Universidad Politécnica Salesiana

Nombre: Fernando Sanchez

Materia: Sistemas Expertos

Lógica Difusa.

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Objetivo:

- Familiarizarse con las operaciones fundamentales de los conjuntos difusos y cómo desarrollar las 3 etapas fundamentales de modelado de un sistema difuso: fuzzification, inference, defuzzification.

Enunciado:

En un galpón se tiene una temperatura de 18 grados centígrados, y una humedad de aproximadamente 22 grados centígrados. Según estos valores determinar cual es la velocidad que debería estar funcionando el motor.

Para revisar las reglas, función de pertinencia y el proceso revisar el siguiente link: https://medium.com/@javierdiazarca/l%C3%B3gica-difusa-ejercicio-2-bases-de-la-ia-1a8ae594cc15

En base a ello, desarrollar e implementar el sistema dentro de Python o Java en donde me permita modificar los valores de la temperatura y humedad, generando así un sistema experto basado en lógica difusa para obtener la velocidad del motor de aire acondicionado.

Este sistema deberá tener la opción de poder modificar los valores de la temperatura y humedad con un scroll bar y obtener la velocidad de giro. Ademas, deberá presentarme las graficas de pertenencia de INPUT/OUPUT del sistema difuso y como estas varían de acuerdo al cambio de las variables.

Instalar y importar la API fuzz, scikit-fuzzy , para proporciona el funcionamiento del algoritmo de logica difusa

```
import skfuzzy as fuzz

from skfuzzy import control as ctrl
```

In [3]:
```
pip install fuzz
```

```
Collecting fuzz
  Downloading fuzz-0.1.1-py3-none-any.whl (4.7 kB)
Installing collected packages: fuzz
Successfully installed fuzz-0.1.1
Note: you may need to restart the kernel to use updated packages.
```

In [2]:
```
pip install scikit-fuzzy
```

```
Collecting scikit-fuzzy
  Downloading scikit-fuzzy-0.4.2.tar.gz (993 kB)
     |████████████████████████████████| 993 kB 188 kB/s eta 0:00:0
138
Requirement already satisfied: numpy>=1.6.0 in /Users/fernandosanc
hez/opt/anaconda3/lib/python3.8/site-packages (from scikit-fuzzy)
(1.19.0)
Requirement already satisfied: scipy>=0.9.0 in /Users/fernandosanc
hez/opt/anaconda3/lib/python3.8/site-packages (from scikit-fuzzy)
(1.5.0)
Requirement already satisfied: networkx>=1.9.0 in /Users/fernandos
anchez/opt/anaconda3/lib/python3.8/site-packages (from scikit-fuzz
y) (2.4)
Requirement already satisfied: decorator>=4.3.0 in /Users/fernando
sanchez/opt/anaconda3/lib/python3.8/site-packages (from networkx>=
1.9.0->scikit-fuzzy) (4.4.2)
Building wheels for collected packages: scikit-fuzzy
  Building wheel for scikit-fuzzy (setup.py) ... done
  Created wheel for scikit-fuzzy: filename=scikit_fuzzy-0.4.2-py3-
none-any.whl size=894068 sha256=4cd5d4af69f56f5f084632cc4f6d59cc3a
6de10e67860c1a5ef29dd50132f4f5
  Stored in directory: /Users/fernandosanchez/Library/Caches/pip/w
heels/2c/04/80/7eefb1a2de7d36aefd06432fab2a1486caf0a0596a7067391a
Successfully built scikit-fuzzy
Installing collected packages: scikit-fuzzy
Successfully installed scikit-fuzzy-0.4.2
Note: you may need to restart the kernel to use updated packages.
```

