# Terms of Reference

Student Name: Sam Fuller

Course: MSc Intelligent systems and robotics

Proposer: Sam Fuller

Supervisor: John North

# Background

The main research objective of the project is to determine the suitability of the functional paradigm as a development environment for fuzzy logic systems. The three programmed deliverables are the functional language compiler, the fuzzy logic library, and a selection of example programs.

## The functional language compiler

This is an executable program that will turn a file coded in the functional language, to pure JavaScript. The input shall be two file locations (the input file, and the output file). The compiler will be written in prolog, the advantage of Prolog is its ability to process a list input with a set of given rules about the language. Prolog has been used as a compiler for other functional language such as Erlang (Armstrong, et al., 1992). I have learned about prolog in the MSc AI Programming module and will use some of this knowledge, however; it is still both a new language and paradigm to me, therefore extra research will be done into the language, and consideration for bug fixing and lack of knowledge must be built into the time schedule.

The compiler will produce JavaScript code, this language has been chosen for many reasons. The first reason is that JavaScript is a high-level language, that has many functions built into the language. Being a high-level language, it also has garbage collection and type prediction, therefore; although consideration for both will be needed, it lessens the work needed by my compiler and therefore required for this project. The most important reason to chose JavaScript is its compatibility with HTML and CSS. This acts as a very powerful output, but also allows the language to be run on any platform that supports a modern internet browser.

## The fuzzy logic library

The fuzzy logic library will be written in the functional language, it will show the capability of the language, and complete the main research objective of the project. The fuzzy logic library must be able to: fuzzify numeric inputs, calculate an output using the fuzzy inputs and a rule base, defuzzify the output. This part of the project will use my knowledge from the MSc Fuzzy Logic module. The exact nature of the fuzzification and defuzzification will need to be researched, however; it will include multiple membership functions (at least triangular, trapezoidal and gaussian).

## The examples

The purpose of the examples is to display the functionality of the other two deliverables. Only a few examples are needed to show this, however; they must show all functionality of both the programming language and fuzzy logic library. Abstract examples can be used to show the functionality of single elements, however; real life examples will be programmed to show its uses i.e.

* The Fibonacci sequence, a sequence where each element is defined as the sum of the previous two elements, this demonstrates recursion.
* the FizzBuzz game, a game in which each multiple of 3 is replaced with fizz, 5 with buzz and multiple of 3 and 5 is replaced with fizzbuzz, this demonstrates list building, concatenation and strings.
* a generic fuzzy Mamdani system, an abstract system where all types of membership function are used and a variety of rules show what the library is capable of.

# Deliverables

The deliverables of the project will be:

* The language compiler (written in prolog, compiles to JavaScript)
* Fuzzy logic library (written in the functional language)
* Several test programs
* Testing information
* Dissertation

# Academic Objectives

I have several personal academic objectives that completing this project will satisfy:

* Gain more experience of the functional paradigm
* Improve my knowledge of Fuzzy logic systems and mathematics
* Improve my ability in both an intermediary language and Prolog

# Research Questions

The research questions that will be answered during this assignment are:

* Is the functional paradigm more convenient for the development of fuzzy logic systems?
* Is HTML + CSS a suitable output for a functional language?
* Is it efficient to compile a functional language to another high-level language such as JavaScript?

# Background Research Objectives

The research that needs to be done before completing the assignment:

* General Prolog research
* What are the important components (operators, syntax, ect) of functional languages?
* How many other languages compile to other high-level languages, and what is the most suitable language to compile to?
* What are the multi-lingual computing standards, what possible inputs are there, is the English alphabet acceptable, or should the language be able to recognise more characters?
* What stages do modern compilers use to compile to an intermediary language?
* What are the key parts of a fuzzy logic system?
* What functions are necessary in a fuzzy logic library?

# Product Objectives

The requirements for the three components are:

The compiler should be able to:

* Compile the functional code to an intermediary language quickly and without error
* Allow for function definitions to be constructed and evaluated
* Produce code that is both processor time and memory space efficient, it is expected that the compiler will not create code that is as efficient as coding natively in the intermediary language
* Allow for easy multithreading of a program (if not done automatically)

The fuzzy library should be able to:

* Contain all necessary features needed to create a fuzzy logic system
* Be coded in the functional language created for this project
* Demonstrate the capability of the language created

The examples should be able to:

* Show all functionality of the language created
* Show all functionality of the fuzzy library created
* Show a range of example programs

# Risk Assessment

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| Risk Identification | Probability | Impact | Assessment (probability and impact) | Risk Monitoring, mitigation and management |
| The project requires too much time to be completed by the deadline | Medium | High | This risk is troubling, not completing the project would have a serious impact | The language development is split into segments, the functional language is the priority, the fuzzy library and examples are secondary, and can be ignored if necessary |
| Loss of files or access to my computer | Low | Very High | A loss of all progress would set the project back heavily | The project will be stored on my one drive and backed up on GitHub, one drive will allow me to access the files on any computer, GitHub will provide a backup in the case one drive is not working (a failure on Microsoft’s side, or account loss). In addition, I have access to family and library computers. |

