A Boring Follow-Up Paper to “Which ITG Stepcharts are Turniest?” Titled, “Which ITG Stepcharts are Crossoveriest and/or Footswitchiest?”

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Abstract

In which I deliver on last year’s promise of future work.

Categories and Subject Descriptors D.D.R. [*Exercise and Fitness*]: Arcade Dance Games

Keywords crossovers, footswitches, jacks, sidefoots

1. Introduction

Let’s resume right where I left off in my last paper (Blum 2016), shown in Figure 1. Unlike mainstream conferences, SIGBOVIK doesn’t make me waste space repeating all the background material, and I can just say go read that paper first and get back to me. It’s probably a lot funnier than this one anyway, which is gonna be sort of dry, and really of interest only to other ITG players who already know what’s going on.

The TL;DR is that I made a program which figures out how to foot stepcharts in the least crossovery possible way (short of double-stepping everything), then found which charts ultimately had the most. The algorithm also naturally identifies footswitches and jacks, and sometimes it’s smarter than me in amusing ways. I put all the goodies in a giant spreadsheet at `http://tinyurl.com/crossoveriest`, and the program itself is of course freely available at `https://github.com/bblum/sigbovik/blob/master/itg/code/ITG.hs`.

2. Revisiting Turniness (Flashback Scene)

Recall Table 1 from the last paper, in which I left undefined the facings for LL, DD, UU, and RR, the four footswitches. I show a typical DD/UU footswitch pattern in Figure 2(a), and typical LL/RR switches (henceforth “crossover footswitches”) in Figure 2(b). To step these patterns, the player still alternates feet as usual, but must lift one foot off the repeated arrow before stepping it with her other foot. Chart authors will often, but not always, include a “mine cue” (shown in the figure) to hint that the second foot should switch onto the same arrow.

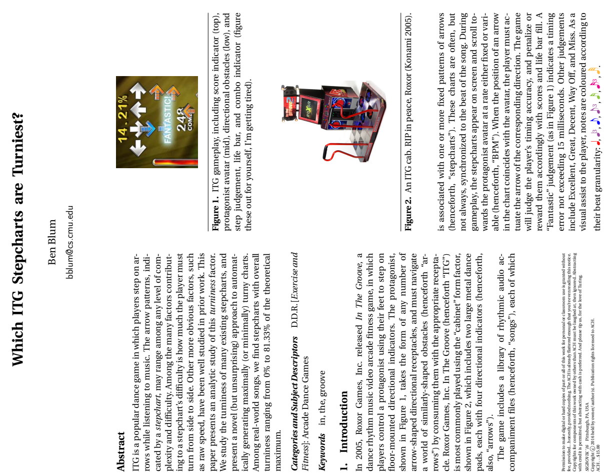
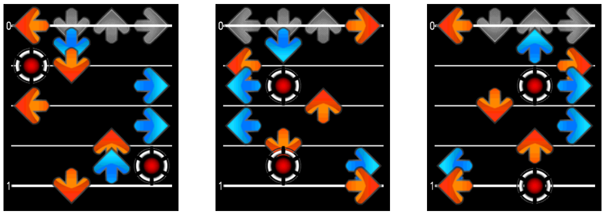


Figure 1. (okay twist your head to read this)

		Right foot ←	Right foot ↓	Right foot ↑	Right foot →
Left foot	←	**?**	UR	UL	U
Left foot	↓	DL	**?**	L	UL
Left foot	↑	DR	R	**?**	UR
Left foot	→	D	DR	DL	**?**

Table 1. Facing directions.



(a) DD, UU (b) LL, RR (c) RR, LL

Figure 2. Footswitches of various crossoveriness/facing.

It is tempting to assign the facings L, U, U, and R respectively to the LL, DD, UU, and RR footswitches. However, Figure 2(c) shows that if a footswitch begins with a crossover on U, the facing should be reversed: the RR footing should face L, and LL should face R. "Spin-switches" with D facing are also theoretically possible, arising from patterns such as $LURDDL$ or $LDRUUL$, or similarly, "270-switches", as shown in Figure 4(a).

