A Support tool for Boolean Networks

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1 Introduction

Boolean networks are a well-studied discrete model used to emulate more complex systems. Good examples of their uses are within biological networks such as gene regulatory networks [1] [2]. The applications are also wider-ranging than just biological systems and may also be used to emulate control systems [3].

A Boolean network is constructed from a set of nodes whose state is dictated by a Boolean value. These correspond to 1(active) and 0(inactive). Each node has attached a set of rules dictating what value it should be set to on the next round of iteration, these may be in the form of logical expressions or truth tables. For the example of genes, the nodes would represent those genes and the edges the interactions between them [4].

A consistent problem with boolean networks pertains to the state space explosion. This simply describes the exponential complexity of a Boolean network as the number of nodes increases. Due to the nature of each node being able to start from any state, this allows for 2^n number of starting states. As a node is added to the network this will double the number of states availiable. In Figure 2 C it is clear that with a 3 node state that there are 8 permutations for this network. Due to this specific approaches have to be taken. This can include splitting up larger networks or simpler approaches like only processing requested traces [4].

There are also some more minor nuances with the structure and form of the network as detailed in [5]. For the current application however, synchronus and asynchronus networks will be the focus.

Fig. 1 A

Fig. 1 C

State	Input (t)			Output (t+1)		
	A	B	C	A'	B'	C'
1	0	0	0	0	1	1
2	0	0	1	0	0	1
3	0	1	0	0	1	1
4	0	1	1	1	0	1
5	1	0	0	0	1	0
6	1	0	1	0	0	0
7	1	1	0	0	1	0
8	1	1	1	1	0	0

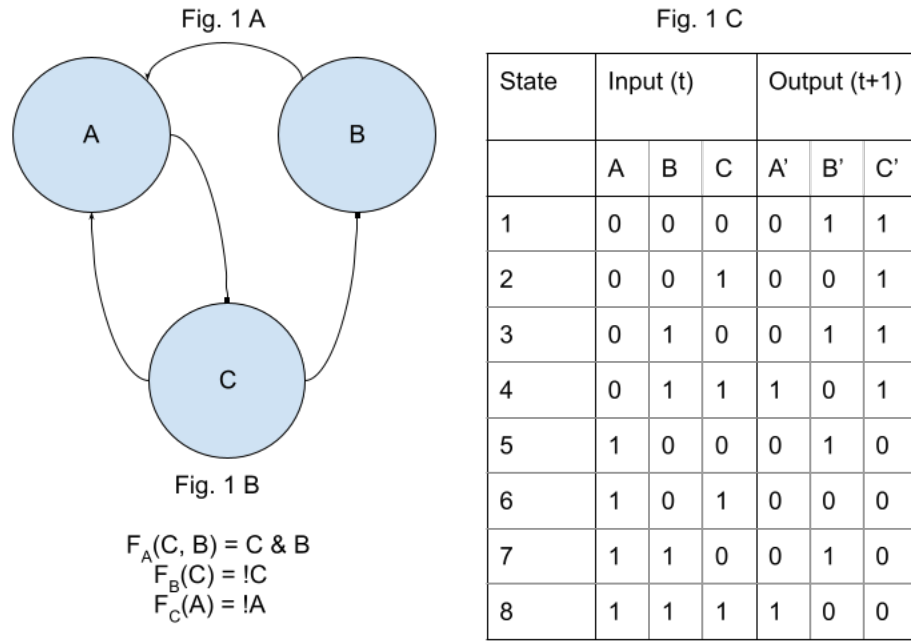Fig. 1 B

$F_A(C, B) = C \& B$
$F_B(C) = !C$
$F_C(A) = !A$

Figure 1: A Boolean network descriptor (A), expressions (B) and truth table (C).

The end goal of this project is the design and develop a Boolean network support tool. It should have the ability to construct, analyse and visualise Boolean networks. There are current tools that are availiable that are designed for some or all of these tasks depending on their scope.

