Truth is always strange

Fuzzy Logic in Python


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Agenda

About me.

What the “egg” is fuzzy logic.

The infamous “tipping problem” example

About Me

- Juan Manuel Álvarez Quiñonez.
- Roots for “la mechita” (since 198x)
- Student/teacher/ researcher in univalle
- Electronics Engineer. (2005)
- Telematics Specialist (2008)
- Superior education specialist (2011)
- System engineering master (2019 -I hope so!)

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What the EGG is fuzzy logic

fuzzy logic?

- Most of the decisions made on programming are hard.
- Also, humans sometimes uses vague terms to describe data and situations.
- Fuzzy logic provides a simple form to use human terms and cope with gray areas for decisions.

The boiling egg problem

I want to build an app which helps me to make to the perfect boiled egg.

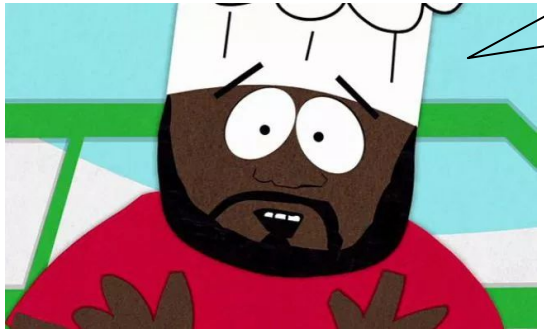
Mom told me: “just put an egg in boiling water for **about** 5 minutes”

- I got some perfect eggs.
- but others came out very soft
- and others a bit overcooked (and I learned that boiled eggs can get burn)

The boiling egg problem

In order to improve my results I asked to a chef friend and he told me:

- If you have big eggs you need to boil them more than five minutes.
- If you have small eggs you need to boil them less than five minutes.



Predicates

If <antecedent> then <consequence>

In our problem we have two predicates:

- If eggs are **big** then the boiling time will be **large**.
- If eggs are **small** then the boiling time will be **short**.

Universe and crisp values.

The range of values for a variable is called the universe of that variable.

Each of the values that a variable can have is called a crisp value.

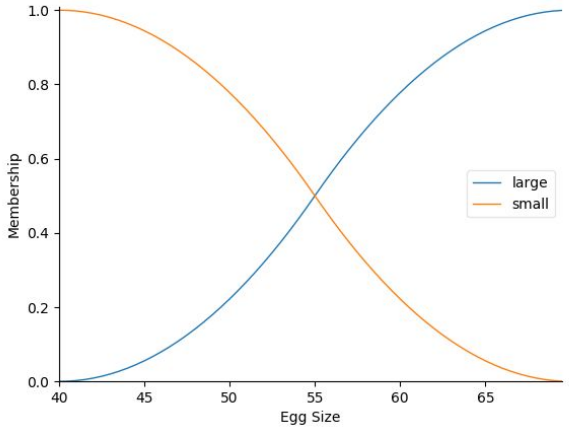
In our problem we have two variables (and an universe for each one):

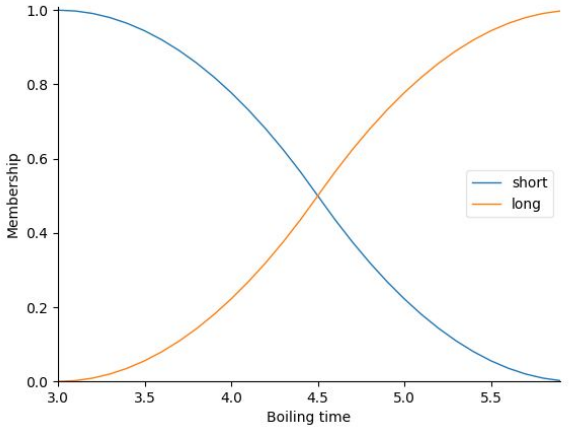
- Size (40-70 grams).
- Time (3-6 minutes).

fuzzy sets

In order to classify size as “large” or “small” we use fuzzy sets.

A fuzzy set is a set (as the name implies) where the elements can have partial membership. It is, that the membership of an element can be any number from 0 (totally out of the set) to 1 (totally in the set)