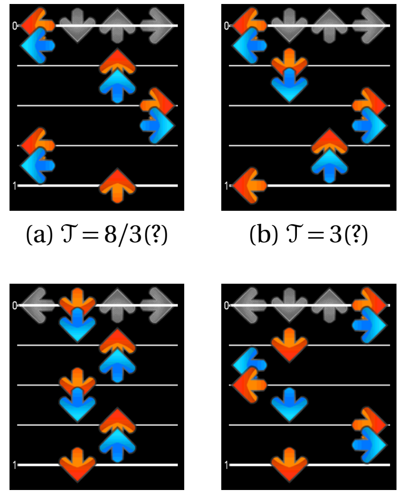
Before I realized that, I modified the turniness algorithm (Blum 2016) to face footswitches as above, and it surprised me with charts of $\mathcal{T} > 2$, in excess of the theoretical maximum! I show one such chart in Figure 3(a), in which the step from LL ($\phi = L$) to UL ($\phi = DR$) has individual $\mathcal{T} = 3$, and so on for $UL \rightsquigarrow_R UU \rightsquigarrow_L RU \rightsquigarrow_R RR$. The steps $RR \rightsquigarrow_L LR \rightsquigarrow_R LL$ are both candles ($\mathcal{T} = 2$), resulting overall in $\mathcal{T} = 8/3$ for the whole chart.

Indeed, when I further modified the algorithm to force DD switches to face D (i.e., always facing the direction of the repeated arrow), it produced the chart shown in Figure 3(b), with overall $\mathcal{T} = 3$. (Note its resemblance to the basic spin pattern, $LDRU$, whose $\mathcal{T} = 2$.)

To fairly represent a human player's desire to step in the least turny of ambiguous ways, I extended the algorithm to provide either the assigned facing, from above, or its polar opposite, chosen at runtime by whichever is closer to the presequent facing. This restores the maximum overall chart turniness to $\mathcal{T} = 2$, a new example of which is shown in Figure 3(c). Figure 4(b) also shows a real-world chart exhibiting this pattern.

However, note that individual steps may still have $\mathcal{T} = 3$, as shown in Figure 3(d). In this example, the step $DL \rightsquigarrow_L LL$ assigns LL to face L, but the subsequent step to LD cannot avoid facing UR. The reason charts still cannot exceed overall $\mathcal{T} = 2$ is that setting up such a situation requires a $\mathcal{T} = 1$ step, which negates the benefit. A chart could conceivably end right before such a step, sneaking through some small ϵ extra turniness (VII 2014) (similar to the case of 270s in (Blum 2016)), but *sustained* average $\mathcal{T} > 2$ remains impossible.

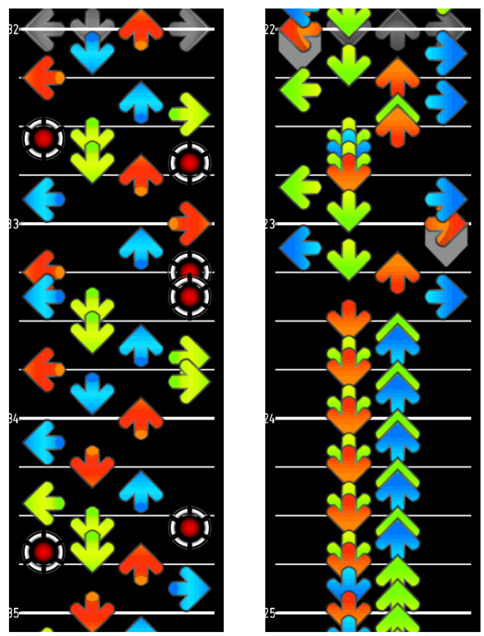
Another approach could assign such a footswitch the opposite footing of the previous facing, regardless of the arrow itself; so in this case the LL would face UL, and each step would have exactly $\mathcal{T} = 2$.



(a) $\mathcal{T} = 8/3(?)$ (b) $\mathcal{T} = 3(?)$

(c) $\mathcal{T} = 2$. (d) $\mathcal{T} = 2 + \epsilon$.

Figure 3. The turniest footswitch patterns. (a) and (b) are false positives (see prose), while (c) and (d) provide theoretically maximal turniness.



(a) Web33,260.8 (12, Rikame 5) (b) Fuego (12, Best of Gazebo)

Figure 4. Real-world examples of turny footswitches.