1. Boolesim [6]
2. VisiBool [7]
3. GinSim [8]

2 Aims and Obejectives

The aim of this project is to develop a support tool for Boolean networks, specifically for the case of their construction, analysis and visualisation.

2.1 Project objectives:

1. Research example boolean networks
2. Research and evaluate current Boolean network tools
3. Identify the key requirements for this tool
4. Identify user necessities for the tool
5. Develop approaches to visualise Boolean networks
6. Research and develop techniques to combat state space explosion
7. Develop a prototype support tool for Boolean networks
8. Perform user studies and effectiveness of developed tool (Evaluate the end tool)

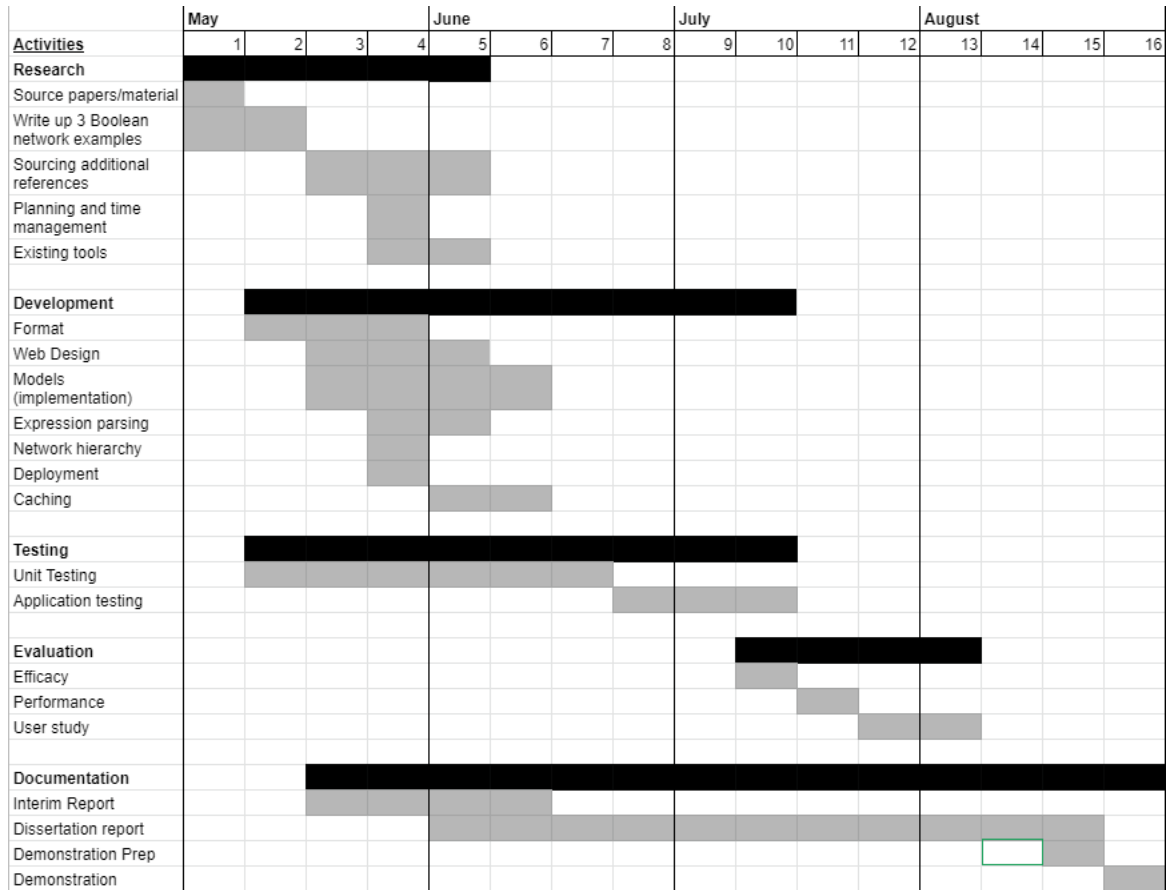# 3 Progress

3.1 test

4   Project Plan

Figure 2: Project plan gantt chart

References

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