What is hijacking?

"Hijacks" are transitions between different 2 person juggling patterns which meet certain criteria.

I have written a program which can find hijacks, and put it online, to allow anyone to generate their own transitions. I will first give some background to these patterns, and then show how you can use my website to rederive transitions we previously knew about and find new transitions. Then, I will present an amusing sequence of transitions which I believe meets the current definition of a hijack, but perhaps should be ruled out. Finally, I will give some closing thoughts on what I personally think a hijack is.

Background

"In passing, hijacking is where one passer decides to change what pattern they are passing and their actions transitions their partner into a compatible pattern. One passer is making an active choice, the other is passively responding." Ed Clark

Aidan Burns first described Hijacking in *The Highgate Collection*. He gave some examples of hijacks and provided some explanation of how to work them out:

"There are some simple rules for working out possible hijacks in period five patterns.

1. *You can throw a club to a hand that is expecting to receive a zip. Let's call this the hijack club*
2. *If someone throws a hijack club to you, then you have a club that you wanted to zip but now can't. You should throw this 'problem' club to the hand that threw the hijack club.*
3. *If there is a club 'missing' from you pattern, you should zip to avoid a gap.*

Also you may need to add transition throws to lo-jack a pattern.

Use these rules to work out some hijacks on paper and then try to apply them in practice" Aidan Burns, in *The New Highgate Collection.*

Ed Clark further developed the theory of hijacking and suggested 9 general rules for hijacks in the article '*Hijacking in period 3, 5 and 7*'. Ed was able to generate many transitions intuitively, but at the time his article was written there was no systematic way for generating hijacks.

I have developed a program which can systematically generate hijacks. Along the way I have tried out many new patterns and transitions and reflected on what I consider to be a hijack. This process is still ongoing, however I wish to share my ideas and code, to allow others to try out the new patterns I have found and find their own. I will present some transitions found by the generator, deferring a discussion on the distinguishing features of a hijack until the end of the article.

1.) Rederiving the classical hijacks

To check my generator was giving reasonable output, I asked it to find transitions starting in 6 club why not (77862), and transitioning into patterns made up only of 2s, 6s, 7s, and 8s. You can see the output by going to jugglehacker.com and entering 7,7,8,6,2 as the starting pattern (6 club why not) and 2,6,7,8 as the permitted throws. These are the default values on the website, so you shouldn't even need to type them! You will, however, need either software which can read .xlsx files, such as Microsoft Excel, or to enter an email address so a Google Sheet can be shared with you.

If it has worked, you should now be looking at a diagram like this:

Note: If you requested a .xlsx file, it will be in the first tab. Otherwise, it will be on the website page which confirms a Google Sheet has been shared with you.

Node number	Pattern
1	[7, 7, 8, 6, 2, 7, 7, 8, 6, 2] [7, 8, 2, 7, 6] vs [7, 6, 7, 8, 2]
2	[6, 7, 8, 6, 8, 2, 7, 8, 6, 2] [6, 8, 8, 7, 6] vs [7, 6, 2, 8, 2]
3	[8, 8, 8, 2, 7, 2, 6, 6, 6, 7] [8, 8, 7, 6, 6] vs [8, 2, 2, 6, 7]
4	[6, 7, 7, 7, 8, 2, 7, 7, 7, 2] [6, 7, 8, 7, 7] vs [7, 7, 2, 7, 2]
5	[7, 8, 8, 2, 7, 7, 2, 6, 6, 7] [7, 8, 7, 2, 6] vs [8, 2, 7, 6, 7]
6	[7, 2, 7, 8, 6, 7, 2, 7, 8, 6] [7, 7, 6, 2, 8] vs [2, 8, 7, 7, 6]
7	[7, 2, 8, 6, 7, 7, 2, 8, 6, 7] [7, 8, 7, 2, 6] vs [2, 6, 7, 8, 7]
8	[7, 7, 7, 7, 2, 7, 7, 7, 7, 2] [7, 7, 2, 7, 7] vs [7, 7, 7, 7, 2]
9	[8, 2, 8, 6, 7, 2, 6, 8, 6, 7] [8, 8, 7, 6, 6] vs [2, 6, 2, 8, 7]
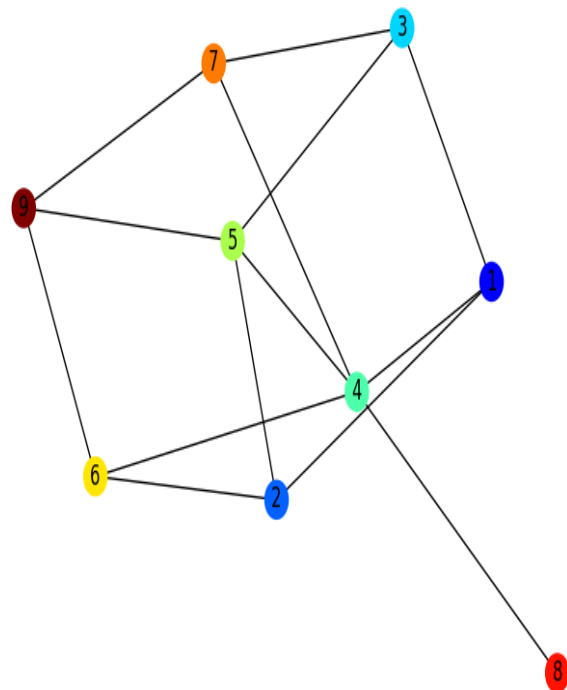
Yours may look slightly different, but the information it contains will be the same. So, what is this saying? Let's look at node 4, the key tells us that this node represents the pattern [6,7,7,7,8,2,7,7,7,2] (this is the global siteswap) or [6,7,8,7,7] vs [7,7,2,7,2] (these are local siteswaps, funky bookends vs parsnip).

