Fuzzy Wakeup System

# Introduction

As a part of the course Fuzzy Logic & Control Systems we have created a control system that uses fuzzy logic. This control system is based upon the notion of an alarm but has also been thought about to be extended to a fully featured “wakeup system”. The difference is that the wakeup system helps you all the way until you’re fully awake. This could include things as the amount of coffee you get, the length of the shower and so on.

We did it because the idea was interesting enough and something were we thought we could incorporate what we had learned. DID IT WORK. WAS IT WORTH IT

# Background

## Sleep

Talk about research about sleep here. Assume novice.

## Usage of fuzzy logic

# Simulation / Model

## Inputs

## Rules

## Defuzzification methods

## Outputs

# Results & Analysis

## Results

## Evaluation

# Conclusions

# Inputs

* First meeting (VERY EARLY: <6am, EARLY, NORMAL, LATE, VERY LATE: >1pm)
* Last meal or drink (JUST BEFORE SLEEP: <1h, RECENTLY BEFORE SLEEP, NORMAL, A FAIR AMOUNT BEFORE SLEEP, A LONG TIME BEFORE SLEEP: >7h)
* Went to sleep (VERY EARLY, EARLY, NORMAL, LATE, VERY LATE)
* Slept day before (VERY LITTLE <3, LITTLE, NORMAL: 7, MORE THAN NORMAL, A LOT: >12)
* Current sleep cycle (which cycle are you in) (DEEPLY ASLEEP, ASLEEP, LIGHT SLEEP, AWAKE)
* (exercise)
* (temperature in room)
* (time worked) (NONE, LITTLE, NORMAL, A LOT, VERY MUCH TOO MUCH)
* (mood)
* (commute time)
* (weekday)
* (season)
* (sunrise time)
* (importance of day)
* (REM-sleep)
* (songs listened to)
* (movement)

# Outputs

* Volume of alarm - Sebastian
* Time of alarm - Fabian
* Coffee - Aran
* (thermostat)
* (rate of wakeup)
* (song)
* (light)

# Rules

The rules are categorized based upon output

* Time to sleep is calculated based upon these inputs:
  + First meeting
  + Last meal or drink
  + Went to sleep
  + Slept day before
  + Current sleep cycle
* Here are some rules I came up with
  + IF First meeting IS VERY EARLY AND Went to sleep IS VERY LATE Time to sleep IS VERY LITTLE
  + IF First meeting IS VERY EARLY AND Went to sleep IS LATE Time to sleep IS VERY LITTLE
  + IF First meeting IS EARLY AND Went to sleep IS VERY LATE Time to sleep IS VERY LITTLE
  + IF First meeting IS EARLY AND Went to sleep IS LATE Time to sleep IS LITTLE
  + IF First meeting IS NORMAL AND Went to sleep IS LATE Time to sleep IS LITTLE
  + IF First meeting IS NORMAL AND Went to sleep IS NORMAL Time to sleep IS ENOUGH
  + IF First meeting IS NORMAL AND Went to sleep IS EARLY Time to sleep IS ENOUGH
  + IF Went to sleep IS EARLY AND Current sleep cycle IS DEEPLY ASLEEP Time to sleep IS LONGER THAN USUAL
  + IF Slept day before IS VERY LITTLE AND First meeting IS VERY LATE Time to sleep is LONGER THAN USUAL
  + IF Slept day before IS LITTLE AND First meeting IS LATE Time to sleep is LONGER THAN USUAL

