CCOD
Lab 7 13.10.2016
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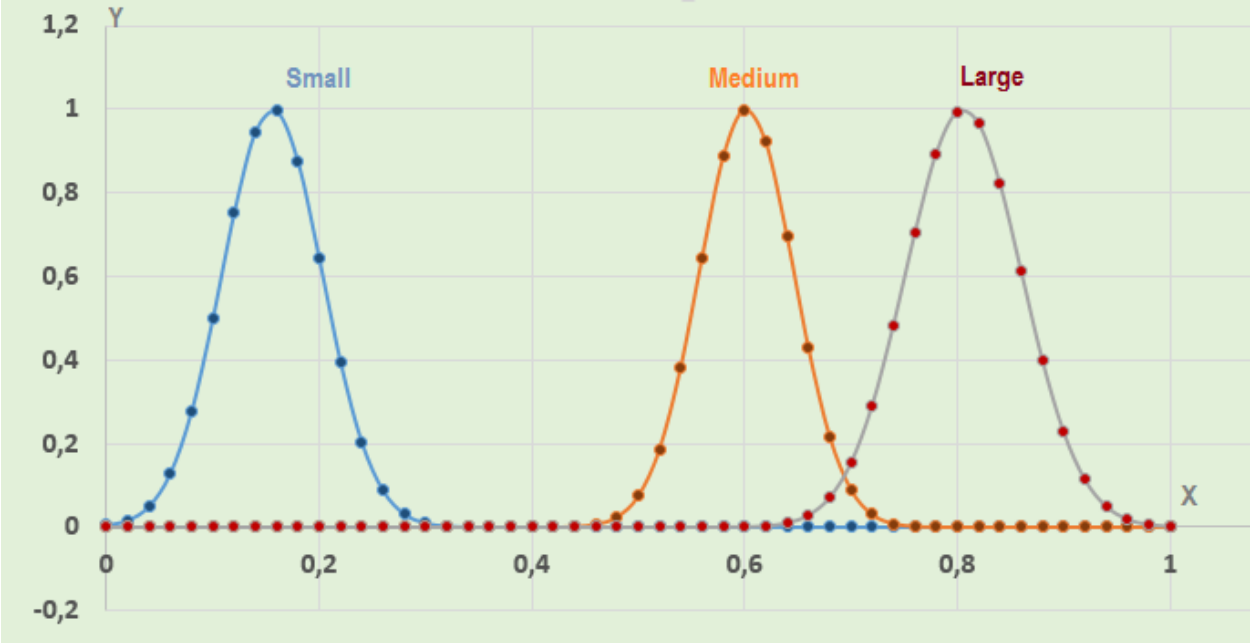
Below you can see 3 Gaussian Membership Function of small, medium and large x-y coordinate:



I've created 3 rules for each family A, B, C:

Rule 1: **If x1=large; x2=large; x3=small; x4=small, then Family A**.

Rule 2: **If x1=large; x2=large; x3=large; x4=medium, then Family B.**

Rule 3: **If x1=large; x2=medium; x3=large; x4=large, then Family C.**

Data to evaluate

Iris Flower Database to validate

Setosa				Versicolor				Virginica			
x_1	x_2	x_3	x_4	x_1	x_2	x_3	x_4	x_1	x_2	x_3	x_4
0.65	0.80	0.20	0.08	0.89	0.73	0.68	0.56	0.80	0.75	0.87	1.00
0.62	0.68	0.20	0.08	0.81	0.73	0.65	0.60	0.73	0.61	0.74	0.76
0.59	0.73	0.19	0.08	0.87	0.70	0.71	0.60	0.90	0.68	0.86	0.84
0.58	0.70	0.22	0.08	0.70	0.52	0.58	0.52	0.80	0.66	0.81	0.72
0.63	0.82	0.20	0.08	0.82	0.64	0.67	0.60	0.82	0.68	0.84	0.88
0.68	0.89	0.25	0.16	0.72	0.64	0.65	0.52	0.96	0.68	0.96	0.84
0.58	0.77	0.20	0.12	0.80	0.75	0.68	0.64	0.62	0.57	0.65	0.68
0.63	0.77	0.22	0.08	0.62	0.55	0.48	0.40	0.92	0.66	0.91	0.72

Below you can find an example of calculation for next data:

Setosa				
x_1	x_2	x_3	x_4	x_1
0.65	0.80	0.20	0.08	0.89

To detect flower we need to find Y value and use next comparisons

$$y = \begin{cases} 1 & \text{A} \quad \text{if} \quad \hat{y} < 1.5 \\ 2 & \text{B} \quad \text{if} \quad 1.5 \leq \hat{y} < 3.0 \\ 3 & \text{C} \quad \text{if} \quad 3.0 \leq \hat{y} \end{cases}$$

Below you can see formula for Y

$$y_j = \frac{\sum_{k=1}^{H}(M_k(\mathbf{x}) \cdot g_k)}{\sum_{k=1}^{H} M_k(\mathbf{x})}$$

where

$$M_k(\mathbf{x}) = \prod_{i=1}^{N} \mu_{ik}(x_i)$$

where μ_{ik} is i-th attribute of k-th rule

For calculating μ we will use next formula:

$$\mu(x) = \exp\{-\frac{(x - avg)^2}{\sigma^2}\}$$

For small we will use:

```
function small(x) {
    return Math.exp(-((x - 0.1556) * (x - 0.1556)) / 0.00447);
};
```

For medium:

```
function medium(x) {
    return Math.exp(-((x - 0.6019) * (x - 0.6019)) / 0.004);
};
```

For large:

```
function large(x) {
    return Math.exp(-((x - 0.806) * (x - 0.806)) / 0.006);
};
```

We have all the data. So, let's find M1, M2 and M3:

Rule 1: **If x1=large; x2=large; x3=small; x4=small, then Family A**.