# Appendices

## Schedule of Activities

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Task / Week | 01-Jul | 08-Jul | 15-Jul | 22-Jul | 29-Jul | 05-Aug | 12-Aug | 19-Aug | 26-Aug | 02-Sep | 09-Sep | 16-Sep |
| Research |  |  |  |  |  |  |  |  |  |  |  |  |
| Literature review |  |  |  |  |  |  |  |  |  |  |  |  |
| Language Compiler |  |  |  |  |  |  |  |  |  |  |  |  |
| Fuzzy Library |  |  |  |  |  |  |  |  |  |  |  |  |
| Testing |  |  |  |  |  |  |  |  |  |  |  |  |
| Examples |  |  |  |  |  |  |  |  |  |  |  |  |
| Dissertation |  |  |  |  |  |  |  |  |  |  |  |  |

## Ethical Review Form

**Faculty of Technology  
Application to Gain Ethical Approval  
Taught Masters Degree Student**

*NOTE: If your research involves using human tissue or fluid samples or animals please DO NOT use this form. You should seek guidance from the Chair of the Faculty Human Research Ethics Committee (FREC) before starting your project.*

All Taught Masters that include a research project or dissertation require ethical approval. Students must complete this form and discuss the likely outcome with their project supervisor. There are four possible outcomes:

1. No interaction with human beings is planned and no identifiable data on or from individuals is used.
2. Students interview individuals, carry out surveys, observe, and participate with adults who understand the research and are aware they can withdraw their participation at any time. Supervisors must ensure that the appropriate boxes in section 2 are ticked and that the student knows how to address the ethical concerns.

*For projects which fall under outcome 1 or 2, this ethical application form should be signed by the student and the project supervisor. Nothing further is required; the form does not need to go to the FREC.*

1. The research is with vulnerable people who may not understand the research and their role (eg children, hospital patients, people with mental health issues, subordinates in power relationships, etc). This also applies to research into illegal activities or research that could produce a risk of injury to anybody. The student / researcher must find ways to address these problems and the supervisor must be confident that these have been addressed satisfactorily.

*For projects which fall under outcome 3, the ethical application form should be signed by the student and project supervisor and a copy of the review form sent to the FREC (via* [*amsmith@dmu.ac.uk*](mailto:amsmith@dmu.ac.uk)*). Once the FREC accepts the review form, the student and supervisor will be notified and the student may start work on the project.*

1. The research is ethically problematic.

*For projects which fall under outcome 4, this ethical application form should be signed by the student and project supervisor and a copy of the review form submitted to the FREC (via* [*amsmith@dmu.ac.uk*](mailto:amsmith@dmu.ac.uk)*) for resolution. Once resolved, the student and supervisor will be notified and the student may start work on the project.*

**All outcomes**

Once approved, the form should be submitted by the student to the relevant Blackboard Dissertation shell. A copy of the form and, *where relevant*, the following supporting documents, must be included in the project report (dissertation) as appendices when it is submitted for assessment.

Supporting documents (may apply to outcome 2, 3 or 4):

* Information that will be provided to the study participants
* Participant consent form
* Other documentation as advised by the supervisory team

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| 1. Applicant | | | |
| Surname | Fuller | First Name | Sam |
| DMU Email Address | p15194468@my365.dmu.ac.uk | Student ID Number | P15194468 |
| Working title of the proposed investigation: Fuzzy Logic and the Functional Paradigm | | | |

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| **2. Delete ‘Yes’ or ‘No as appropriate in table below. If you answer any of the following questions with ‘Yes’, then specific ethical issues WILL be raised that MUST be addressed. You will need to explain in detail in section 3 how you will address these ethical issues, and consult your supervisor.**  Has your research proposal identified any of the following research activities?   |  |  | | --- | --- | | Gathering information from or/and about human beings through: interviewing, surveying, questionnaires, observation of human behaviour | No | | Using archived data in which individuals are identifiable | No | | Researching into illegal activities, or activities at the margins of the law | No | | Researching into activities that have a risk of personal injury anybody. | No | | Research that might impact on human behaviour, for example on autonomous vehicles. | No | | Researching topics that are concerned with the following ‘sensitive research’ areas: access to web sites normally prohibited on university servers, or extremism and radicalisation, criminal activities, etc. | No |   For more information about whether your research should be classified as sensitive see: <http://www.dmu.ac.uk/research/ethics-and-governance/sensitive-research.aspx> ). |
| **Are there additional factors that could give rise to ethical concerns eg communication difficulties?** |
| There are no ethical issues with the functional language or fuzzy logic library that will be developed for the project.  It could be argued that the language developed might be used unethically, however; this could also be said of any other langauge. |

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| 3. How will the issues you have raised in response to questions 2 be addressed? |
| There are no ethical issues that need addressing. |

*Note: you should consider the following:*

* *Providing articipants with the full details of the objectives of the research*
* *Providing information appropriate for those whose first language is not English*
* *Voluntary participation with informed consent (through the provision of a consent form)*
* *Written description of involvement*
* *Freedom to withdraw*
* *Keeping appropriate records*
* *Signed acknowledgement and understanding by participants*
* *Relevant codes of conduct / guidelines*