3. Analyzing Crossoveriness

The major flaw of the turniness algorithm (Blum 2016) was that it didn't care whether a stream started with the left or right foot; it simply exploited the symmetry of Table 1 to find turniness regardless of footing. Hence, it could not distinguish technical footing patterns which

```haskell
data Step = L | D | U | R | Jump deriving Eq

data AnalysisState = S { steps :: Int, xovers :: Int, switches :: Int, jacks :: Int,
                         lastStep :: Maybe Step, doubleStep :: Bool, lastFlip :: Bool,
                         lastFoot :: Bool, stepsLR :: [Bool] }

commitStream :: AnalysisState -> AnalysisState
commitStream s = s { xovers   = xovers   s + if f then ns - nx else nx,
                     switches = switches s + fromEnum (f == lastFlip s && doubleStep s),
                     jacks    = jacks    s + fromEnum (f /= lastFlip s && doubleStep s),
                     lastFlip = f, stepsLR = [] }
    where ns = length $ stepsLR s
          nx = length $ filter not $ stepsLR s
          -- reverse the stream's footing if more L/R steps were crossed over than not.
          f = nx * 2 > ns || nx * 2 == ns && ((switches s > jacks s) == lastFlip s)

analyzeStep :: AnalysisState -> Step -> AnalysisState
analyzeStep s step
    | step == Jump = (commitStream s) { lastStep = Nothing, doubleStep = False }
    | lastStep s == Just step = stream (commitStream s) { doubleStep = True }
    | otherwise = stream s
    where foot = not $ lastFoot s
          -- record whether we stepped on a matching or crossed-over L/R arrow.
          addStep ft L steps = steps ++ [ft]
          addStep ft R steps = steps ++ [not ft]
          addStep ft _ steps = steps -- U/D don't help to determine L/R footing.
          stream s = s { steps = steps s + 1, lastStep = Just step, lastFoot = foot,
                         stepsLR = addStep foot step $ stepsLR s }

analyze :: [Step] -> AnalysisState
analyze = commitStream . foldl analyzeStep (S 0 0 0 0 Nothing False False False [])
```

Figure 5. Pseudocode description of the crossoveriness and footswitchiness algorithm.

could affect the way a human would play the chart. It often played charts inhumanly, facing backwards and/or stepping 270s for most of a song.

So, my contribution this year is an algorithm which plays more naturally, and which consequently can report on a chart's technical patterns beyond simple turniness. The algorithm realizes three principles of ITG:

1. Alternate feet as much as possible.
2. Step crossed-over as little as possible.
3. Jumps or jacks allow the player to reset her footing.

Figure 5 describes the algorithm in pseudocode. To summarize it in prose:

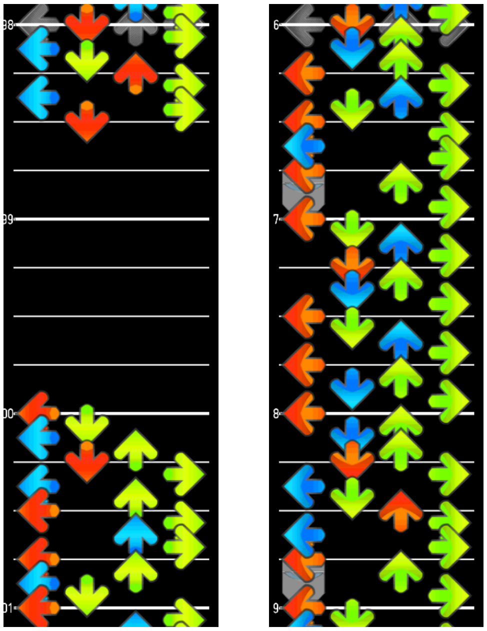
- Split the chart into several units of stream, the boundaries of which occur at every jump and any time an arrow is repeated.
- Step each stream with alternating feet.
- Compare the number of matching steps (i.e., L foot on L arrow or R on R) versus crossover steps. If the latter is greater, re-step the stream with opposite feet from before (this kills the crossovers).
- After flipping each stream, if necessary, count the total crossovers in the whole chart.

4. Analyzing Footswitchiness

Because we split the chart whenever an arrow is repeated, figuring out whether that arrow is stepped with different feet on either side of the stream boundary is a natural consequence of figuring out how to step each stream individually. This is also shown in Figure 5's pseudocode. To summarize in prose, if neither stream needed to be flipped (or if both did), then the alternating feet assumption holds, and the repeat must be a footswitch.

5. Analyzing Jackiness

A jack occurs when a repeat arrow is stepped with the same foot, rather than alternating (hence the name, from "jackhammer"). You've got the idea by now, right?



(a) Paradise Lost (16, Cirque du Lykan) (b) Heartbeat (13, TranceNation)

Figure 6. The doublesteps in some streamy charts must be identified, and the stream split, lest "too much" of the following stream appear completely crossed-over.