Lines in the diagram mean we can hijack between patterns. For example, because nodes 4 and 6 are connected, that means we can hijack from funky bookends vs parsnip into maybe (pass pass self zip heff). Ok, but how do we actually do the transition? That's where the other tabs come in. The "Transitions" tab tells you how to do the transitions. It's a table. Row 1 of the tab gives the pattern we are transitioning into, and column A, gives the pattern we have come from. Row 5 gives all the transitions from funky bookends vs parsnip. Column G gives all the transitions into maybe. So, cell G5 gives you the transition represented by the line from node 4 to node 6:

Active [7, 2, 7, 7, 2]4[8, 7, 7, 6, 2]

Passive [7, 6, 7, 8, 7][7, 6, 2, 8, 7]

The active juggler throws parsnip, i.e. pass zip pass pass zip, then a flip and then throws heff pass pass self zip i.e. maybe.

Notably, my generator found a new 5 club pattern which can go against popcorn. Locally, it is pass self heff zip zip. I have chosen to call it whoops, as the zip zip almost feels like you've made a mistake when you juggle it. It is node 3 in the diagram above.

This diagram will let you find loops of patterns. For example, I have filmed the loop from why not (node 1), up to funky bookends vs parsnip (node 4) down to 6 club not why (node 7), down to popcorn vs whoops (node 3) and up to why not again (back to node 1). You can use the diagram to make you own loops!

The eagle-eyed amongst you will spot that in the video I did a flip to transition from not why to popcorn vs whoops ([72678]4[88766]) but my website gives a transition with no transition throws (by "transition throws" I mean throws which don't belong to either the pattern we are transitioning to or from, such as the flip in the video). This relates to the fact that previously my generator was trying to add in transition throws before it had considered all possible ways we might be able to transition without transition throws. However, it does raise a question: If we have found a transition which doesn't need a transition throw, do we also look for transitions with transition throws? Or do we only put in transition throws if there are no transitions without transition throws? I.e. is [72678]4[88766] a hijack, or should it be ruled out because there is [7, 8, 7, 2, 6][7, 6, 6, 8, 8]? I personally enjoyed doing the flip to transition from not why to popcorn vs whoops, and think the other transition looks less fun (although at time of writing I haven't tried it out). Furthermore, if we have found a transition by using a flip, do we want to keep looking and see if a self of a heff as a transition throw in a different place will let us transition too? I'm not sure how I feel about this.

2. Deriving new hijacks

All the patterns in the above loop are valid siteswaps locally. For example, funky bookends vs parsnip is in our loop, and both funky bookends and parsnip are valid patterns in their own right (77786 and 77722). However, consider the global period 10 siteswap 7867277862. Here one juggler is doing pass self zip pass self and the other is doing heff pass pass heff zip. These patterns cannot be done against themselves! I wanted to find a loop of hijacks between patterns such as this. You can see the diagram if you enter 7,8,6,7,2,7,7,8,6,2 into the starting pattern field of my website and 2,6,7,8 into the permitted throws field, you should end up looking at something like this:

Node number	Pattern
1	[7, 8, 6, 7, 2, 7, 7, 8, 6, 2] [7, 6, 2, 7, 6] vs [8, 7, 7, 8, 2]
2	[6, 8, 6, 7, 8, 2, 7, 8, 6, 2] [6, 6, 8, 7, 6] vs [8, 7, 2, 8, 2]
3	[7, 8, 8, 2, 8, 8, 2, 7, 8, 2] [7, 8, 8, 2, 8] vs [8, 2, 8, 7, 2]
4	[6, 7, 8, 6, 8, 2, 8, 6, 7, 2] [6, 8, 8, 8, 7] vs [7, 6, 2, 6, 2]
5	[7, 2, 7, 8, 6, 7, 2, 8, 6, 7] [7, 7, 6, 2, 6] vs [2, 8, 7, 8, 7]
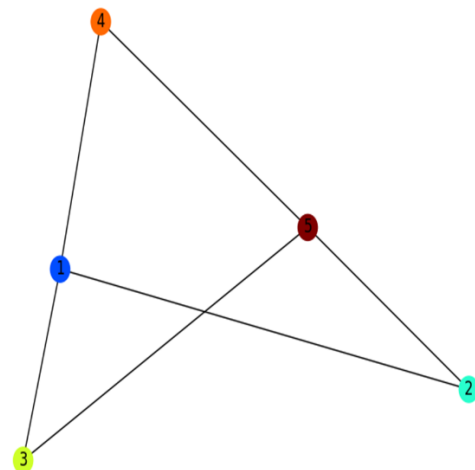
I have named the loop between nodes 1, 2, 4 and 5 "Lisa's Loop". You can see it being juggled in [this video.](#)

Lisa's loop is interesting, locally giving patterns which are almost familiar - for example pass self pass self zip is very nearly why not (pass self pass heff zip). I have resisted the urge to give the new patterns names such as 'not why not' or 'not not why' or 'kind of maybe'. Instead I will refer to them as e.g. 'phphz' to mean pass heff pass heff zip.

3. Thoughts on what makes a hijack and discovering suspicious hijacks.

In trying to formulate a simple definition of a hijack I considered formulating it in terms of what is happening to the global siteswap. My first guess was to have two "operations" which we'll call "add a pass" and "remove a pass". "Add a pass" refers to the active juggler throwing a pass which would collide with the passive juggler's zip, and the passive juggler throwing a different throw instead of the zip (let's say they throw a single pass here). For example, here is 6 club why not, with the passive juggler's zip in bold is:

[7,7,8,6,2,7,7,8,6,**2**]

If the active juggler throws a pass to collide with the zip, this will force the passive juggler to throw a pass instead of the zip. Let's leave the active juggler's throws as question marks for now:

[?,7,?,6,?,7,?,8,?,7]

So the passive juggler is now in funky bookends (pass pass self pass heff).

Let's use 2s, 6s, 7s and 8s to replace the question marks to find out what the active juggler could be doing! This could be done by hand, but with longer periods this quickly becomes tedious, and is exactly the sort of task computers are well suited to. Regardless of how we did it, the possible solutions are:

[7,7,2,6,7,7,7,8,2,7]

[7,7,8,6,7,7,7,8,6,7]

So the active juggler can be doing parsnip (pass pass zip pass zip) or funky bookends.

Now, it may be tempting to rule out the transition from 6 club why not into both jugglers doing funky bookends, because funky bookends is a 7 club pattern. We could simply add some rule to the definition of a hijack about how the number of clubs has to be the same before and after the transition, but why rule out some potentially hilarious transitions?

I present the following video, where me and my Brother perform a series of hijacks between patterns with different numbers of clubs. We do this by putting clubs between our legs to reduce the number of clubs being juggled and take them out again to increase the number of clubs being juggled. My generator cannot currently find these types of transitions. I note that it appears to take a beat of time to put the club under the leg, but not to take it out. I have no immediate plans to adapt the generator to find hijacks where the number of clubs being juggled changes.

Overall, I like Aidan's original definition, and propose the following minor change:

"There are some simple rules for working out possible hijacks in period five patterns.

1. *You can throw a club to a hand that is expecting to receive a zip. Let's call this the hijack club*
2. *If someone throws a hijack club to you, then you have a club that you wanted to zip but now can't. You should agree in advance what the passive juggler will do with this 'problem' club.*
3. *If there is a club 'missing' from you pattern, you should zip to avoid a gap.*

Also you may need to add transition throws.

Use these rules to work out some hijacks on paper and then try to apply them in practice"
Aidan Burns, in *The New Highgate Collection.*

Ed proposes that in period 3 patterns the 'problem' club should be thrown as a zap, in period 5 patterns as a single, in period 7 patterns as a double and so on.

I personally like the idea of hijacking in some very long period pattern, so I think throwing the 'problem' club as a single, regardless of the period or the pattern, is a viable alternative.