Passing Siteswap

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1 Introduction

There are a couple of variations of siteswap notation for passing. For example, Buhler–Graham–Wright introduced a notion of juggling poset. Any passing siteswap can be represented by using a juggling poset, but it is not so handy. On the other hand, we are familiar with the usual siteswap, i.e., siteswap for two hands. Why not interpret the usual siteswap as a siteswap for passing? In this note, we propose several ways of interpretation from the usual siteswap to the passing siteswap. We can not obtain all passing patterns in this way, but we can still find infinitely many new, interesting passing siteswaps. One of the good points of our method is the simplicity of the notation. For example, 7 club 3-count is "966," Jim's 3-count is "7746666," or Flurry is "726" in our notation.

2 Basic idea

Remember how 77722 goes in the usual siteswap. We associate the right hand and the left hand alternately to the sequence in the following:

```
7 7 7 2 2 7 7 7 2 2 ...
R L R L R L R L R L ...
```

Now two jugglers, say Hide and Tomoko, juggle this sequence as a passing pattern. So they associate H and T instead of R and L.

```
7 7 7 2 2 7 7 7 2 2 ...
H T H T H T H T H T ...
```

But both Hide and Tomoko have two hands, they actually juggle as follows:

```
number    : 7 7 7 2 2 7 7 7 2 2 ...
Hide/Tomoko: H T H T H T H T H T ...
hand      : R R L L R R L L R R ...
club      : 1 2 3 4 5 4 5 1 2 3 ...
```

Then this is a 5 club passing pattern, and it looks like 7 club 1-count with some hand acrosses. Hide's sequence is 77272 and Tomoko's sequence is 72772. Looking at the sequence more carefully, we find that Hide's 7 is straight pass, while Tomoko's 7 is cross pass. (We assume that they are passing in the face to face position.) In

1

the usual siteswap 2 means holding a prop, but in our case 2 means the (self) hand across.

Next, imagine Hide and Tomoko is doing 77722 in the above sense. If we identify Hide's right and left hands with a big Right hand, and identify Tomoko's right and left hands with a big Left hand, then we get a picture of the usual 77722 siteswap by this imaginary big juggler — let's call him Ninja. This is the basic idea of how to connect the usual siteswap and our passing siteswap.

3   Asynchronous patterns

Ninja's asynchronous siteswap such as 77722 is interpreted an asynchronous passing siteswap for Hide and Tomoko. The rule of the interpretation is the following:

```
(rule)  Ninja  : R  L  R  L
        H & T : HR TR HL TL
```

Hide starts first with his right hand, and then Tomoko's right hand follows. Hide takes Ninja's right hand, and Tomoko takes Ninja's left hand. This implies that even numbers are self, and odd numbers are pass. As for even numbers, multiple of 4 (0,4,8,...) is straight self, and even but not multiple of 4 (2,6,10,...) is cross self. More practically,

```
number: self throw
     0 : empty hand
     2 : hand across
     4 : holding a club or flourish
     6 : cross single spin
     8 : straight double spin
    10 : cross triple spin
```

Odd numbers are a little bit tricky. The same number for Hide and for Tomoko means different type of pass.

```
number: Hide's pass : Tomoko's pass : spin
     5 : cross       : straight      : half? (fast)
     7 : straight    : cross         : single (slow)
     9 : cross       : straight      : double
    11 : straight    : cross         : triple
```

Let us see an example. 7777266 is a 6 club passing pattern known as Mild Madness.

```
      number : 7 7 7 7 2 6 6 7 7 7 7 2 6 6 7 7 7 7 2 6 6
 Hide/Tomoko : H T H T H T H T H T H T H T H T H T H T H
        hand : R R L L R R L L R R L L R R L L R R L L R
  pass / self : p p p p s s s p p p p s s s p p p p s s s
cross/straight: s c s c c c c c s c s c c c c c s c s c c c c
        club : 1 2 3 4 5 6 5 1 2 3 4 6 5 6 1 2 3 4 5 6 5
```

Hide's sequence is 7726776, that is pass, pass, hand across, self, pass, pass, self, and all passes are straight. Tomoko's sequence is 7767726, that is pass, pass, self, pass, pass, hand across, self, and all passes are cross.

4 Synchronized patterns

Ninja's synchronized siteswap is translated into a synchronized passing siteswap for Hide and Tomoko. Synchronized passing means that at each time two hands (not necessarily two hands of one juggler) are position of throwing clubs. There are three different translations — HT, RR, RL.

