

#### Alexander King *(Twitter and Cohost)*

#GDC23 Game Developer's Conference, March 24th 2023



### AGENDA

Games are filled with *numbers* (& why that might be) Numbers have their own distinct aesthetic qualities •We can make deliberate choices about the numbers in our games (and should do so) Some practical examples thereof to use in your own work



1	1/10 2/10 11/25	4s Mars +121,200 0s Moon +15,000 7s Earth +64,560	+ <sup>4</sup> 121,200 <sup>4</sup> 46,000 <sup>4</sup> 30,000 <sup>4</sup> 3.17 M <sup>4</sup> 710,160 <sup>4</sup> 27,914	1/10 Sun	3 Solar	Flares	1	16/25 Temp	2 2/5 erature Fluc INNEF SYSTE	solat SOLAT		02 1102 +102 102 102 102	2		2/10 0 0 0 0 0 0 0 0 0 0 0 0 0	Sea of	Tranquility		1/10 Mars
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<ul> <li>1</li> <li>2</li> <li>3</li> <li>4</li> <li>5</li> <li>6</li> <li>7</li> </ul>	A Rarity Common Common Epic Epic Epic Epic Rare	11s       B       Effect       Speed       Payout       Speed       Payout       Discount       Click	+ <sup>4‡</sup> 2,636 C Notes Change these to match Change these to match Effect all generators Effect all generators Effect all generators	D Rank 0 1 1 1 1 1 0	E Rank 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	F Rank 2 3 4 4 4 4 4 0.8	G / 1.2	H Rank 4 7 7 16 16 16 16 1.6	l Rank 5 14 14 32 32 32 32 2	J Rank 6 30 30 64 64 64 64 3	K Rank 7 68 68 128 128 128 128 128	L Rank 8 160 256 256 256	M Rank 9 396 396 512 512 512 512 9	N Rank 10 1024 1024 1024 1024 1024 1024	O Rank 11 2048 2048 2048 2048 2048 2048 2048	P Rank 12 4096 4096 4096 4096 4096 24	Q Rank 13 8192 8192 7E+07 7E+07 7E+07 7E+07 31	R Rank 14 16384 16384 3E+08 3E+08 3E+08 3E+08 32+08	S Rank 327 327 1E+ 1E+ 1E+
<ul> <li>1</li> <li>2</li> <li>3</li> <li>4</li> <li>5</li> <li>6</li> <li>7</li> <li>8</li> </ul>	A Rarity Common Common Epic Epic Epic Epic Rare Rare	11s       B       Effect       Speed       Payout       Speed       Payout       Discount       Click       Payout	+ # 2,636 C Notes Change these to match Change these to match Effect all generators Effect all generators Effect all generators 1 card per class (moons	D Rank 0 1 1 1 1 1 0 1	E Rank 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	F Rank 2 3 4 4 4 4 4 0.8 8	G / 1.2	H Rank 4 7 16 16 16 1.6 32	l Rank 5 14 14 32 32 32 32 2 64	J Rank 6 30 30 64 64 64 3 3	K Rank 7 68 68 128 128 128 128 4 256	L Rank 8 160 256 256 256 256 6 512	M Rank 9 396 396 512 512 512 512 9 1024	N Rank 10 1024 1024 1024 1024 1024 1024 1024 10	O Rank 11 2048 2048 2048 2048 2048 2048 18 4096	P Rank 12 4096 4096 4096 4096 4096 24 24 8192	Q Rank 13 8192 8192 7E+07 7E+07 7E+07 31 2E+06	R Rank 14 16384 16384 3E+08 3E+08 3E+08 3E+08 39 5E+06	S Rank 327 327 1E+ 1E+ 1E+
<ul> <li>1</li> <li>2</li> <li>3</li> <li>4</li> <li>5</li> <li>6</li> <li>7</li> <li>8</li> <li>9</li> </ul>	A Rarity Common Common Epic Epic Epic Rare Rare Rare Rare	11sBEffectSpeedPayoutDiscountOlickPayoutPayoutPayoutPayoutPayout	+ # 2,636 C Notes Change these to match Change these to match Effect all generators Effect all generators Effect all generators 1 card per class (moons Solar Winds Only	D Rank 0 1 1 1 1 1 0 1 1 1 1 1 1	E Rank 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	F Rank 2 3 3 4 4 4 4 4 0.8 8 8 8	G / 1.2 / 1.	H Rank 4 7 7 16 16 16 16 1.6 32 32	I Rank 5 14 14 32 32 32 32 2 64 64 64	J Rank 6 30 30 64 64 64 64 3 128 128	K Rank 7 68 68 128 128 128 128 128 4 256 256	L Rank 8 160 256 256 256 256 512 512	M Rank 9 396 396 512 512 512 512 9 1024 1024	N Rank 10 1024 1024 1024 1024 1024 1024 1024 2048 2048	O Rank 11 2048 2048 2048 2048 2048 2048 18 4096 4096	P Rank 12 4096 4096 4096 4096 24 8192 8192	Q Rank 13 8192 8192 7E+07 7E+07 7E+07 31 2E+06 1E+09	R Rank 14 16384 16384 3E+08 3E+08 3E+08 3E+08 39 5E+06 6E+09	S Rank 327 327 1E+ 1E+ 1E+ 1E+ 3E+
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<ul> <li>1</li> <li>2</li> <li>3</li> <li>4</li> <li>5</li> <li>6</li> <li>7</li> <li>8</li> <li>9</li> <li>10</li> <li>11</li> <li>12</li> </ul>	A Rarity Common Common Epic Epic Epic Rare Rare Rare	B         Effect         Speed         Payout         Speed         Payout         Discount         Click         Payout - Sol	+ #2,636 C Notes Change these to match Change these to match Effect all generators Effect all generators Effect all generators 1 card per class (moons Solar Winds Only	D Rank 0 1 1 1 1 0 1 1 1 1	E Rank 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	F Rank 2 3 3 4 4 4 4 4 4 4 4 8 8 8 8 8 8 8 8 8 8	G / 125	H Rank 4 7 7 16 16 16 16 1.6 32 32 32	I Rank 5 14 14 32 32 32 32 2 64 64 64 64 3125	J Rank 6 30 64 64 64 3 128 128 128 128	K Rank 7 68 68 128 128 128 4 256 256 256 78125	L Rank 8 160 256 256 256 6 512 512 390625	M Rank 9 396 396 512 512 512 512 9 1024 1024 1024 2E+06	N Rank 10 1024 1024 1024 1024 1024 1024 2048 2048 2048	O Rank 11 2048 2048 2048 2048 2048 18 4096 4096 5E+07	P Rank 12 4096 4096 4096 4096 24 8192 8192 2E+08	Q Rank 13 8192 8192 7E+07 7E+07 7E+07 31 2E+06 1E+09 1E+09	R Rank 14 16384 16384 3E+08 3E+08 3E+08 39 5E+06 6E+09 6E+09	S Rank 327 327 1E+ 1E+ 1E+ 3E+ 3E+







