ of Americans deal with hunger (Food Waste, 2018). This wastefulness does not only cause harm on the individual level, but the economy suffers as well. The USDA states that in 2010, the US wasted nearly $161 billion on food that made its way into the trash instead of into a mouth (Information Sources). Food waste is not limited to just our country. According to the Food and Agricultural Organization (FAO), ⅓ of all food produced for human consumption worldwide is wasted (Food Loss and Food Waste). We'd be remiss to not also consider the environmental drawbacks of our vastly incompetent food production on the whole. Many of Earth's resources that go into producing this food, from the land and water that nurtures the produce, to the gasoline that powers the many modes of food transportation, are wasted in this process. To make matters worse, these statistics are only concerned with food *waste.* If one factors in the numbers on food *loss*, when food is literally lost or ruined before being purchased, one thing becomes painfully clear. We, as a species, simply have to do something to waste less food, and as computer scientists, we can start with technology.

At first glance, it may not be obvious how technology can aid us in making strides toward a more efficient food future. However, upon further inspection, there seems to be a wealth of technologically leaning groups who are committed to decreasing food waste worldwide, some even going so far as to say their services can reduce up to 50% of previously wasted food, and thus increase profit margins by 6% (About). Using various tracking technologies, ZestLabs enables shippers to keep track of how quickly their produce is progressing, that is to say, perhaps, how quickly it is ripening. For example, if it is ripening unusually fast, the shipper will be notified and can possibly send that produce to a closer destination, making sure the product arrives on shelves before it has gone bad. Not unlike most tech startups however, a lot of these ventures revolve around profits. In the example above, ZestLabs seems primarily concerned with increasing revenue for a select few in the produce supply chain. The cause is still a positive one, yet this raises some questions into the role money plays in finding solutions for certain problems whose solutions do not so clearly lead to profit.

As part of our search for possible technological solutions to food waste, artificial intelligence (AI) must enter the fray. Whereas previously mentioned companies are using manual data entry, some groups are implementing different AI methodologies to more quickly identify food that is susceptible to waste, allowing for the swift handling of the product. Machine learning (ML) is at the forefront of modern AI implementations, and for good reason. ML algorithms enable computers to exhibit highly specialized task behavior, in both virtual and physical environments. Much emphasis has recently been placed on computer vision, by which a computer can take digital imagery as input, and apply a machine learning algorithm to begin to discern and classify various features of the image. This includes both still images (photographs) as well as moving images (video). Computer vision and food don't seem to have much to do with each other. Some companies are proving that couldn't be less true. A hospital in Japan has partnered with Hitachi to use a machine learning algorithm that processes photographs of patient's food trays to determine what food was and was not consumed (Hitachi, 2018). With this information, the caregivers can adjust how much food should be given to each patient individually, meaning if they are eating less, then less food will be given. This can lead to a vast reduction in the amount of the hospital as a whole is wasting.

As such, our team decided to invert the problem and document how simple it can be to create an AI that *contributes* to some of the world's most prevalent forms of squander, in our case, food waste. To do this, we've created an embedded AI system that loosely implements the theories found in rule based expert systems (RBES). Our AI aids users in creating grocery lists. This entails a few key elements, which will henceforth be detailed.

First we start with some data (as all good scientists do). Our data is a UK Government set of 'detailed annual statistics on family food and drink purchases' [1]. This data set is far more detailed than the scope of our project called for, more on that in a bit, but it was readily available and well organized. We also investigated the possibility that this data set may be skewed, in support of some political bias, but found this to be unlikely. The trustworthiness and soundness (read; lack of bias) of data is a crucial element in the ethical concerns that can arise when using AI, so we took the necessary precautions to eliminate this concern. With a solid data set chosen, we had to process this data. To do so, our first step involved some despecficiation. There are entries in the data set for various kinds of milk. We choose to summate these subtypes into one supertype; milk. Throughout all the data, we had to amalgamate many subtypes into supertypes. This made parsability high, but specificity low. This tradeoff was one we were willing to incur in order to limit the number of mistakes a user could make when entering a product name. After these reductions of complexity, our program calculates the average consumption on a weekly, per household basis.

With the data processed, we used these averages as the basis of our suggestions. We assume a pre-existing knowledge of the user's refrigerator contents which allows us to calculate a difference between the quantities possessed and the average quantities consumed. This difference is what our agent will suggest the user purchase on their next trip to the grocery store. However, because these suggestions are based on averages, the suggested amounts are almost always too accurate. That is to say, our agent might suggest the user purchase .47826 liters of milk to match the average.

To many, this is a useless suggestion. Thus, we implement some rules which help guide the agent towards a more realistic suggestion. These rules rely on some common sense knowledge, a feature not so easily implemented in other forms of AI, particularly in neural nets. We can, for example, never suggest the user purchase a quantity of milk less than a half liter because we, as the programmers, know that lesser quantities can not reliably be found in a supermarket. There are other such rules implemented, such as the number of eggs to purchased cannot be less than six, or meat is purchased by the pound. We essentially always 'round up' to some known accessible value. It is this 'rounding up common sense' that we feel could lead our agent to contribute to food waste. If we suggest the user purchase more than they actually may need, the the amount of excess food may increase. This excess food is almost guaranteed to be wasted. The issue is that this rounding behavior is, in many cases, the only way to provide a realistic suggestion. So as designers, we could simply feel as though this possibly wasteful design decision is forced upon us.

However, following this algorithm, our agent is able to quickly and accurately generate shopping lists. Yet, there were several moments throughout our design process in which we questioned whether it was truly a reflection of AI, and more specifically of a RBES. We found it difficult to make the transition from a fairly simple algorithm to something that exhibited more ‘intelligent’ behavior. It goes without saying that intelligence is quite difficult to quantify, yet we still desired a more distinct showing of these sorts of behaviors from our algorithm. This was our foremost struggle. We made the decision to counterbalance this flaw with a more ethics centered approach to the project.

We feel as though this implementation displays how easy it can be for us as computer scientists, and more broadly as designers, to not take into account the ways in which our products can affect not only our users but also our environment. With rising population numbers worldwide, food waste is set to have an even greater impact as the number of mouths to feed grows. It is our ethical duty while designing and implementing technological systems to consider the many ways in which we are shaping the world.

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[1] https://www.gov.uk/government/statistical-data-sets/family-food-datasets