4.1 Type HT

Hide and Tomoko take Ninja's sequence alternately. The rule is as follows.

```
(rule)  Ninja : (R, L)  (R, L)
        H & T : (HR,HL) (TL,TR)
```

Ninja's right corresponds to Hide's right and Tomoko's left. Ninja's left corresponds to Hide's left and Tomoko's right. A multiple of 4 (0,4,8,...) is self, and pass is otherwise (2,6,10...). A number with "x" is cross, and a number without "x" is straight.

```
2, 6, 10,...  : straight pass
2x,6x,10x,... : cross pass
0, 4, 8,...   : straight self
4x,8x,12x...  : cross self
```

For example, (6,6) is the 6 club synchronized 1-count. Let us see another example. (6,4)(6x,4)(4,6)(4,6x) is a 5 club pattern. If you do 4 as a single straight self, this pattern looks like 5 club 1-count with extra single selves.

```
number : (6,4)(6x,4)(4,6)(4,6x)(6,4)(6x,4)(4,6)(4,6x)
H / T  :  H H  T  T  H H  T T   H H  T  T  H H  T T
R / L  :  R L  L  R  R L  L R   R L  L  R  R L  L R
p / s  :  p s  p  s  s p  s p   p s  p  s  s p  s p
c / s  :  s s  c  s  s s  s c   s s  c  s  s s  s c
 club  :  1 2  3  4  5 2  1 4   5 3  1  2  4 3  5 2
```

Hide's sequence is (6,4)(4,6), that is (straight pass, straight self) (straight self, straight pass). Tomoko's sequence is (4,6x)(6x,4) if we write numbers in (right, left) order and this is (straight self, cross pass)(cross pass, straight self).

4.2 Type RR

Hide's right and Tomoko's right are synchronized, and so both their left hands as well. The rule is as follows.

```
(rule)  Ninja : (R, L)  (R, L)
        H & T : (HR,TR) (HL,TL)
```

Hide takes Ninja's right and Tomoko takes Ninja's left. A number with "x" is pass, and a number without "x" is self. For self, a multiple of 4 is straight. For pass, a multiple of 4 is cross.

```
   2, 6, 10,...  : cross self
   2x,6x,10x,... : straight pass
   0, 4, 8,...   : straight self
   4x,8x,12x...  : cross pass
```

For example, (6x,6x) is the 6 club asynchronous 1-count, (6x,6x)(6,6) is the 6 club 2-count. Let us see another 6 club passing pattern (8x,6)(6,8)(2,6x). This is a neat variation of 3-count passing.

```
number : (8x,6)(6,8)(2,6x)(8x,6)(6,8)(2,6x)(8x,6)(6,8)(2,6x)
H / T  :  H  T  H T  H T   H  T  H T  H T   H  T  H T  H T
R / L  :  R  R  L L  R R    L  L  R R  L L   R  R  L L  R R
p / s  :  p  s  s s  s p    p  s  s s  s p   p  s  s s  s p
c / s  :  c  c  c s  c s    c  c  c s  c s   c  c  c s  c s
 club  :  1  2  3 4  5 6    5  2  3 1  6 4   6  2  3 5  4 1
```

Hide's sequence is 8x,6,2 that is pass, self, self (all cross). Tomoko's sequence is 6,8,6x that is self, self, pass (cross, straight, straight).

4.3   Type RL

Hide's right and Tomoko's left are synchronized. The rule is as follows.

```
(rule)  Ninja  : (R, L)  (R, L)
        H & T : (TL,HR) (TR,HL)
```

Hide takes Ninja's left and Tomoko takes Ninja's right. A number with "x" is pass, and a number without "x" is self. A multiple of 4 is straight for both pass and self.

```
   2, 6, 10,...  : cross self
   2x,6x,10x,... : cross pass
   0, 4, 8,...   : straight self
   4x,8x,12x...  : straight pass
```

For example, (8x,6)(6,8x) is the 7 club 2-count, (10,6)(6,6)(8x,6)(6,10)(6,6)(6,8x) is the 7 club popcorn.

