Preface

I became interested in Conway's Game of Life in the 1980s when I wrote a Game of Life program for an Amstrad CPC 464. This little computer with 64K of memory ran on a Z80 microprocessor with a 4 MHz clock. The program had a closed universe of 64 × 128 cells. Just big enough to hold some complex patterns. It ran fast enough to make manual searches for interesting interactions practical. Over a number of years I found the fanout and takeout patterns described in this book. I developed the fanout pattern into the matrix addressable memory cell which just fitted into the 64 × 128 universe.

My interest in Conway's Game of Life was reawakened towards the end of the 1990s when I got an Internet connection and discovered the patterns that other people had found in the Game of Life. With these extra components and the very powerful program Life32 by Johan Bontes I realised that I had all the pieces to build a Turing machine based on the my memory cell. This I proceeded to do using two stacks for the Turing tape. The completed machine was published on the Internet in 2000. I claimed that the design of the Turing machine allowed it to be extended to make a universal Turing Machine.

Between 2009 and 2014 I rebuilt the Turing machine as a fully universal Turing machine. This involved increasing the size of the memory used for the finite state machine to hold the larger universal Turing Machine program and adding stack constructor patterns to build stack cells as the machine is running so that the Turing machine never runs out of blank tape.

In order to demonstrate the universal Turing machine it was important that the machine ran reasonably quickly. I therefore designed a universal Turing machine that runs in polynomial time by taking advantage of the available size of the finite state machine's memory. This universal Turing machine requires a description of the simulated Turing machine as a list of transitions that can be in any order.

While investigating the best ordering of this list I formulated the problem as a simple Quadratic Assignment Problem and found that I could solve this with a simple procedure. I was not able to prove formally that the Quadratic Assignment Problem had been solved but informally it is very convincing.

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June 2014

http://www.springer.com/978-3-319-19841-5

Turing Machine Universality of the Game of Life

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2016, XV, 177 p. 141 illus., Hardcover
ISBN: 978-3-319-19841-5