New rules

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| IF | First meeting | IS | VERY EARLY | THEN | Time of alarm | VERY EARLY |
| IF | First meeting | IS | EARLY | THEN | Time of alarm | EARLY |
| IF | First meeting | IS | NORMAL | THEN | Time of alarm | JUST RIGHT |
| IF | First meeting | IS | LATE | THEN | Time of alarm | LATE |
| IF | First meeting | IS | VERY LATE | THEN | Time of alarm | VERY LATE |
| IF | First meeting | IS | EARLY | THEN | Song | CALM |
| IF | First meeting | IS | NORMAL | THEN | Song | ENERGETIC |
| IF | First meeting | IS | LATE | THEN | Song | CALM |
| IF | First meeting | IS | VERY LATE | THEN | Song | CALM |
| IF | First meeting | IS | EARLY | THEN | Light | VERY BRIGHT |
| IF | First meeting | IS | NORMAL | THEN | Light | BRIGHT |
| IF | First meeting | IS | LATE | THEN | Light | BRIGHT |
| IF | First meeting | IS | VERY LATE | THEN | Light | VERY BRIGHT |
| IF | Last meal or drink | IS | JUST BEFORE | THEN | Volume of alarm | MEDIUM |
| IF | Last meal or drink | IS | RECENTLY | THEN | Volume of alarm | MEDIUM |
| IF | Last meal or drink | IS | NORMAL | THEN | Volume of alarm | LOW |
| IF | Last meal or drink | IS | A FAIR AMOUNT | THEN | Volume of alarm | LOW |
| IF | Last meal or drink | IS | FAR AWAY | THEN | Volume of alarm | LOW |
| IF | Last meal or drink | IS | JUST BEFORE | THEN | Time of alarm | LATE |
| IF | Last meal or drink | IS | RECENTLY | THEN | Time of alarm | LATE |
| IF | Last meal or drink | IS | NORMAL | THEN | Time of alarm | JUST RIGHT |
| IF | Last meal or drink | IS | A FAIR AMOUNT | THEN | Time of alarm | JUST RIGHT |
| IF | Last meal or drink | IS | FAR AWAY | THEN | Time of alarm | JUST RIGHT |
| IF | Went to sleep | IS | VERY EARLY | THEN | Volume of alarm | LOW |
| IF | Went to sleep | IS | EARLY | THEN | Volume of alarm | LOW |
| IF | Went to sleep | IS | NORMAL | THEN | Volume of alarm | MEDIUM |
| IF | Went to sleep | IS | LATE | THEN | Volume of alarm | MEDIUM |
| IF | Went to sleep | IS | VERY LATE | THEN | Volume of alarm | HIGH |
| IF | Went to sleep | IS | VERY EARLY | THEN | Time of alarm | VERY EARLY |
| IF | Went to sleep | IS | EARLY | THEN | Time of alarm | EARLY |
| IF | Went to sleep | IS | NORMAL | THEN | Time of alarm | JUST RIGHT |
| IF | Went to sleep | IS | LATE | THEN | Time of alarm | LATE |
| IF | Went to sleep | IS | VERY LATE | THEN | Time of alarm | VERY LATE |
| IF | Went to sleep | IS | VERY EARLY | THEN | Rate of wakeup | SLOW |
| IF | Went to sleep | IS | EARLY | THEN | Rate of wakeup | NORMAL |
| IF | Went to sleep | IS | NORMAL | THEN | Rate of wakeup | NORMAL |
| IF | Went to sleep | IS | LATE | THEN | Rate of wakeup | NORMAL |
| IF | Went to sleep | IS | VERY LATE | THEN | Rate of wakeup | FAST |
| IF | Went to sleep | IS | VERY EARLY | THEN | Song | AMBIENT |
| IF | Went to sleep | IS | EARLY | THEN | Song | CALM |
| IF | Went to sleep | IS | NORMAL | THEN | Song | ENERGETIC |
| IF | Went to sleep | IS | LATE | THEN | Song | ENERGETIC |
| IF | Went to sleep | IS | VERY LATE | THEN | Song | ENERGETIC |
| IF | Went to sleep | IS | VERY EARLY | THEN | Light | NORMAL |
| IF | Went to sleep | IS | EARLY | THEN | Light | NORMAL |
| IF | Went to sleep | IS | NORMAL | THEN | Light | NORMAL |
| IF | Went to sleep | IS | LATE | THEN | Light | BRIGHT |
| IF | Went to sleep | IS | VERY LATE | THEN | Light | VERY BRIGHT |
| IF | Slept day before | IS | VERY LITTLE | THEN | Time of alarm | LATE |
| IF | Slept day before | IS | LITTLE | THEN | Time of alarm | LATE |
| IF | Slept day before | IS | NORMAL | THEN | Time of alarm | JUST RIGHT |
| IF | Slept day before | IS | MORE THAN NORMAL | THEN | Time of alarm | JUST RIGHT |
| IF | Slept day before | IS | A LOT | THEN | Time of alarm | JUST RIGHT |
| IF | Slept day before | IS | VERY LITTLE | THEN | Rate of wakeup | VERY BRIGHT |
| IF | Slept day before | IS | LITTLE | THEN | Rate of wakeup | BRIGHT |
| IF | Slept day before | IS | NORMAL | THEN | Rate of wakeup | NORMAL |
| IF | Slept day before | IS | MORE THAN NORMAL | THEN | Rate of wakeup | NORMAL |
| IF | Slept day before | IS | A LOT | THEN | Rate of wakeup | NORMAL |
| IF | Current sleep cycle | IS | DEEPLY ASLEEP | THEN | Volume of alarm | HIGH |
| IF | Current sleep cycle | IS | ASLEEP | THEN | Volume of alarm | NORMAL |
| IF | Current sleep cycle | IS | LIGHT SLEEP | THEN | Volume of alarm | LIGHT |
| IF | Current sleep cycle | IS | AWAKE | THEN | Volume of alarm | LIGHT |
| IF | Current sleep cycle | IS | DEEPLY ASLEEP | THEN | Thermostat | LOWER |
| IF | Current sleep cycle | IS | ASLEEP | THEN | Thermostat | LOWER |
| IF | Current sleep cycle | IS | LIGHT SLEEP | THEN | Thermostat | LOWER |
| IF | Current sleep cycle | IS | AWAKE | THEN | Thermostat | HIGHER |
| IF | Current sleep cycle | IS | DEEPLY ASLEEP | THEN | Rate of wakeup | SLOW |
| IF | Current sleep cycle | IS | ASLEEP | THEN | Rate of wakeup | SLOW |
| IF | Current sleep cycle | IS | LIGHT SLEEP | THEN | Rate of wakeup | NORMAL |
| IF | Current sleep cycle | IS | AWAKE | THEN | Rate of wakeup | FAST |
| IF | Current sleep cycle | IS | DEEPLY ASLEEP | THEN | Song | ENERGETIC |
| IF | Current sleep cycle | IS | ASLEEP | THEN | Song | ENERGETIC |
| IF | Current sleep cycle | IS | LIGHT SLEEP | THEN | Song | CALM |
| IF | Current sleep cycle | IS | AWAKE | THEN | Song | AMBIENT |
| IF | Current sleep cycle | IS | DEEPLY ASLEEP | THEN | Light | VERY BRIGHT |
| IF | Current sleep cycle | IS | ASLEEP | THEN | Light | BRIGHT |
| IF | Current sleep cycle | IS | LIGHT SLEEP | THEN | Light | NORMAL |
| IF | Current sleep cycle | IS | AWAKE | THEN | Light | NORMAL |