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| 4. To which ethical codes of conduct have you referred? |
| I have referred to both the IEEE and BCS ethical codes of conduct. |

*Note: For the Faculty of Technology these codes typically include those published by the BCS, ACM, IEEE or other applicable codes such as the code of the Social Research Association or specific funding bodies, such as the ESRC. Links to some of these codes are available on the Faculty of Technology FHREC website.* [*http://www.dmu.ac.uk/research/ethics-and-governance/dmu-policies-and-external-requirements-.aspx*](http://www.dmu.ac.uk/research/ethics-and-governance/dmu-policies-and-external-requirements-.aspx)

**Please note, if the methodology changes in relation to ethical considerations after submission, you can submit a new form, following the same procedure.**

**AUTHORISATION**

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| --- | --- | --- | --- |
| Signature of Applicant | | | |
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| Signed | Sam Fuller | Date | 16/07/2019 |
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| --- | --- | --- | --- |
| Approval signature of Supervisor | | | |
|  | | | |
| Signed |  | Date |  |
| *Outcome [circle number] ( 1 2 3 4 )*  Name of Supervisor \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |

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| *Where necessary*, authorising signature (FHREC Chair) | | | |
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| Signed |  | Date |  |
| *Outcome [circle number] ( 1 2 3 4 )*  Name of FHREC chair \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |

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| **Conditions** |
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| *Where necessary*, full approval - authorising signature (FHREC Chair) | | | |
|  | | | |
| Signed | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Date | \_\_\_\_\_\_\_\_\_\_\_\_ |

**NOTES FOR GUIDANCE:**

1. Participants cooperation in a research project is entirely voluntary at all stages. They must not be misled when being asked for co-operation.
2. Participant anonymity must be strictly preserved. If the Participant, on request from the Researcher, has given permission for data to be passed on in a form which allows that Participant to be personally identified:  
   (a) the Participant must first have been told to whom the information would be supplied and the purpose for which it will be used  
   (b) the Researcher must ensure that the information will not be used for any non-research purpose and that the recipient of the information has agreed to conform to the requirements of any relevant Code of Practice.
3. The Researcher must take all reasonable precautions to ensure that the Participant is in no way directly harmed or adversely affected as a result of their involvement in a research project.
4. The Researcher must take special care when interviewing vulnerable people – for example children or the elderly. The Faculty ethics representative will give advice on gaining consent for studies involving vulnerable people.
5. Participants must be told (normally at the beginning of the interview) if observation techniques and/or recording equipment are used, except where these are used in a public place. If a respondent so wishes, the record or relevant section of it must be destroyed or deleted. Participant anonymity must not be infringed by the use of such methods.
6. Participants must be enabled to check, without difficulty, the identity and bona fides of the Researcher.
7. Researchers should ensure data is held securely, and follow university and legal requirements regarding data protection and data storage.

## BCS Accreditation Checklist

**IMAT3451 BCS Accreditation Checklist**

**Student Name** SamFuller

**P-number** p15194468

**Programme** Intelligent Systems and Robotics

**Email address** p15194468@my365.dmu.ac.uk

**Project Title** Fuzzy Logic and the Functional Paradigm

**Project Proposer** Self

**Supervisor**

John North, De Montfort University, Johnn@dmu.ac.uk

**BCS Accreditation**

Your supervisor needs to check your contract against this list and sign if you are on a BCS accredited course. Take note of this and be sure that you mention all requirements.

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| --- | --- | --- | --- | --- | --- |
| This contract contains an elucidation of the problem, the objectives of  the project and a risk analysis | | | | X  **Yes** | **No** |
| The contract states that the project will include an in-depth investigation of the context and literature, and where appropriate, other similar products | | | | X  **Yes** | **No** |
| The contract states that the final report will contain a clear description of the stages of the life cycle undertaken | | | | X  **Yes** | **No** |
| The contract states that the final report will contain a description of how verification and validation were applied. | | | | X  **Yes** | **No** |
| The contract states that the report will contain a description of the use of tools to support the development process | | | | X  **Yes** | **No** |
| The contract states that the final report will contain a critical appraisal of the project, indicating the rationale for any design/implementation decisions, lessons learnt during the course of the project, and evaluation (with hindsight) of the project outcome and the process of its production (including a review of the plan and any deviations from it) | | | | X  **Yes** | **No** |
| The contract states that there will be a description of any research hypothesis | | | | X  **Yes** | **No** |
| The contract states that all research will be fully referenced | | | | X  **Yes** | **No** |
| **Contract is suitable for BCS Accredited Project** | X  **Yes** | **No** | **Supervisor**  **Signature** |  | |

**Student\_Sam Fuller\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date\_16/7/19\_\_\_\_\_\_\_\_**

**Proposer Sam Fuller\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date\_16/7/19\_\_\_\_\_\_\_\_**

**Supervisor\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Then keep the signed copy somewhere safe: include it with your initial submission. Your supervisor will require a copy as well.