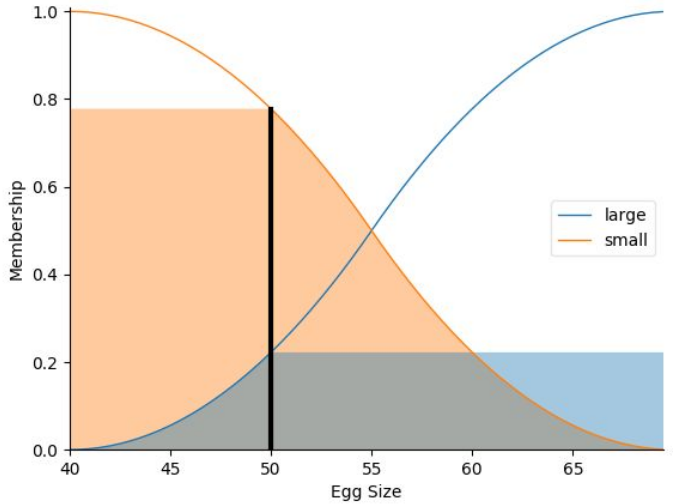


First demo

Fuzzification

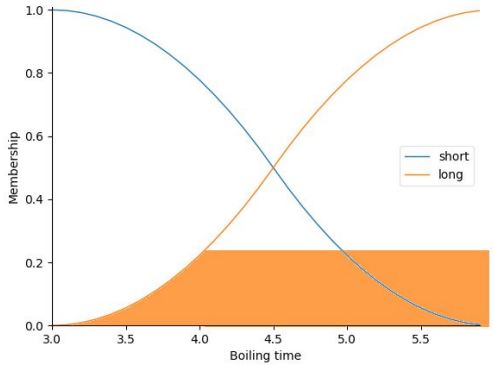
We are going to evaluate a 50 grams egg.

The system shows that according our sets definition, that egg is 77% small and 23% large

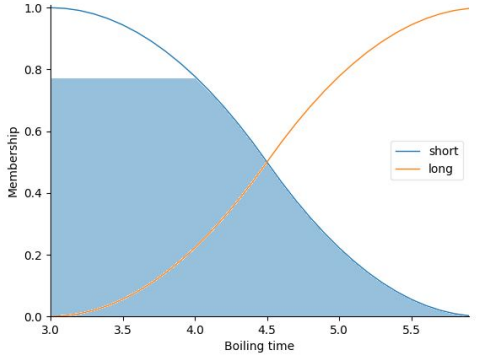


Inference

- If eggs are **big** then the boiling time will be **large**.



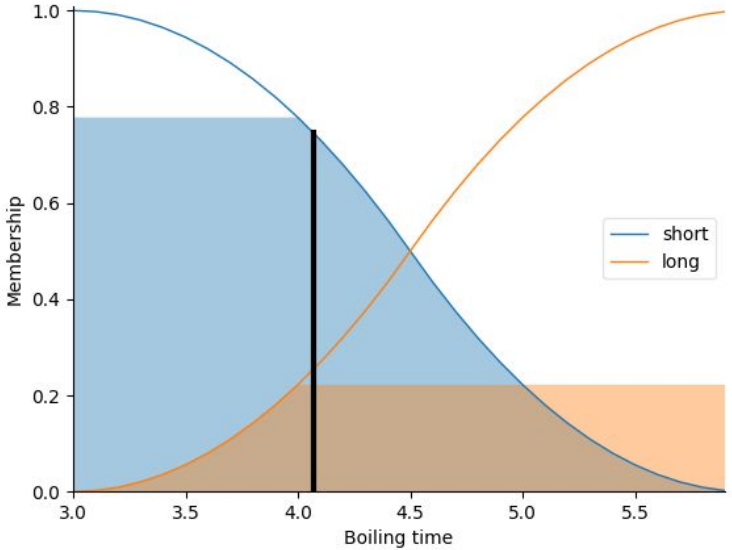
- If eggs are **small** then the boiling time will be **short**.



Defuzzification

In the inference process the system builds a geometric shape and founds the “center of gravity” of that shape.

After that system must produce a crisp value which corresponds to the found value.



The infamous “tipping problem” example

The tipping problem

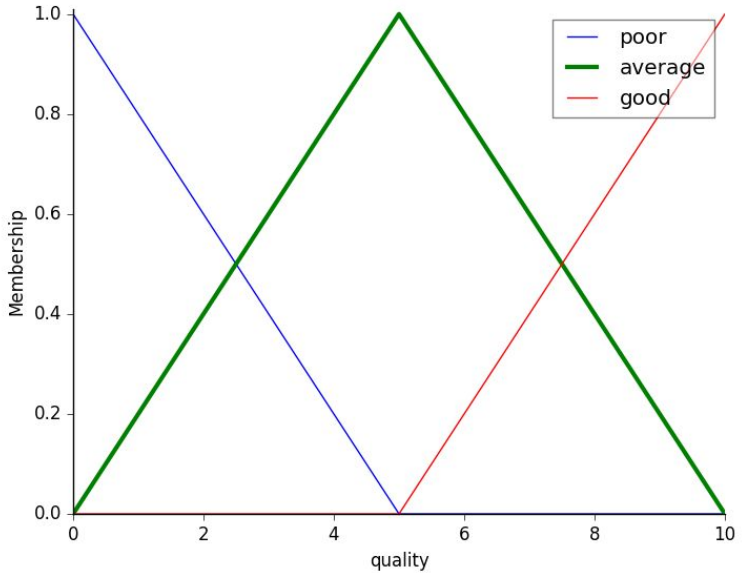
A group of friends goes for dinner, at the time to pay the bill they debate about how much they should tip to the staff. So one of the friends gives three simple rules:

- IF the service was good or the food quality was good, THEN the tip will be high.
- IF the service was average, THEN the tip will be medium.
- IF the service was poor and the food quality was poor THEN the tip will be low.