Algorithm 1: HeuristicallyDoublestep($\mathcal{S}$)

Input : $\mathcal{S}$, a step sequence $s_0 \dots s_n$
Invariant: $\forall s_i, s_j \in \mathcal{S}, j = i+1 \rightarrow \neg\text{StreamBoundary}(s_i, s_j)$
Input : $n_{\mathtt{flip}}$, heuristic minimum length
Input : $\%_{\mathtt{flip}}$, heuristic percentage, initially 100

for $i \in \text{length}(\mathcal{S}) \wedge \neg\text{defined}(i_{\mathcal{DS}})$ **do**
  $\mathcal{S}' \leftarrow \{s_k | s_k \in \text{LRs}(\{s_j | s_j \in \mathcal{S} \wedge j \geq i\}) \wedge k \leq n_{\mathtt{flip}}\}$
  if $|\mathcal{S}'| = n_{\mathtt{flip}} \wedge |\text{Crossovers}(\mathcal{S}')| \geq \%_{\mathtt{flip}} \times |\mathcal{S}'|$ **then**
    $i_{\mathcal{DS}} \leftarrow i$
  end
end
if defined $(i_{\mathcal{DS}})$ **then**
  if $i_{\mathcal{DS}} = 0$ **then**
    $i_{\mathcal{DS}} \leftarrow \text{FindUnflippedSection}(\{s_i | s_i \in \mathcal{S} \wedge i \neq 0\})$
  end
  HeuristicallyDoublestep($\{s_i | s_i \in \mathcal{S} \wedge i < i_{\mathcal{DS}}\}$)
  HeuristicallyDoublestep($\{s_i | s_i \in \mathcal{S} \wedge i \geq i_{\mathcal{DS}}\}$)
else
  CommitStream($\mathcal{S}$)
end

6. Forced Doublesteps

After painstakingly translating the pseudocode from Figure 5 into a real implementation, I found it vulnerable to false positives when a single double-step could force a long section of stream to be stepped backwards. As an extreme example, consider the pattern $LRLRLRLR$—D—$LRLRLRLR$. Because no jumps or jacks allow the footing to be reset, either the first or last 4 pairs of LRs must be stepped crossed-over.

Figure 6 shows two examples from real-world charts: in (a), the player must not alternate feet across the measure break, while in (b), two L arrows are replaced with rolls for an artistic visual accent, which must be stepped twice each. On inspection, these charts should be stepped with no crossovers, but were evaluated otherwise (730 XOs (27.9%) and 173 XOs (9.6%), respectively).

To handle such cases, I extended the algorithm with a heuristic to identify when a stream becomes "too crossed-over" for "too long", and to force a doublestep by splitting the stream to flip it back. Algorithm 1 shows the implementation. I will not summarize how it works due to space limitations, but the description should be intuitive enough. The heuristic evaluated Figure 6's charts as having 0 crossovers each and 1 and 21 doublesteps, respectively. In my analysis next section, I will use $n_{\mathtt{flip}} = 9$ (determined by inspection of a few favourite charts, which should be scientifically rigorous enough for anyone).

7. Evaluation

Our experimental corpus has grown considerably since last year, and now comprises 11,666 stepcharts. I ran the crossoveriness/etcetera algorithm on all of them, and counted the total steps (not including jumps), crossovers, footswitches, jacks, forced doublesteps, and crossover switches for each. I also grouped the charts by author and by song pack to calculate each author's/pack's overall crossoveriness/etc. You can view the entire dataset at `http://tinyurl.com/crossoveriest`.

Tables 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 summarize the dataset as "leaderboards" for each category. They present the data the same way as last year (Blum 2016), so I won't explain it again. Suffice to say that ITG enthusiasts should use their personal chart style preferences to navigate these tables and find song or pack recommendations or feel proud of themselves or whatever.

In the by-author analysis, I excluded authors with fewer than 10 charts, like last time. Also, in by-author and by-pack, I excluded 1-, 2-, and 3-foot charts, on the pretense that they often ignore the alternating feet assumption (though I also admit this biases the analysis against DDR/Konami). Nevertheless, DDR charts generally ruled the single-digits, even in footswitchiness, showing perhaps more technical depth than I gave them credit for.

By the way, the theoretical maxima for XO%, FS%, and JK% are 50-ϵ, 100-ϵ, and 100-ϵ, respectively (VII 2014).

Ft.	Name	Pack	#XO
6	Autoload	ITG 3	54
7	Tetris	CuoReNeRo M'PacK	58
8	Pulse	CuoReNeRo M'PacK	94
9	MAX Forever	CuoReNeRo M'PacK	107
10	J-PARA SUPER MEGAMIX	CuoReNeRo M'PacK	141
11	Somebody I Used To Know	Best of Gazebo	114
12	Credens Justitiam	Stuff B Likes	136
13	Banshee Strikes	VocaJawnz	152
14	Slow Down	Sexuality Violation 2	160
15	yoshikawa45 vs siesta45	Rikame's Simfiles 4	111
16	Your Best Nightmare	Undertale	97
	no 17s-19s with ≥50 XOs		
20	Rainbow Dimension	Rikame's Simfiles 2	84
21	Teenage Dream	Sexuality Violation 2	280

Table 2. Charts with the most total crossovers (XOs).