# Research

<http://sleepfoundation.org/how-sleep-works/how-much-sleep-do-we-really-need/>

<http://www.joybauer.com/insomnia/how-food-affects-sleep.aspx> - Summary: eat at least three hours before bedtime. Eating just before might keep you awake

<http://www.webmd.com/sleep-disorders/features/cant-sleep-adjust-the-temperature> - Summary: You should have the room a little bit colder when you sleep. But at a comfortable level ☺

# The assignment

## The report

Individual report

Structure (normally 5 sections)

* Introduction
  + 1 to 2 paragraphs
  + What did you do?
  + Why did you do it?
  + Did it work?
  + Was it worth using fuzzy logic?
* Background
  + 3 to 4 paragraphs
  + Domain specific
    - Assume novices
  + Fuzzy logic
    - Assume readers too this module
    - TSK vs. Mamdani
  + Motivation: Why fuzzy logic is better suited for this task?
* Simulation / Model
  + Biggest section (minimum 5 paragraphs)
  + Describe inputs (linguistic variables, MFs, etc.)
  + Rules
    - Concentrate on key rules
    - List concisely
    - Use appendix if appropriate
  + Composition and / or defuzzification methods
  + Outputs (MFs / linear models)
  + *Don't include the code (FIS file) in write-up.*
* Results & Analysis
  + Results
    - Screen-shots
    - Table of I/O examples
    - General (i.e. full sentences)
    - Again, focus on key results.
  + Evaluation
    - Is the results good? Bad? Different? Run some simulations and comment.
    - No gold-standard. Justify your choices.
* Conclusions
  + 1 to 2 paragraphs
  + Was a fuzzy solution justifies?
    - Analytical approach does not have closed-form solution or is inefficient.
    - Solution may rely heavily on expert knowledge, which could be difficult to incorporate in traditional control system (i.e. subjective matters).

## Expectations

* Proper English (Grammar, punctiotion, full sentences)
* Reasonable amount of references, 3 to 5 preferred.
  + Both fuzzy logic and domain specific references.
  + Peer-reviewed (i.e. avoid wikipedia / anonymous webpages)
* Don't plagiarize
* Results, screenshots, rules, etc… will be the same for everyone in a group.
* The simulation submission is to verify you did what you're reporting to have done.
* The best and worst group may be investigated.
* The coursework is marked individually, but good group-work helps.
* Avoid over-complication the problem: Fuzzy logic is deployed to simplify solutions, not the other way around.