μ1 = 0.017318153368134238

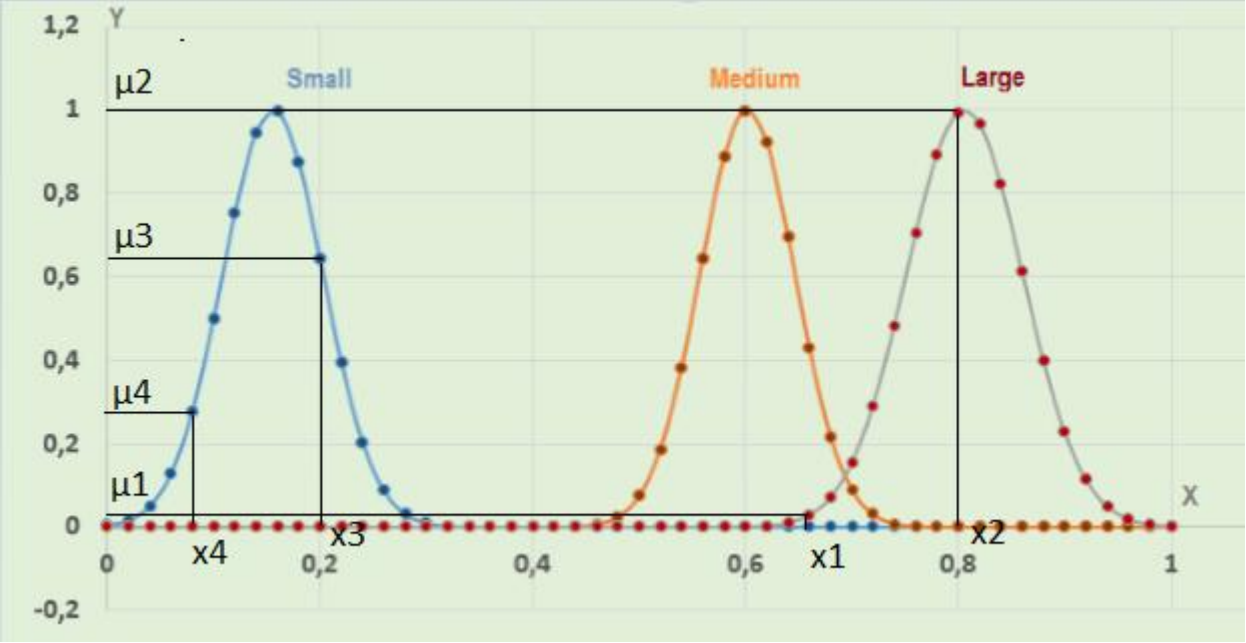
μ 2 = 0.9940179640539353

μ 3 = 0.643379752487798

μ 4 = 0.27842570409799405

M1 = μ1* μ2* μ3* μ4 = 0.0030836753435

You can also find μ from the graph, but it's not a good idea. The μ's value can be very small.