Ft.	Name	Pack	XO%
4	DAM DIRIRAM	DDR 3rdMIX	27.3
5	STRICTLY BUSINESS	DDR 1st	21.4
6	STRICTLY BUSINESS	DDR 1st	20.9
7	MOBO⋆MOGA	DDR EXTREME	17.3
8	PARANOiA	DDR 1st	19.6
9	Dazzlin Darlin	r21twins	22.0
10	Enchanted Journey	ITG Rebirth	19.3
11	Lune Noir	r21freak Friendship	13.4
12	W'peg is Fucking Over	best of r21freak ii	14.3
13	The Sampling Paradise	The Paradise Sampler	15.6
14	Slow Down	Sexuality Violation 2	13.3
15	yoshikawa45 vs siesta45	Rikame's Simfiles 4	10.8
	no 16s-19s with ≥10% XO		
20	Rainbow Dimension	Rikame's Simfiles 2	10.7
21	Teenage Dream	Sexuality Violation 2	11.8

Table 3. Charts with the highest percentage of XOs among total steps.

8. Discussion

To verify the algorithm's accuracy, I manually inspected a random (read: not random) sample of the charts at or near the top of the various leaderboards (read: I played a lot of Stepmania). I also consulted a leading expert in the field of automated ITG chart analysis (read: myself), who reported that the algorithm is infinitely more accurate than the prior state-of-the-art.

Honestly though, it works really well. Last year's algorithm was often finicky and prone to all sorts of false-positives, while this one plays ITG in a recognizably human way (almost) without fail. It was a joy to use.

Surprises. On occasion, the algorithm surprised me by stepping with crossover footswitches which, at first glance, I would probably jack or double-step. However, these always proved to be perfectly valid alternative footings, in some cases requiring considerable look-ahead.

Ft.	Name	Pack	#FS
6	Sweat Shop	ITG Rebirth 2 Beta	56
7	Silent Hill	DDR 3rdMIX	29
8	Pulse	CuoReNeRo M'PacK	41
9	Dr. Boom-Bombay	fort rapids vii	34
10	Eat 'Em Up!	Mute Sims 5	54
11	Nemeton	The Legend of Zim 4	97
12	Nemeton	Subluminal	140
13	Love Is Eternity	Subluminal	140
14	Switch	Getty	347
15	Danse Macabre	Aoreo's Ariginals	201
16	Weird Science	Stamina Showcase	61
17	Arcane Apparatus	Tachyon Gamma	32
18	Metallic-A-	Oh Henry! Mad Stamina	27
19	Geronimo	Sexuality Violation 3	39
20	Scatman's World	Jimmy Jawns 2	22
21	He He He	Jimmy Jawns 2	4
22	Architecture	SPEEEDCOOOORE 4	24
23	Geronimo	Sexuality Violation 3	39

Table 4. Charts with the most total footswitches (FSs).

Ft.	Name	Pack	FS%
3	Sweat Shop	ITG Rebirth 2 Beta	15.3
4	DROP THE BOMB	DDR 3rdMIX	9.8
5	MAKE IT BETTER	DDR 2ndMIX	20.0
6	Sweat Shop	ITG Rebirth 2 Beta	18.2
7	5.1.1	DDR MAX	12.9
8	La Señorita Virtual	DDR 3rdMIX	8.4
9	PARANOiA KCET	DDR 2ndMIX	10.2
10	Delhi Ill	Mute Sims 6	11.6
11	Sweat Shop	ITG Rebirth 2 Beta	11.8
12	Nemeton	Subluminal	14.8
13	Love Is Eternity	Subluminal	16.8
14	Switch	Getty	15.7
15	Flames of the Sky	fort rapids vii	16.5
16	Mermaid Island	Tachyon Alpha	9.5
	no 17s+ with ≥5% FS		

Table 5. Charts with the highest percentage of FSs.

Ft.	Name	Pack	#XF
	no 8s- with ≥12 XFs		
9	Dr. Boom-Bombay	fort rapids vii	18
10	Toxic	Sexuality Violation 2	12
11	Heart Shooter	VocaJawnz	44
12	Web 33,260.8	Rikame's Simfiles 5	16
13	Toxic	Sexuality Violation 2	12
14	Fancy Footwork	Cirque du Zeppelin	40
15	yoshikawa45 vs siesta45	Rikame's Simfiles 4	20
	no 15s+ with ≥12 XFs		

Table 6. Charts with the most crossover footswitches (XFs). (Here I chose 12 as the cut-off to exclude a bunch of ambiguously-patterned charts from DDR.)