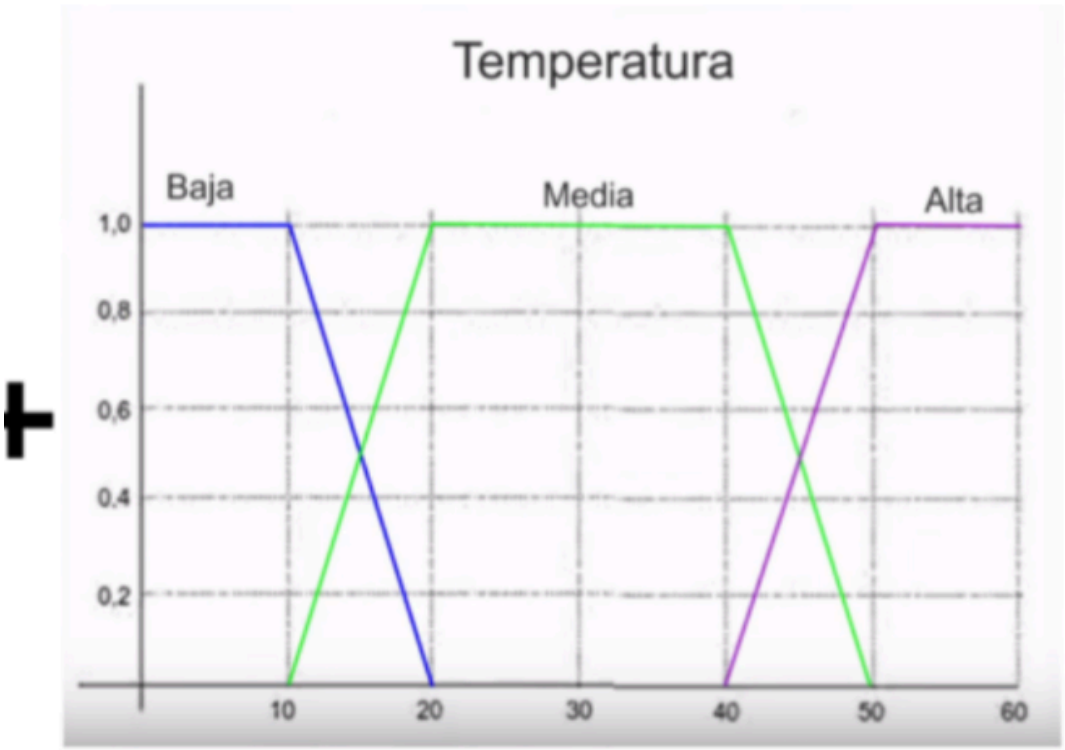
In [21]:
```
import numpy as np
import skfuzzy as fuzz
from skfuzzy import control as ctrl
```

Creación nuevos antecedentes que contienen variables y miembros del universo.

Creación de las funciones

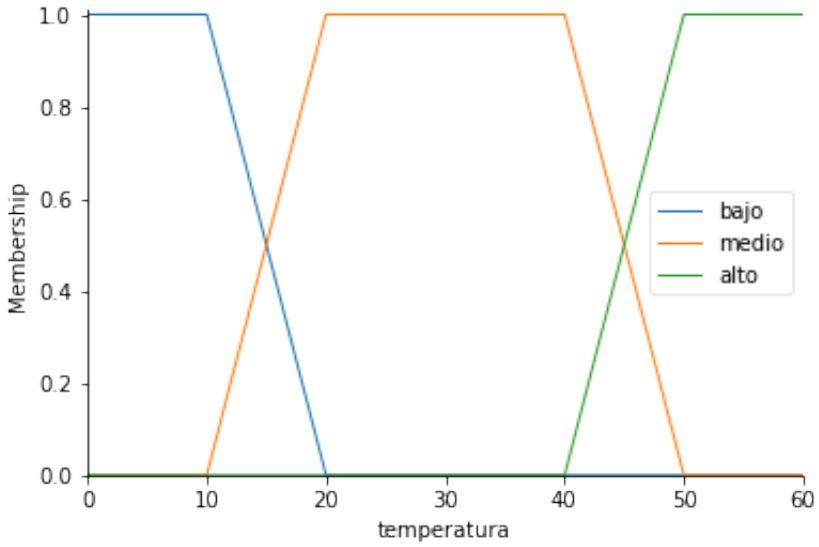
In [38]:
```
# New Antecedent/Consequent objects hold universe variables and
# functions
temperatura = ctrl.Antecedent(np.arange(0, 61, 2), 'temperatura
humedad = ctrl.Antecedent(np.arange(10, 71, 2), 'humedad')
RPMotor = ctrl.Consequent(np.arange(0, 61, 2), 'RPMotor')
```