Rule 2: **If x1=large; x2=large; x3=large; x4=medium, then Family B.**

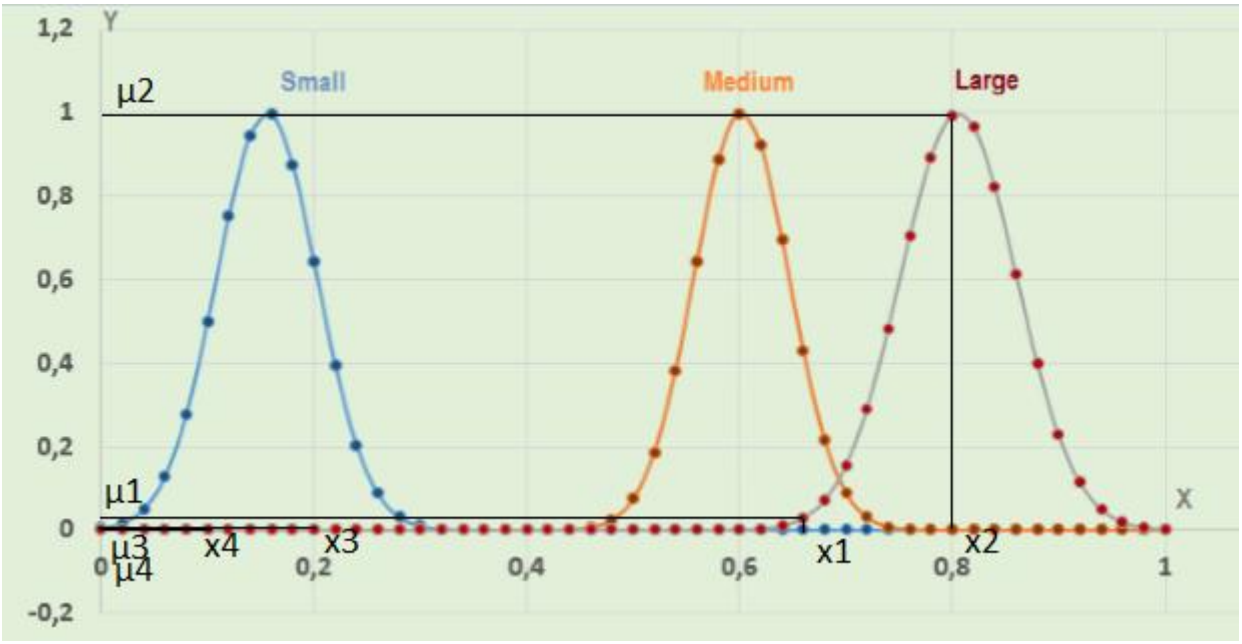
μ 1 = 0.017318153368134238

μ 2 = 0.9940179640539353

μ 3 = 2.6216332747033475e-27

μ 4 = 2.671527189077588e-30

M2 = μ1* μ2* μ3* μ4 = 1.205666943189679e-58



Rule 3: **If x1=large; x2=medium; x3=large; x4=large, then Family C.**

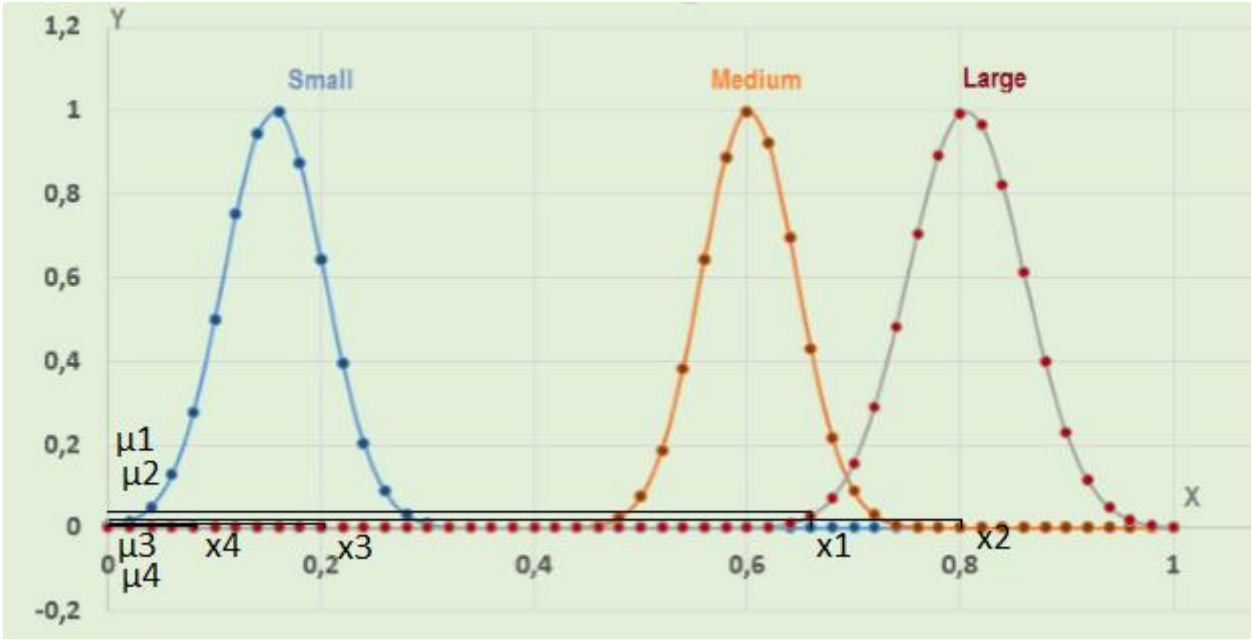
μ 1 = 0.017318153368134238

μ 2 = 0.000054850322038625596

μ 3 = 2.6216332747033475e-27

μ 4 = 7.062637934056824e-39

M3 = μ1* μ2* μ3* μ4 = 1.7588129171190555e-71



Using next formula, we can calculate Y:

$$y_j = \frac{\sum_{k=1}^{H}(M_k(\mathbf{x}) \cdot g_k)}{\sum_{k=1}^{H} M_k(\mathbf{x})}$$

.

Y = 1.0

Y < 1.5, so **A** flower is detected.

Below you can see evaluated rules

Data №:	Family A	Family B	Family C	Result:
№ 1	A	B	C	Good
№ 2	A	B	C	Good
№ 3	A	B	C	Good
№ 4	A	C	C	Not Good
№ 5	A	B	C	Good
№ 6	A	B	C	Good
№ 7	A	B	C	Good
№ 8	A	B	C	Good
Success Rate:	100%	87.5%	100%	87.5%