Antecedents

Food quality:

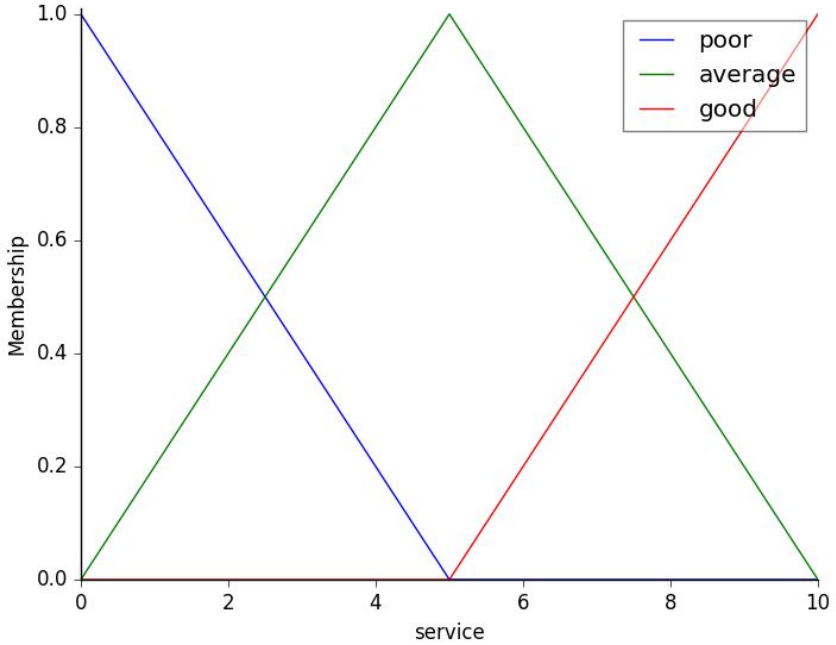
- Universe: from 0 (inedible junk) -10 (perfect food)
- A rule of thumb is that the universe should be splitted in odd sets (preferably 3,5 or 7)



Antecedents

Service quality:

- Universe: from 0 (no service/ rudeness) -10 (excellent service)
- A rule of thumb is that the universe should be splitted in odd sets (preferably 3,5 or 7)



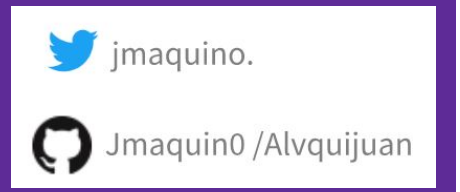
Logic operations

As in boolean (also called crisp) logic there is three basic operations:

- Negation: Is defined as not(x)=1-x
  - quality.isGood(9)=0.9
  - not(quality.isGood(9))=1-0.9=0.1
- Conjunction: Is defined as and(x,y)=min(x,y)
  - quality.isPoor(9)=0
  - service.isPoor(2)=0.6
  - and(quality.isPoor(9),service.isPoor(2))=0
- Inclusive disjunction: defined as or(x,y)=max(x,y)
  - quality.isGood(9)=0.9
  - service.isGood(2)=0
  - or(quality.isGood(9),service.isGood(2))=0.9

Second demo

Questions or comments



Credits

images:

- Slide 3: Juan M Álvarez (taken by a former coworker)
- Slide 5: (c) John Atkitson, wrong hands (https://wronghands1.com/gallery-june-2011/gray-area-2/)
- Slide 6: creative commons (https://pixabay.com/es/huevo-quemado-torpe-olvidadiza-938142/)
- Slide 7: South park studios Instagram (https://www.instagram.com/p/jVJtAgEWft/?taken-by=southpark))
- Slide 13: Creative commons (https://pixabay.com/es/amigos-celebraci%C3%B3n-cena-mesa-581753/)
- Twitter logo: https://about.twitter.com/en_us/company/brand-resources.html
- Github logo: https://github.com/logos

Contents:

- An Egg-Boiling Fuzzy Logic Robot (https://www.youtube.com/watch?v=J_Q5X0nTmrA)
- A fuzzy control primer (https://pythonhosted.org/scikit-fuzzy/userguide/fuzzy_control_primer.html)