TITLE: **A MATHEMATICAL INVESTIGATION INTO JUGGLING**

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INTRODUCTION:

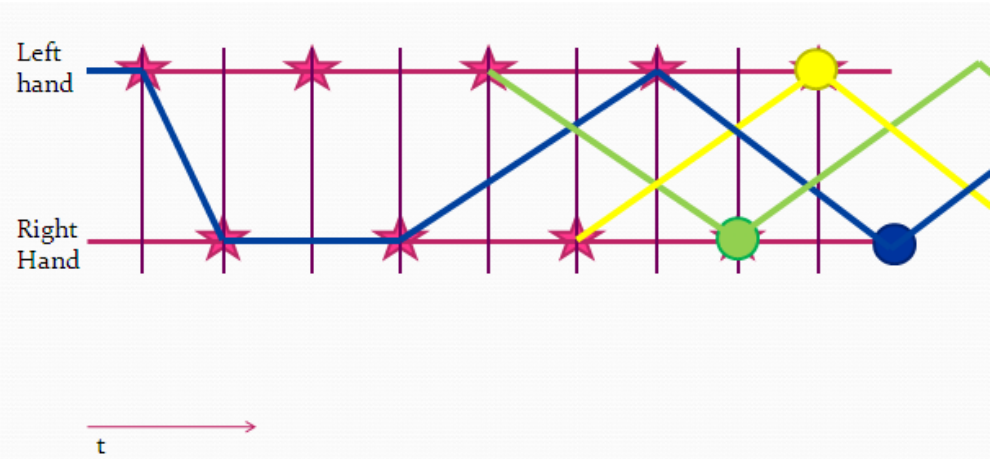
The following is an investigation I have presented to some of my classes and in other mathematical contexts:

Mathematical investigations often contain the richest most rewarding sides of mathematics. In this paper I will investigate Juggling. We will look into ways of using numbers to describe juggling patterns, and to develop new patterns. We will create a mathematical model with which to describe different patterns. These models will enable us to 'slow' time down and develop a whole trick before we worry about picking up juggling balls. We will use ladder notation and site-swap notation (common concepts in the juggling community) which both categorise throws by giving them a number related to how the ball is in the air. We will use these notations to develop 'new' tricks (known to the juggling community but unknown to the beginner juggler).

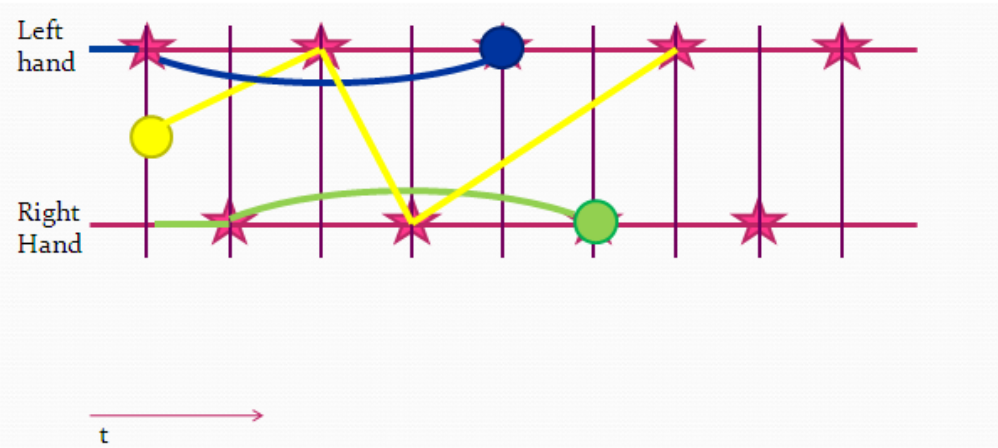
CONTENT:

After a brief discussion about mathematics and mathematical modelling in general, I will start speaking about site-swap notation. The basic concept is that juggling works with a steady beat. Every beat a ball is thrown (and it is easy to see that for this process to be sustainable a ball must be caught every beat). If we attach a number to each throw representing how many beats it will be in the air, we can turn some (not all) tricks into a series of numbers. In this way a 3-ball cascade becomes the pattern 3-3-3-3-3-3-3. Every throw is isomorphic, it has a flight time of 3 beats. A 3-ball shower is 5-1-5-1-5-1 … here every throw with the right hand has a flight time of 5 beats every through with the left hand has a flight time of one beat. Ladder notation is related to site-swap but slightly more graphic.

Below is a picture of ladder notation for 1-2-0-3-3-3-3-3-3-3-…



In the talk I will introduce the two notations (using the pattern above), and then we will derive the trick below (4-4-1-3)



In will then give time for people to try derive their own tricks (no 7's please), which I will try to juggle.