Funcion de membresía personalizada de entrada para construir interactivamente con un
antecedente para la temperatura:

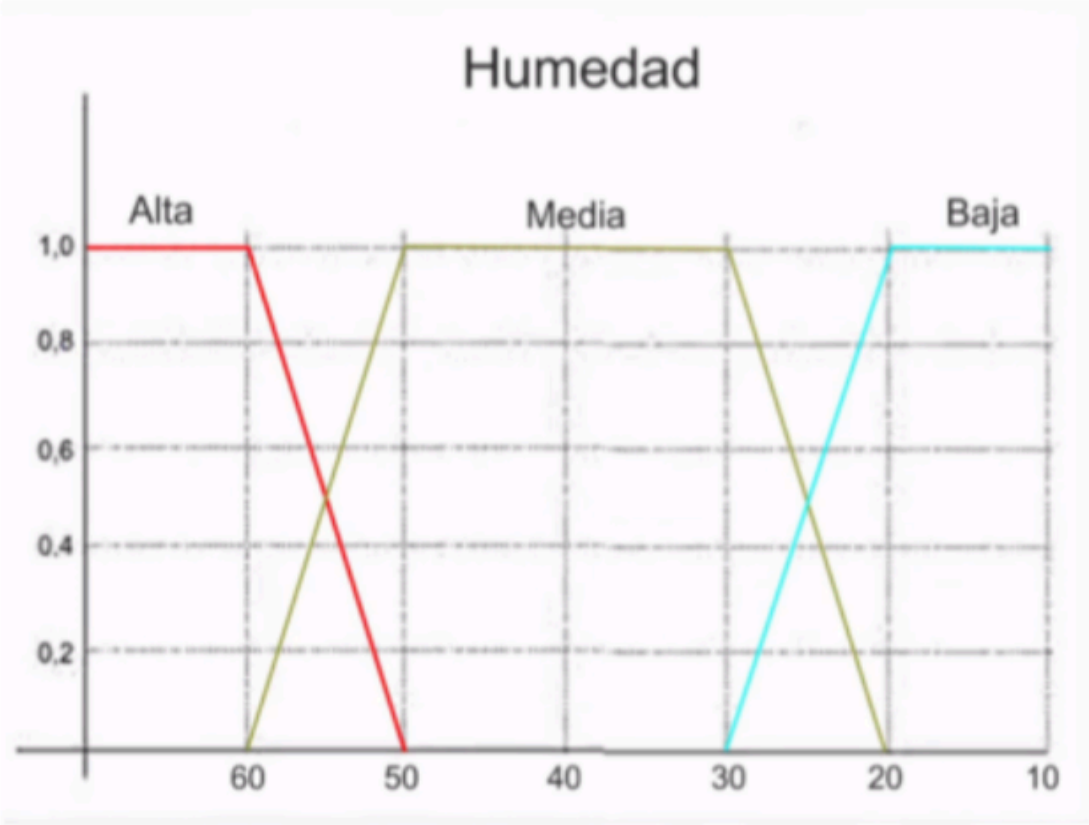


In [151]:
```
# Custom membership functions can be built interactively with a
# Pythonic API

temperatura['bajo'] = fuzz.trapmf(temperatura.universe, [-1, 0,
temperatura['medio'] = fuzz.trapmf(temperatura.universe, [10, 2
temperatura['alto'] = fuzz.trapmf(temperatura.universe, [40, 50
temperatura.view()
```

```
Exception in Tkinter callback
Traceback (most recent call last):
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/tkinter
/__init__.py", line 1883, in __call__
    return self.func(*args)
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/tkinter
/__init__.py", line 804, in callit
    func(*args)
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backends/_backend_tk.py", line 270, in idle_draw
    self.draw()
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backends/backend_tkagg.py", line 9, in draw
    super(FigureCanvasTkAgg, self).draw()
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backends/backend_agg.py", line 393, in draw
    self.figure.draw(self.renderer)
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backend_bases.py", line 1556, in _draw
    def _draw(renderer): raise Done(renderer)
matplotlib.backend_bases._get_renderer.<locals>.Done: <matplotlib.
backends.backend_agg.RendererAgg object at 0x7f89f9f8d460>
```

