1. a. i)

Height(H)	$\mu(H)$	$\mu(H) \cdot H$	Instances
1.676	0	0	1
1.727	0.1	0.1727	1
1.753	0.23	0.40319	3
1.778	0.36	0.64008	2
1.803	0.48	0.86544	2
1.829	0.61	1.11569	1
1.854	0.74	1.37196	1
1.880	0.87	1.6356	3
1.930	1	1.930	2
1.956	1	1.956	1
1.981	1	1.981	1
2.032	1	2.032	2

$$\mu(H) = \begin{cases} 0 & \text{if } x \le a \\ \frac{x-a}{b-a} & \text{if } a \le x \le b \\ 1 & \text{if } x \geq b \end{cases} \quad \text{where } a = 1.707 \text{ and } b = 1.905$$

To get the proportion we add all of membership function together, by the number of instances of that membership function and divide them by 20, the total number of people in the Universal set.

$$P = \frac{1}{20} \sum_{h}^{H} \mu(h) \cdot \#H$$
$$= \cancel{0.6245}\ 0.6215$$

To get the average we multiply ~~the~~ each ~~value~~ Height by their membership value ~~and divide~~ add them all together and divide the answer by the sum of all the membership functions by the instances it occurs.

$$A = \left(\sum_{h}^{H} \mu(h) \cdot h \cdot |h|\right) / \left(\sum_{h}^{H} \mu(H) \cdot |h|\right)$$
$$= 1.902563154$$

ii) To get the boolean set Tall*, I got an Alpha-cut of Tall with alpha set as the crossover point, giving a function as follows:

$$A_{0.5} = \{x \in X;\ \mu_A(x) \geq 0.5\}$$

This gives us a Tall* set of

H	Instances
1.829	1
1.854	1
1.880	3
1.930	2
1.956	1
1.981	1
2.032	2

The proportion will be the cardinality of Tall* divided by the cardinality of the Universal Set S.

$$P = |Tall^*| \,/\, |S|$$
$$= \frac{11}{20} = 0.55$$

The average height of someone in this set being the sum of all heights divided by the cardinality of the set Tall*

$$\cancel{A\ \Sigma H}\ A = \left(\sum_h^H h\right) / |Tall^*|$$
$$= 1.925818182$$

iii) The cardinalities are ~~not~~ the same, we can think of cardinality as the sum of the membership functions of a set, where the membership function of any boolean set, such as tall*, 1.a. iii) is either 0 or 1, so, their cardinalities would only be equal if tall was equal to its own core, and tall's core was also equal to tall*.

1.b. According to Zadeh, we can use the membership functions to form a set Π_x, which describes the possibilistic distribution of a set and that this describes the linguistic constraint on the original set, which is similar to how a statistical probability distribution describes a ~~tin~~ constraint on a set. The differ, however, in that Π_x describes a fuzzy constraint, and does this by showing the likelihood that any value from the original set conforms to the constraint, whereas a statistical probability distribution describes how a boolean constrait has effected a set.

2.a. She used a fuzzy control system as to implement a linear control system for AGV's is very complex, and requires the use of many sensors. While this is possible to do, the researchers who were able to do this often had large sponsors like the U.S. Department of Defense, but for the majority of researchers, they don't have the funding to implement a ~~for~~ linear system, and so, use non-linear control systems, with fuzzy logic being the most popular.

2b. The fuzzy sets used in the control system are the two inputs and the output, the inputs are the error between the ~~positions~~ centre of the image and the centre of the line, and the difference between the current and previous error, and the output is the absolute turn of the wheel to correct the error in degrees. The feedback loop is the current error being used in the next frame, so that errors can be corrected, and the output is deployed by adding it to the integral of the error and passing the answer to the wheel, and the ~~oper~~ Fuzzy control framework used was MOFS (Miguel Olivares' Fuzzy Software). The integral is found by adding the previous integral to the current error times the inverse of the framerate times a constant weight of 0.6

The two inputs are applied to a ~~Mamdani~~ Mamdani type system that implements a product inference model with 49 if-then rules to obtain the output, which is then added to the integral of the error.