Author	Charts	Total Steps	XO%
Konami	530	114623	8.03
sssmsm	41	17219	6.55
NEMORIGINAL	44	20165	5.36
M. Emirzian	23	9307	5.16
J. DeGarmo	16	4362	4.86
D. Renzetti	18	7877	4.47
R. McKanna	47	14855	4.23
M. Puls	26	8379	4.18
King of Light	24	8817	4.13
D. Bernardone	217	76290	4.10
D. D'Amato	107	36265	3.92
bblum	32	32382	3.76
	...		
B. Vergara	13	15454	0.091
Aoreo	21	27990	0.089
Zaia	368	448460	0.080
t0ni	85	128964	0.058
Burn	27	60052	0.057
Dirk	12	21996	0.055
Happy Feet	30	57888	0.040
@@	63	199530	0.026
Arvin	79	108612	0.023
Drazu	153	221460	0.021
teejusb	11	11298	0.018
Fraxtil	19	25612	0

Table 7. Chart authors with the highest/lowest XO%.

Author	Charts	Total Steps	FS%
Konami	530	114623	2.29
bblum	32	32382	1.29
M. Puls	26	8379	1.16
R. McKanna	47	14855	1.11
mudkyp	63	42792	1.09
S. Venkat	24	11084	0.96
K. Ward	281	86475	0.89
xRGTMx	19	11734	0.88
sssmsm	41	17219	0.85
D. Bernardone	217	76290	0.83
ATB	31	20673	0.82
Happy Feet	30	57888	0.82
	...		
Hsarus	18	70162	0.070
Drazu	153	221460	0.057
@@	63	199530	0.037
Revolver	11	8302	0.036
T. Swag	13	22909	0.031
Dirk	12	21996	0.023
B. Vergara	13	15454	0.019
warpdr!ve	16	19090	0.016
Burn	27	60052	0.015
teejusb	11	11298	0.009
t0ni	85	128964	0.002
S. Tofu	26	34609	0

Table 8. Chart authors with the highest/lowest FS%.

Author	Charts	Total Steps	JK%
King of Light	24	8817	12.94
R. McKanna	47	14855	9.95
Konami	530	114623	9.63
P. Shanklin	21	9834	8.91
M. Puls	26	8379	8.90
K. Ward	281	86475	8.80
ATB	31	20673	8.46
J. DeGarmo	16	4362	8.30
D. Bernardone	217	76290	7.98
Renard	45	15035	7.94
C. Foy	133	52418	7.72
Yoko	10	4128	7.63
	...		
bblum	32	32382	1.56
B. Vergara	13	15454	1.31
Arvin	79	108612	1.30
Drazu	153	221460	1.06
Zaia	368	448460	0.86
Aoreo	21	27990	0.78
T. Swag	13	22909	0.70
@@	63	199530	0.61
warpdrive	16	19090	0.49
Dirk	12	21996	0.35
Burn	27	60052	0.28
Hsarus	18	70162	0.27

Table 9. Chart authors with the highest/lowest JK%.

Pack	Charts	Total Steps	XO%
DDR 1st Mix to Extreme	530	114623	8.03
r2112	47	18377	4.50
the best of r21freak	100	45156	4.22
the best of r21freak ii	48	25024	4.16
In The Groove 2	222	66113	4.05
In The Groove Rebirth+	108	43758	3.99
r21twins	52	22347	3.89
In The Groove 3	320	106363	3.61
CuoReNeRo MeGaPacK	423	248625	3.45
In The Groove	1408	491819	3.27
r21freak Friendship Pack	47	20363	3.13
BemaniBeats 4	31	18464	3.02
	...		
Tachyon Epsilon	150	208830	0.064
SPEEEDCOOOORE 4	101	123814	0.064
TranceMania	80	121415	0.062
Cirque du Lykan	129	160312	0.059
Cirque du Zonda	45	74890	0.057
Jimmy Jawns	109	170894	0.044
Getty	26	53528	0.043
Tachyon Delta	32	36712	0.038
Tachyon Gamma	32	36134	0.033
Oh Henry! Mad Stamina	46	152326	0.028
Causality Violation	10	19507	0.021
Fast Track to Brutetown	29	46082	0.020