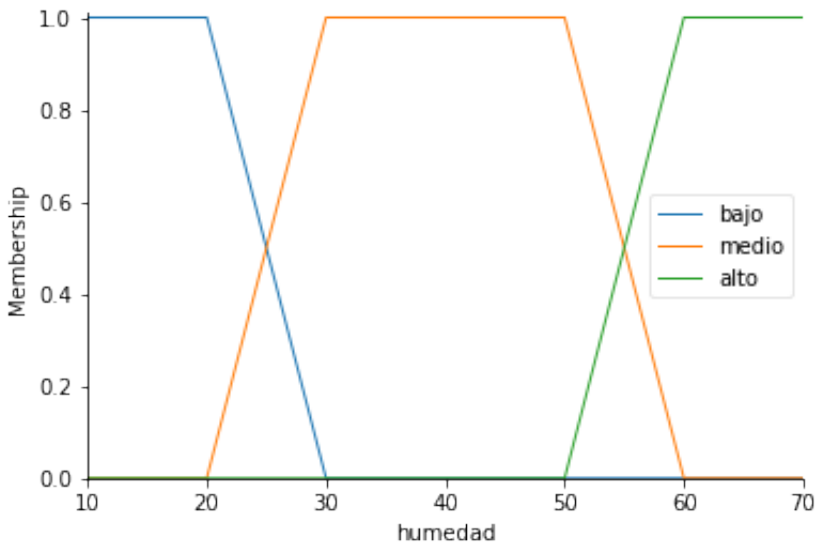


Funcion de membresía personalizada de entrada para construi
r interactivamente con un
antecedente para la humedad:

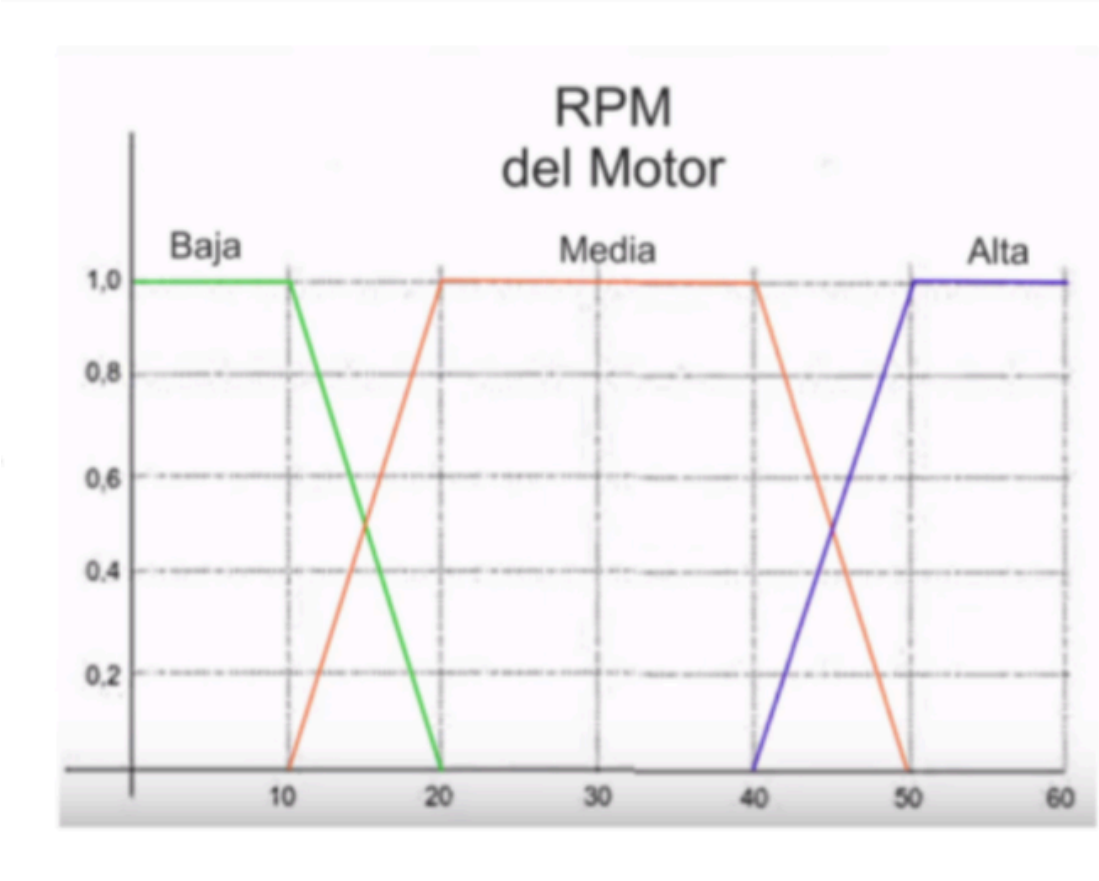


In [150]:
```
1
2 humedad['bajo'] = fuzz.trapmf(humedad.universe, [-1,10, 20, 30]
3 humedad['medio'] = fuzz.trapmf(humedad.universe, [20, 30, 50, 6
4 humedad['alto'] = fuzz.trapmf(humedad.universe, [50, 60, 70, 71
5 humedad.view()
```

```
Exception in Tkinter callback
Traceback (most recent call last):
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/tkinter
/__init__.py", line 1883, in __call__
    return self.func(*args)
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/tkinter
/__init__.py", line 804, in callit
    func(*args)
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backends/_backend_tk.py", line 270, in idle_draw
    self.draw()
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backends/backend_tkagg.py", line 9, in draw
    super(FigureCanvasTkAgg, self).draw()
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backends/backend_agg.py", line 393, in draw
    self.figure.draw(self.renderer)
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backend_bases.py", line 1556, in _draw
    def _draw(renderer): raise Done(renderer)
matplotlib.backend_bases._get_renderer.<locals>.Done: <matplotlib.
backends.backend_agg.RendererAgg object at 0x7f89db4cb610>
```

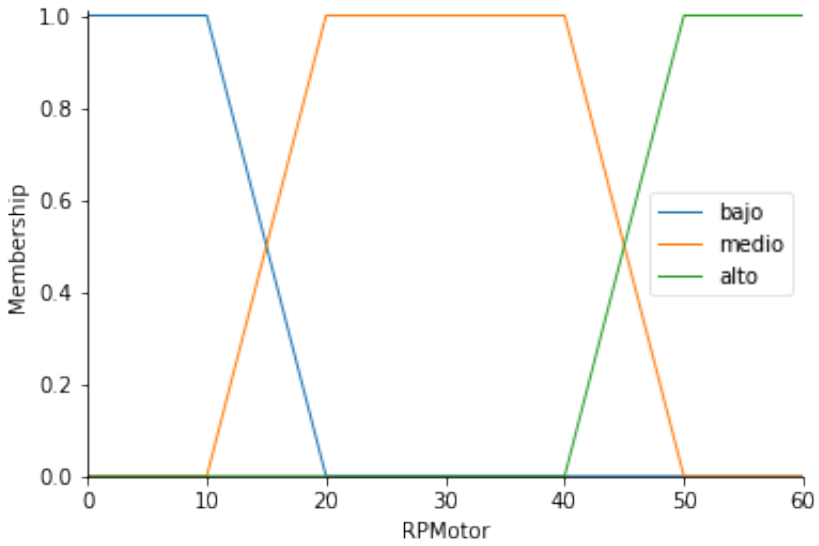


Funcion de membresía personalizada de entrada para construi
r interactivamente con un
antecedente para el RPM del Motor:



In [149]:
```
1 RPMotor['bajo'] = fuzz.trapmf(RPMotor.universe, [-1,0, 10, 20])
2 RPMotor['medio'] = fuzz.trapmf(RPMotor.universe, [10, 20, 40, 5
3 RPMotor['alto'] = fuzz.trapmf(RPMotor.universe, [40, 50, 60, 61
4 RPMotor.view()
```

```
Exception in Tkinter callback
Traceback (most recent call last):
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/tkinter
/__init__.py", line 1883, in __call__
    return self.func(*args)
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/tkinter
/__init__.py", line 804, in callit
    func(*args)
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backends/_backend_tk.py", line 270, in idle_draw
    self.draw()
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backends/backend_tkagg.py", line 9, in draw
    super(FigureCanvasTkAgg, self).draw()
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backends/backend_agg.py", line 393, in draw
    self.figure.draw(self.renderer)
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backend_bases.py", line 1556, in _draw
    def _draw(renderer): raise Done(renderer)
matplotlib.backend_bases._get_renderer.<locals>.Done: <matplotlib.
backends.backend_agg.RendererAgg object at 0x7f89db466040>
```