2.c i) 49 is relevant as for the two inputs there 7 possible values, so there are 49 possible combinations of inputs.

ii)

ii)	B.L.	L.	L.L.	C.	L.R.	R.	B.R.
B.N.	G.R.	G.R.	B.R.	B.R.	R.	L.R.	Z.
N.	G.R.	B.R.	B.R.	R.	L.R.	Z.	L.L.
L.N.	B.R.	B.R.	R.	L.R.	Z.	L.L.	L.
Z.	B.R.	R.	L.R.	Z.	L.L.	L.	B.L.
L.P.	R.	L.R.	Z.	L.L.	L.	B.L.	B.L.
P.	L.R.	Z.	L.L.	L.	B.L.	B.L.	G.L.
B.P.	Z.	L.L.	L.	B.L.	B.L.	G.L.	G.L.

iii) To validate the rules, they used a supervised machine learning algorithm where the data came from a human driver driving over a line, they only needed the input from the camera and the output of the drivers turning the wheel, and then trained the rules so that each input would lead to the corresponding wheel turn that the human driver gave. They did this by increasing the weight of a rule everytime it occured ~~and~~ along with the wheel turn, and everytime a weight is negative it sets the output to be the one given by the human.

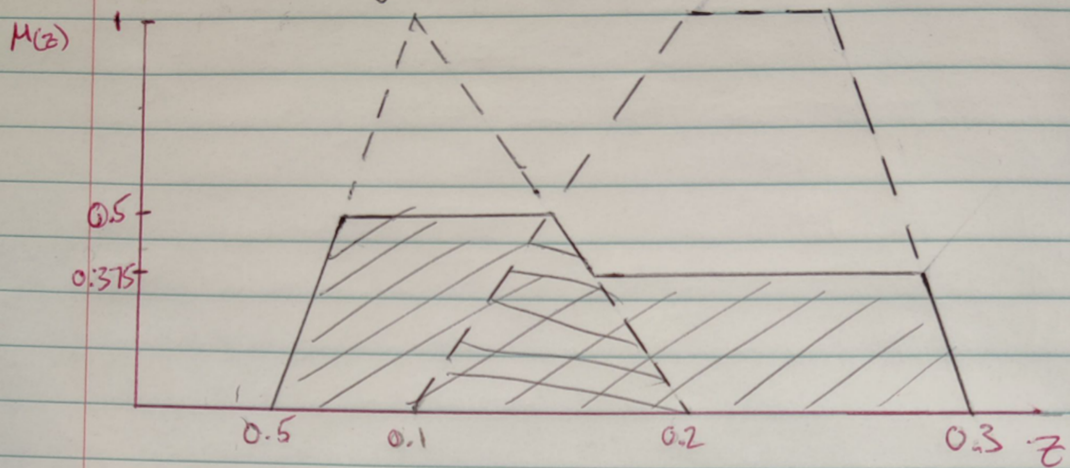
3. a. One of the reasons he gives for using fuzzy logic is the health care trend is determined by the complex relationship between various factors, and these relationships are inherently fuzzy. He also states that fuzzy set theory deals with the ambiguity whereas probability theory deals with randomness, but after an event occurs, randomness disappears, ~~the~~ but ambiguity does not. Its like saying that there is a ~~0.5~~ 50% chance of an event occuring, but once the event has occurred that is irrelevant, however, there exist fuzziness in ~~the~~ how we define the event, for example, whether it is good or bad, even after the event occurs.

b. The first thing to note are his two rules that a high CPI and low Medicare gives a high trend, and moderate CPI and moderat Medicare give a moderate trend. With this information, we can calculate the trend to be the most likely value, or the centre of gravity of the ~~membership~~ plot of the membership function As it could be either Trend high or Trend mod however, we must find the average of the both of these.

First, we plug in our values of CPI and Medicare into CPI_HIGH and Medicare_LOW which give membership functions of 0.5 and 0.375 respectively, ~~1~~ we then use the intersection of the minimum operator, which is 0.375, to truncate the Trend_High function ~~to~~ to 0.375.

We do the same again for CPI_Mod, Medicare_Mod and Trend_Mod, to truncate Trend_Mod at 0.5.

We can then graph these two membership functions together to give a graph that looks like this



We then find the centre of gravity (or centroid) of the polygon created, and use the z value of this coordinate as our average, and thus our trend. The centroid of this polygon is 0.168, 0.21, so our trend is 0.168 or 16.8%.

c. If we were to relax the ~~member~~ conditions on the fuzzy sets, we would get a larger minimum operator to truncate the triangles in the graph above, and the graph above would see the triangles getting wider, and their intersection higher, because of this, our centroid would end up both higher, and further to the right, as the Mod-High has a plane at the top, so it will always have a larger area, and thus more influence on the centroid. By constraining the conditions, the opposite would happen, the minimum operator would get smaller and the triangles thinner, pushing the centroid to the left and down. So, relaxing conditions increases the trend, and constraining conditions decreases the trend.