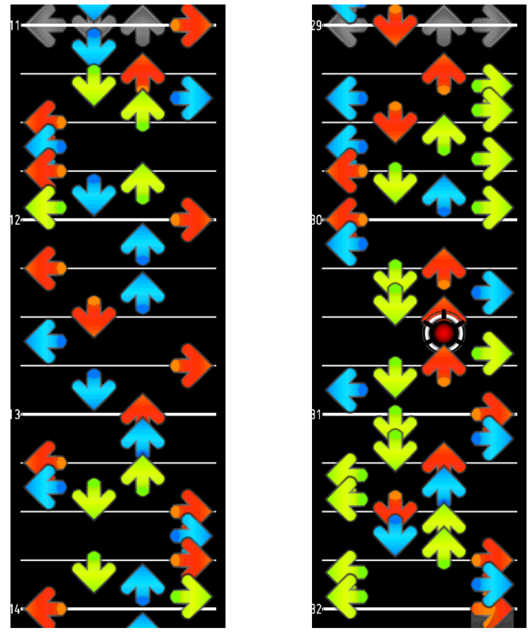
Table 10. Packs with the highest/lowest XO%.

Pack	Charts	Total Steps	FS%
Subluminal	17	13418	4.70
Aoreo's Ariginals 2	16	15222	2.42
DDR 1st Mix to Extreme	530	114623	2.29
Aoreo's Ariginals	31	26418	2.26
rocky mount xi	113	79986	0.97
In The Groove 2	222	66113	0.93
FA and Chill	35	22045	0.86
Getty	26	53528	0.85
Undertale	19	14722	0.84
r2112	47	18377	0.82
Fort Rapids VI	75	75563	0.77
Mute Sims 8	72	47140	0.71
...			
SPEEEDCOOOORE 4	101	123814	0.093
Stamina Showcase	38	126146	0.088
VocaJawnz II	128	183153	0.084
Cirque du Zeppelin	109	102991	0.082
SPEEEDCOOOORE 3	66	69236	0.071
Causality Violation	10	19507	0.051
TranceNation	41	123940	0.047
Oh Henry! Mad Stamina	46	152326	0.046
Tachyon Epsilon	150	208830	0.040
Noisiastreamz	20	41917	0.019
TranceMania 2	40	64109	0.003
TranceMania	80	121415	0.001

Table 11. Packs with the highest/lowest FS%.

Pack	Charts	Total Steps	JK%
DDR 1st Mix to Extreme	530	114623	9.63
r2112	47	18377	8.80
In The Groove 2	222	66113	8.64
Gensokyo Holiday	87	51652	7.87
r21Freak's Friendship Pack 2	32	15649	7.71
Omnifarious	10	5594	7.53
r21twins	52	22347	7.18
Piece of Cake 7	20	11554	6.97
In The Groove	1408	491819	6.97
In The Groove Rebirth+	108	43758	6.97
TLOES Chapter 1	85	42201	6.89
ITG Rebirth 2 Beta	262	99078	6.79
...			
TranceMania 2	40	64109	1.03
Causality Violation	10	19507	0.98
VocaJawnz II	128	183153	0.98
Tachyon Epsilon	150	208830	0.94
Tachyon Delta	32	36712	0.87
Cirque du Lykan	129	160312	0.87
Cirque du Veyron	31	51545	0.79
Cirque du Zeppelin	109	102991	0.77
Oh Henry! Mad Stamina	46	152326	0.67
Stamina Showcase	38	126146	0.56
Cirque du Zonda	45	74890	0.47
TranceNation	41	123940	0.25

Table 12. Packs with the highest/lowest JK%.



(a) Dr. Boom-Bombay (9, fort rapids vii)

(b) Toxic (10/13, Sex'y Violation 2)