Creacion de las reglas:

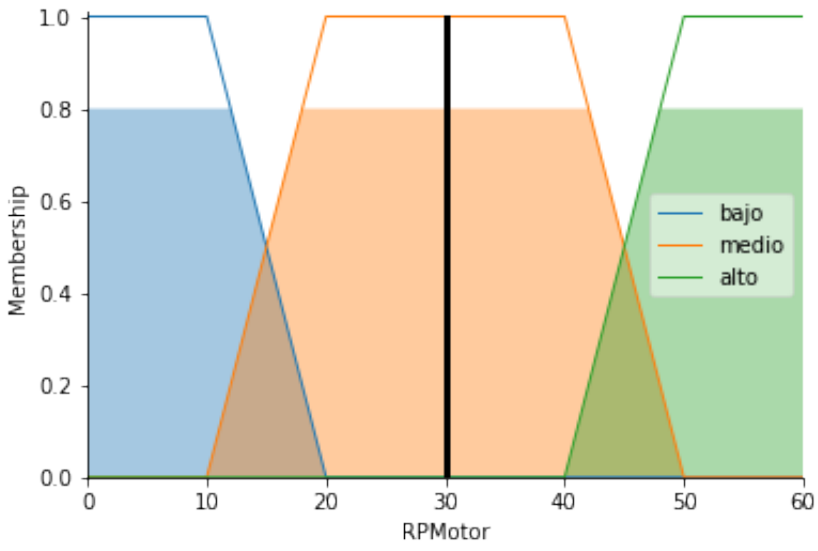
Temperatura	Humedad	RPM del Motor
Baja	Alta	Baja
Media	Alta	Media
Alta	Alta	Media
Baja	Media	Baja
Media	Media	Baja
Alta	Media	Media
Baja	Baja	Baja
Media	Baja	Baja
Alta	Baja	Alta

In [40]:
```
rule1 = ctrl.Rule(temperatura['bajo'] | humedad['alto'], RPMoto
rule2 = ctrl.Rule(temperatura['medio'] | humedad['alto'], RPMot
rule3 = ctrl.Rule(temperatura['alto'] | humedad['alto'], RPMoto

rule4 = ctrl.Rule(temperatura['bajo'] | humedad['medio'], RPMot
rule5 = ctrl.Rule(temperatura['medio'] | humedad['medio'], RPMo
rule6 = ctrl.Rule(temperatura['alto'] | humedad['medio'], RPMot

rule7 = ctrl.Rule(temperatura['bajo'] | humedad['bajo'], RPMoto
rule8 = ctrl.Rule(temperatura['medio'] | humedad['bajo'],RPMoto
rule9 = ctrl.Rule(temperatura['alto'] | humedad['bajo'], RPMoto


```

In [41]:
```
control = ctrl.ControlSystem([rule1, rule2, rule3, rule4, rule5
controlSystemSimulation = ctrl.ControlSystemSimulation(control)
```

In [42]:
```
controlSystemSimulation.input['temperatura'] = 18
controlSystemSimulation.input['humedad'] = 22
controlSystemSimulation.compute()
s=float(controlSystemSimulation.output['RPMotor'])
print(s)
#RPMotor.view(sim=tipping)
plt.show(RPMotor.view(sim=controlSystemSimulation))
```

```
29.999999999999986

<ipython-input-42-97550f786925>:7: MatplotlibDeprecationWarning: P
assing the block parameter of show() positionally is deprecated si
nce Matplotlib 3.1; the parameter will become keyword-only in 3.3.
  plt.show(RPMotor.view(sim=controlSystemSimulation))
Exception in Tkinter callback
Traceback (most recent call last):
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/tkinter
/__init__.py", line 1883, in __call__
    return self.func(*args)
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/tkinter
/__init__.py", line 804, in callit
    func(*args)
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backends/_backend_tk.py", line 270, in idle_draw
    self.draw()
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backends/backend_tkagg.py", line 9, in draw
    super(FigureCanvasTkAgg, self).draw()
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backends/backend_agg.py", line 393, in draw
    self.figure.draw(self.renderer)
  File "/Users/fernandosanchez/opt/anaconda3/lib/python3.8/site-pa
ckages/matplotlib/backend_bases.py", line 1556, in _draw
    def _draw(renderer): raise Done(renderer)
matplotlib.backend_bases._get_renderer.<locals>.Done: <matplotlib.
backends.backend_agg.RendererAgg object at 0x7f89f1092130>
```



