When we choose equal weights, we study $w_1 = \frac{1}{2}$ for class 1, and $w_2 = \frac{1}{2}$ for class 2.

In general, if $w_1 \in [0, 1]$ and $w_2 = 1 - w_1$, we get:

\[ w_1 \tilde{f}_1(t_i) + (1 - w_1) \tilde{f}_2(t_i) \rightarrow \max_{t_i} \]

\[ w_1 (t_i - t_i)^2 + (1 - w_1) (t_i)^2 \rightarrow \max_{t_i} \]

\[-2w_1(t_i - t_i) + (2 - 2w_1) t_i = 0 \]

\[-2w_i t_i + 2w_i t_i + 2t_i - 2w_i t_i = 0 \]

\[\frac{2t_i}{2} = 2w_i + \sqrt{4w_i - 1} \]
Multiobjective optimization is important for cloud computing because we don't really know any perfect specific configuration of the cloud that is the absolute best, so we try to optimize several functions i.e., cost, time, distance, quality of service, etc., and we assign appropriate weights to these functions as to place a value to them. For instance, maybe we care more about time than cost.
3) \( m = 100 \)

\[ P(x) = A + x^{-\alpha} \]

\( \alpha = 3 \)

\( c_0 = 10 \)

\( c_1 = 20 \)

\[ N_0 = m \cdot \left( \frac{c_1}{c_0} \right)^{\frac{1}{\alpha - 1}} \]

\[ N_0 = 100 \cdot 2^{-\frac{1}{2}} = 100 \cdot \sqrt{2} \]

We should buy \( N_0 = 100 \cdot \sqrt{2} \) computing power for in-house computations.

\[ J = \frac{\alpha - 1}{\alpha - 2} \cdot C_0 \cdot \frac{\alpha - 2}{\alpha - 1} \cdot C_1 \cdot \frac{1}{\alpha - 1} \cdot m = \left( \frac{2}{1} \right) \cdot 10^{\frac{1}{2}} \cdot 20^{\frac{1}{2}} \cdot 100 \]

\[ J = 200 \cdot \sqrt{10} \cdot \sqrt{20} \approx 200 \cdot 31.64 \]

If we do all computations exceeding \( m \) in the cloud, the cost is

\[ 100 \cdot \left( 10 + \frac{20}{1} \right) = 100 \cdot 30 \]

\[ = 3000 \]

Optimal arrangement yields a cost of \( 200 \cdot \sqrt{10} \cdot \sqrt{20} \), which is less than 3000.
Year by Year Contract

\[
\begin{align*}
C_t &= \frac{1 - (0.9)^t}{1 - 0.9} \\
C_T &= \frac{1 - 0.9^T}{1 - 0.9} \\
1 - (0.9^8)^2 &= \frac{1 - 0.9}{1 - 0.9^8} \\
9 \cdot 1 - 0.8^2 &= 1 - 0.8 \\
(1 - 0.72)^2 &= 1 - 0.5184 \\
\frac{1 - 0.72}{1 - 0.72} &= \frac{0.4816}{1.0} \\
0.4816 &= \frac{1.62}{1.72}
\end{align*}
\]

Clearly, the cost with a contract is lower than that of a year by year basis, so it is beneficial to sign a contract.
5) Neural Networks are used in cloud computing to automatically reserve resources, schedule jobs, etc. They are used as a form of automatic resource allocators and predictors such as for server placement based on density samples used as training data.

\[ X_1 = 2 \]
\[ X_2 = 3 \]
\[ Y = 6 \]

\[ W_{k,i} = 0 \quad \forall k,i \]
\[ y_i = y = 6 \]
\[ W_i = W_i = 1 \]

\[ \Delta y = 1 - 6 = 5 \]
\[ \Delta W_0 = 1 \cdot 5 = 5, \quad W_0 = 0.5 \]

\[ \Delta W_1 = -0.5 \cdot 5 = -2.5 \]
\[ \Delta W_2 = -0.5 \cdot 5 = -2.5 \]

\[ W_1 = 1 + 2.5 = 2.5 \]
\[ W_2 = 1 - 2.5 = -1.5 \]

\[ \Delta W_{1,0} = -\Delta W_1 \cdot W_1 \cdot (1 - 0.5) = 2.5 \cdot 1 \cdot 0.5 = 0.9 \]
\[ W_{1,0} = 0.9 \]

\[ \Delta W_{2,0} = -\Delta W_2 \cdot W_2 \cdot (1 - 0.5) = 2.5 \cdot 1.5 \cdot 0.5 = 0.9 \]
\[ W_{2,0} = 0.9 \]

\[ \Delta W_1 = -2 \cdot 0.9 = -1.8 \]
\[ \Delta W_2 = -3 \cdot 0.9 = -2.7 \]
\[ \Delta W_{1,1} = -2 \cdot 0.9 = -1.8 \]
\[ \Delta W_{2,0} = -3 \cdot 0.9 = -2.7 \]
Fuzzy techniques are used as controllers, in order to automatically reserve and allocate resources on the cloud.

Fuzzy techniques involve computing a control value that can be used to adjust a current configuration in a system.

First, we need elicitation of expert knowledge on which to base ourselves when defining membership functions to fuzzy sets, which describe to what degree an observation has the property the function describes.

The operations used in fuzzy can vary depending on the application. One simple AND function can be the product $A \times B$.

If DB in A is 0.6, and DB in B is 0.8, then DB $A \cap B = A \times B = 0.48$. 
Green computing is computing using algorithms that take into consideration some criteria in order to less impact or pollute the environment, such as saving energy. Cloud computing requires a lot of energy due to computing power and in turn machines creating heat. This forces us to use more energy on cooling systems. Energy consumption of clouds is high, and so we must take this into consideration and develop technologies and algorithms that less impact our environment.
For the class project, I created a cloud-based, parallelized implementation of a K-means clustering algorithm.

The problem addressed by this project is that sometimes data sets are just too big to fit into one machine, and so chunks of the data set must be loaded on different machines in order to be processed. Communication and synchronization is essential for an algorithm such as K-means, so communication operations were needed to keep the data processing coherent throughout all the machines. Also, parallelization of processing within a machine was used with threads, fully taking advantage of the resources the cloud has to offer.

Remaining improvements could include heuristics to help speed up convergence of the algorithm.
One interesting paper presented in class was Power Management in Cloud Computing using a Green Algorithm. This paper explains how the author tries to achieve efficient use of energy by using an energy function that he seems to interchange. He tests his idea on the ETC function which uses energy minimization, and he tests the Max Util Function, which uses mean utilization maximization.

An architecture of his described system looks as follows:

- Green Resource Allocation
- Virtual Machines
- Physical Machines

Here, the green resource allocator would automatically allocate resources.