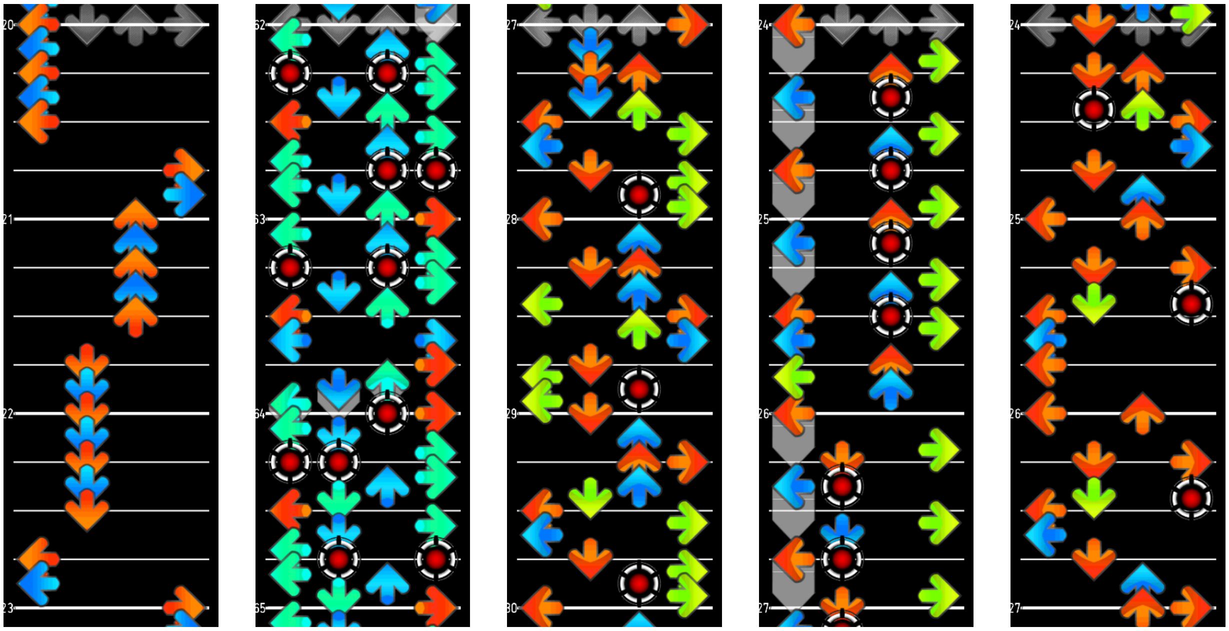
Figure 7. Sometimes the algorithm was smarter than me.

In Figure 7(a), the chart repeats *L* (later *R*) thrice, beginning with the right (later, left) foot. While a human player would jack these repeated arrows, the crossoveriness algorithm performs a double-footswitch, effectively reducing the total crossover steps by 1 each time. In Figure 7(b), a mine cues the player to double-step with her right foot, but the crossoveriness algorithm can begin this section already crossed-over, owing to an earlier *L* jack on which it could switch feet.

Honourable Mentions. I omitted a table for the jackiest charts, on account of most of them being either trivial beginner charts or extra-long megamixes. One deserves a special mention: Sandstorm (Jimmy Jawnz 2), shown in Figure 8(a), has more than twice as many total jacks as the next jackiest chart, clocking in at 1049 (78.5%) with its 15 and 992 (69.6%) with its 17. And looking at that chart, can't you just hear Sandstorm playing in your head already?

I also wanted to highlight the chart with the most crossover switches, shown in Figure 8(b), mostly because the skittle notes should add some nice variety of colour to the paper (with apologies to the dead-tree SIGBOVIK audience reading in greyscale). Figure 8(c), with 2nd place in crossover switches following (b), comes with an edit chart titled "no sidefoots", and to be perfectly honest I just kept saying the word "sidefoots" to myself and giggling a lot while writing this paper.

Sweet spot. Finally, in case it wasn't obvious in the tables, I'll point out that 9-15 is clearly the sweet spot of difficulties for technical stepcharts.



(a) Sandstorm (15/17, J. Jawnz II) (b) Heart Shooter (11, VocaJawnz) (c) '76 (Slow Train) (11, Mute Sims X) (d) Conflict (12, Stephcharts) (e) Matador (11, Valex 8)

Figure 8. Miscellaneous interesting charts I discovered while browsing the giant spreadsheet.

9. Never Work

Let's be honest: this isn't gonna be a paper trilogy. Okay, with that said, here are some things that would be cool to implement in a fantasy universe with infinite free time. (I have renamed this "future" work section accordingly.)

There are a few remaining cases the algorithm doesn't yet understand:

- Doublesteps forced either by mine cues or by holds;
- Crossover and/or bracket jumps, not usually forced but often way less turny than the alternative;
- Forced footings across stream boundaries arising from bracket jumps or jump-footswitches.

For example, Figure 8(d) shows many sequential doublesteps, each forced by a mine cue, but which the algorithm interprets as spins because the flipped stream length falls below $n_{\mathtt{flip}}$. Figure 8(e) shows an example of jump-footswitches which the algorithm fails to count because it ignores the footing of jumps.

These patterns would all have to be identified heuristically. Apart from that being more work than I wanted to do, I also feel that adding too many heuristics to SIGBOVIK research compromises the simple and innocent beauty of an implementation unbound by the demands of mainstream conferences.

10. Conclusion

Please accept my paper. I worked hard on it.

References

B. Blum. Which ITG stepcharts are turniest? SIGBOVIK, 2016.

T. VII. What, if anything, is epsilon? SIGBOVIK, 2014.