In [145]:

```
import tkinter as tk
from matplotlib.backends.backend_tkagg import FigureCanvasTkAgg
from matplotlib.figure import Figure

root= tk.Tk()
b = 0
a = 0
ac = 0
canvas1 = tk.Canvas(root, width = 300, height = 210)
canvas1.pack()
root.title('Practica Logica Difusa')

label = tk.Label (root, text='Temperatura:')
canvas1.create_window(50, 20, window=label)

scroll_bar = Scrollbar(root,width = 20 )
scroll_bar.pack( side = LEFT,fill = X )
mylist = Listbox(root,yscrollcommand = scroll_bar.set,width = 6

for line in range(0, 61):
    mylist.insert(END, str(line))
mylist.pack( side = LEFT, fill = BOTH )
scroll_bar.config( command = mylist.yview )
canvas1.create_window(50, 120, window=mylist)
canvas1.create_window(85, 40, window=scroll_bar)

scroll_bar1 = Scrollbar(root,width = 20 )
scroll_bar1.pack( side = LEFT,fill = X )
mylist1 = Listbox(root,yscrollcommand = scroll_bar1.set,width =

for line1 in range(10, 71):
    mylist1.insert(END, str(line1))
mylist1.pack( side = LEFT, fill = BOTH )
scroll_bar1.config( command = mylist1.yview )
canvas1.create_window(250, 120, window=mylist1)
canvas1.create_window(285, 40, window=scroll_bar1)

label2 = tk.Label (root, text='Humedad:')
canvas1.create_window(250, 20, window=label2)

def aa():
    b = int(mylist.get(int(mylist.curselection()[0])))

    entry1.insert(INSERT, str(b))

def bb():
    a = int(mylist1.get(int(mylist1.curselection()[0])))

    entry2.insert(INSERT, str(a))

def create_charts():
    print(str(ac) + " 1")
    print(str(b)+ " 2")
    print(int(mylist1.get(int(mylist1.curselection()[0]))))
```

```
    controlSystemSimulation.input['temperatura'] = int(entry1.g
    controlSystemSimulation.input['humedad'] = int(entry2.get()
    controlSystemSimulation.compute()
    solucion=float(controlSystemSimulation.output['RPMotor'])

    print(s)
    entry3.insert(INSERT,"Resultado " +str(s))
    #RPMotor.view(sim=tipping)
    plt.show(RPMotor.view(sim=controlSystemSimulation))

button1 = tk.Button (root, text=' Grafico ',command=create_char
canvas1.create_window(150, 160, window=button1)

entry3 = tk.Entry (root,width = 15)
canvas1.create_window(150, 185, window=entry3)

button2 = tk.Button (root, text=' Tomar temperatura ',command=a
canvas1.create_window(150, 60, window=button2)

entry1 = tk.Entry (root,width = 3)
canvas1.create_window(150, 85, window=entry1)

entry2 = tk.Entry (root,width = 3)
canvas1.create_window(150, 135, window=entry2)


button3 = tk.Button (root, text=' Tomar humedad ',command=bb, b
canvas1.create_window(150, 110, window=button3)


root.mainloop()
```

```
0 1
0 2
22
29.999999999999986

<ipython-input-145-e1fefa633a9e>:63: MatplotlibDeprecationWarning:
Passing the block parameter of show() positionally is deprecated s
ince Matplotlib 3.1; the parameter will become keyword-only in 3.3
.
  plt.show(RPMotor.view(sim=controlSystemSimulation))
```

In [ ]:

```
1
```