

Re: juggling's combinatorics problem with siteswap

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From: owenjonesuk (owenjonesuk_at_yahoo.com.nospam)

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Sorry to toppost, but I don't want to make people scroll past the below post and I do want to include it.

There has been some mathematical interest in the maths of juggling, mainly from a graph theoretical point of view. The juggling state graph is (I think) a very good way of understanding the underlying structure of juggling tricks, and for coming up with new ones. Your idea that orbits and periods might be more fundamental is interesting. In practice I'm not sure if many juggling tricks are made up of more than two orbits.

I have recently done some research into the history of siteswap and I found a multitude of papers on the internet. Probably the best source is the Mathematics of Juggling by Burkard Polster. I haven't read it, but several people who have and a very good review online all say that it is completely aimed at mathematical audience and that it has a great list of references.

Owen

PS Siteswap was devised in 1984 or 85, although it didn't take off in popularity for a while.

Xah Lee wrote:

> *A RAPTURE OF SITESWAP*

>

> *thanks to all replies...*

>

> *i think these ideas are very interesting and have the potential to turn into a new sub-branch of network theory (i.e. graph theory). I have not been involved in the juggling community much, but as far as i know these ideas are unexplored, and there's not much if any literature on them.*

>

> *Here's some elaborations.*

>

> *The period number can be given depending on whether the balls are*

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- > colored. In common usage, the period of a pattern is given as if all
- > balls are of the same color...
- >
- > so now a pattern can have attributes of: number of balls, periods (at
- > least two types), number of orbits, distinct orbits (a pattern can have
- > n orbits and some of them being the same), and each orbit has a period.
- > And also ambidextrousness and synchronization considerations.
- >
- > if we assign a symbol to each concept, then we can explore the
- > mathematical relations between them. For example, what patterns are
- > possible with n orbits? Given ambidextrousness and m balls and n
- > colored period, is it possible to have all orbits up to some ceiling
- > number? And can the complete siteswap info be described by some other
- > minimal ways, as perhaps orbits and their periods that more readily
- > shows certain properties? (as if using relations and generators to
- > describe groups.)
- >
- > And in general, a body of theorems can be developed that tells us the
- > constraints and relations between these properties.
- >
- > For example, in the current batch of juggling emulation softwares (i'm
- > aware of Juggling Lab), exhaustive patterns are generated by number of
- > balls, and with filters using the concept of (uncolored) period, max
- > throw, number of jugglers, ground state patterns or excited state
- > patterns... (and few others, some not pertinent in our context such as
- > multiplexing and sync/async) However, no concept of orbit or colored
- > period is considered.
- >
- > these theories can constitute a systematic study related to directed
- > graph theory, with a concept of a pulse (i.e. the regular "throw") For
- > instance, so far we've considered juggling by a single person. When
- > considering two persons interchanging balls, then the associated
- > notation and pattern variation gets more complex. As common in club
- > juggling, we can consider n person juggling balls. The possible
- > patterns are extremely complex, and spectacular when we consider the
- > questions of orbits. We can consider a hand as a node in a network.
- > When a ball leaves a hand to another hand, it constitutes a directed
- > graph in a network. And the clock-regularity of throwing added to the
- > directed network a concept of tick. (now with respect to this pulsation
- > is the notion of periods.)
- >
- > these are just some thoughts. I'm in particular interested in the orbit
- > concept. Besides from the math aspect, i like to know the orbits of
- > patterns i'm juggling. (it's not practical to tell when actually
- > juggling as that distracts; and impossible for higher number of balls
- > one can't even hope to juggle.)
- >
- > one thought started me thinking about these is that i've always been
- > interested in the various mathematical screen savers. (there's the
- > famous but trivial strings, and Game of Life, IFS, fractals, Satori,
- > bouncing billiards ... see this site for a collection of screenshots

> <http://www.jwz.org/xscreensaver/screenshots.html>) One particular type
> is showing objects moving in space, 2D or 3D (or high dimensions
> visualized thru a projection or slice). The way an object (usually just
> a point) moves can be described by different types of algorithms, such
> as by artificial life means (as in boids) or mathematical formula (some
> parametric formula). Now, it is often spectacular to watch objects fly
> in 3D in some kind of formation. Simple familiar cases are those jet
> planes in air shows. For example, in some Olympics opening there are
> dancers of large number with different colored clothing that
> dynamically form shapes to be viewed from a distance. Now that's a 2D
> example. Such can be spectacular in 3D, especially made possible by
> computer animation. For example, in the early video game The Disc of
> Tron, after passing a level there's a animation of several discs flying
> in formation in 3D to form a sphere that grows and shrinks in size.
>
> Now, one of the problems is how to describe such 3D path patterns.
> Artificial life or parametric formulas each gives rather idiosyncratic
> and inflexible visual esthetics. AL approach does not form artificially
> regular patterns and parametric path are too regular and uninteresting.
> Its formulas hard to work with. But now i thought of the siteswap
> notation and juggling may be a solution. We consider each hand as a
> node in a network. Now, the hands need not come in pairs, and can be
> fixed at various coordinate in 3D. Now a throw from one node to another
> can be considered as a directed graph, but now adding a specific path.
> That is, we specify a space curve in which the ball is to travel from
> node A to B. (and the different curves connecting nodes can be made to
> be smooth, as using the math of Bezier curves.) And the ticks in the
> whole network can be smoothed out. In this way, we can built a system
> that describes such particle orbit formation. Eventually we can
> consider the space curves themselves being variable, or the node's
> coordinates themselves following a given system of particle orbit.
> (e.g. math question: what happens when such is nested?)
>
> I think this could have many applications. Foremost is entertainment.
> As a screensaver, it would be beautiful, as there are various needs
> today when playing mp3 music on the computer. I don't know for sure,
> but i imagine this systematic orbit formation notation and mathematics
> (the network theory part) can be applied more seriously in science or
> engineering.
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> -----
>
> for those mathematicians who are not familiar with juggling... here's
> the context:
>
> we are talking about juggling balls. Say 3 balls. One can have tricks
> as throwing them behind back, or catching them under the leg etc., but
> these are not considered here. We only consider throwing balls straight
> up in front of the body. Now, there are many pattern variations. For
> example, with 3 ball, one can throw one ball to the right from left
> hand, then the right hand throws a ball to the left, and repeat. This

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- > *is the most common pattern. (called cascade) Now, another patten has*
- > *the left hand keep throwing ball to the right, and the right hand catch*
- > *and quickly pass to the left hand, so the whole thing cycles in a*
- > *circular pattern. (this pattern is called "shower"). Now when the balls*
- > *increase in number, the possible patterns increases. (polynomial time?)*
- > *About 1990 or so jugglers have developed a notation that describes the*
- > *pattern variations, called siteswap, which is just a sequence of*
- > *digits. (see here for detail: <http://en.wikipedia.org/wiki/Siteswap>)*
- >
- > *Xah*
- > *xah@xahlee.org*
- > *http://xahlee.org/PageTwo_dir/more.html*