5   Conversion from async to sync

An asynchronous pattern can be transformed to a synchronized pattern by shifting one beat on one side of ladder diagram. The rule is the following:

```
(rule)  async sequence ab --> sync sequence (p,q)
        p = a        if a is even
        p = (a-1)x   if a is odd
        q = b        if b is even
        q = (b+1)x   if b is odd
```

For this conversion, we need to divide an asynchronous sequence into two digits segments. For example, 77722 is transformed as follows.

```
   77 72 27 77 22 --> (6x,8x)(6x,2)(2,8x)(6x,8x)(2,2)
```

4

5.1 From async to type RR sync

In this case, the only change is the length of pass. Hide's pass decreases one beat, while Tomoko's pass increases one beat. (No changes for self, no changes for the direction(cross/straight) of pass.)

```
sequence   : 77 72 27 77 22 --> (6x,8x)(6x,2)(2,8x)(6x,8x)(2,2)
Hide/Tomoko: HT HT HT HT HT      H T   H T  H T   H T   H T
hand       : RR LL RR LL RR      R R   L L  R R   L L   R R
```

5.2 From async to type RL sync

In this case, the only change is the length of pass. Hide's pass increases one beat, while Tomoko's pass decreases one beat. (No changes for self, no changes for the direction(cross/straight) of pass.)

```
sequence   : 27 77 22 77 72 --> (2,8x)(6x,8x)(2,2)(6x,8x)(6x,2)
Hide/Tomoko: TH TH TH TH TH      T H   T H   T H  T H   T H
hand       : LR RL LR RL LR      L R   R L   L R  R L   L R
```

For practical convenience for doing RL pattern, Tomoko can start the same sequence as asynchronous pattern after one beat pause.

```
sequence   : -7 77 22 77 72 --> (-,8x)(6x,8x)(2,2)(6x,8x)(6x,2)
Hide/Tomoko: TH TH TH TH TH      T H   T H   T H  T H   T H
hand       : -R RL LR RL LR      - R   R L   L R  R L   L R
```

6 3-count, PPS examples

There are many variations of 3-count and PPS passing patterns for RR, RL type coming from ground state siteswaps.

Notation: Hide takes a sequence from the left part, and Tomoko takes a sequence from the right part.

```
{8x62,86x2} * {68x6,686x,a8x2,ax82}
```

For example, Hide takes 8x62, and Tomoko takes 686x. Then, $(8x,6)(6,8)(2,6x)$ is a 3-count pattern for RR and RL. In the above case, there are $2 * 4 = 8$ different 3-count patterns for RR (and 8 for RL, too). (Remember 2 means hand across, 6 means single, 8 means double, a means triple. Numbers with x means pass, numbers without x means self. For self, 2,6,a are cross, 8 is straight. For RR type, 6x, ax are straight pass, 8x is cross pass. For RL type, 6x, ax are cross pass, 8x is straight pass.)

6.1   6 club

```
3-count
{88x2,ax62,666x} * {88x2,ax62,666x}
{8x82,66x6,a6x2} * {8x82,66x6,a6x2}
{6x62}  * {88x6,886x,ax66,a66x}
{6x82}  * {86x6,8x66}
{8x62,86x2} * {68x6,686x,a8x2,ax82}


PPS
{8x8x2,ax6x2,66x6x}
{6x6x2} * {8x8x6,8x86x,a6x6x,ax6x6}
{6x8x2} * {86x6x,8x66x}
```

6.2   7 club

```
3-count
{6x68,6xa4,668x,6ax4,848x,8ax2} * {886x,88x6,a8x4,ax66,ax84,a66x}
{8xa4,86x8} * {68x6,a46x,a8x2,ax46,ax82}
{6x88,688x,6ax6,8x68,a48x,aax2} * {8x66,8x84,a6x4}
{6xa6,6ax6,a48x,aax2} * {86x6,8x66,8x84,a6x4}
{68xa,8a6x,axa4,88x8,ax68} * {666x,68x4,846x,88x2,ax44,ax62}
{aa6x,ax88,a8x8,axa6} * {66x4,86x2,8x44,8x62}
{8xa6,a6x8,8x88} * {8x46,8x82,a6x2}


PPS
{6x66x,6x8x4} * {88x8x,8ax6x,axax4,ax68x,6x8xa}
{6x6x4} * {a8x8x,aax6x,ax88x,axax6}
{6x6x8,8xax2} * {8x8x6,ax6x6,8x86x,a6x6x}
{6x86x,6x8x6} * {86x8x,8xax4,8x68x,6x6ax}
{6x8x8,6xa6x,axax2,68x8x,6ax6x,ax48x,axax2} * {86x6x,8x66x,8x8x4,ax6x4}
{8x66x} * {axax2}
{8x8x8} * {8x8x2,ax6x2}
{8xa6x,ax6x8} * {8x46x,8x8x2,ax6x2}


1-count
{6x6x6x} * {8x8x8x,8xax6x}
```

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