#### **GOOD NUMBERS TO START WITH**

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39			4^x		1 4		9 16	64	256	1 024	4 096	2,107	65,536	262 144	1 048 576	4 194 304	16 777 216	67 108 864	268 435 456	1 073 741 824	4 294 967 296	129,140,163	68 719 476 736	274 877 906 944	, <del>   </del>
40			5^x	_	1 5		25	125	625	3,125	15,625	78,125	390,625	1,953,125	9,765,625	48,828,125	244,140,625	1,220,703,125	6,103,515,625	30,517,578,125	152,587,890,625	762,939,453,125	3,814,697,265,625	19,073,486,328,125	j 9
41			x^2	-	1		4	9	16	25	36	49	64	81	100	121	144	169	196	225	256	289	324	361	
42			x^3	-	1		8	27	64	125	216	343	512	729	1,000	1,331	1,728	2,197	2,744	3,375	4,096	4,913	5,832	6,859	
43			x^4	-	1		16	81	256	625	1,296	2,401	4,096	6,561	10,000	14,641	20,736	28,561	38,416	50,625	65,536	83,521	104,976	130,321	
44 45			C^X	-	1		32	243	1,024	3,125	7,776	16,807	32,768	59,049	100,000	161,051	248,832	371,293	537,824	759,375	1,048,576	1,419,857	1,889,568	2,476,099	
46																									+
47	Constant	a, ar, ar^2	, ar^3, ar	^4	wl 23.13	1 2	26.6 30	.59023	35.1787629	40.45557736	46.52391396	53.50250105	61.52787621	70.75705764	81.37061629	93.57620874	107.61264	123.7545361	142.3177165	163.6653739	188.21518	216.447457	248.9145756	286.2517619	9
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51	Square N	mbers	owers a	re pa	SC	1	5	15	35	) /( ; 25	) 126	210	330	495	/15	1001	1365	1820	2380	3060	3876	4845	5985	/315	1
52	Pentagona	al Number	-	_		1	5	12	22	20	, 50 5 51	70	92	117	145	121	210	247	287	330	376	425	477	532	2
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56	Pronic					2	6	12	20	30	) 42	2 56	72	90	110	132	156	182	2 210	240	272	306	342	380	J

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#### **GOOD NUMBERS TO START WITH**

	Α	В	С	D 4	▶ F	G	Н	I.	J	к
1	Lev	vel Up Rew	vards Table	9						
2										
3		Note: "Chapter	rs" here refers to	o the unit EXP is	s measured in. It's not th	e same as liter	al 'chapters co	mpleted' beca	use you	get bonus chapters for completing volumes (see tab EXP_Chapter
4		Note: Player st	tarts at level 1, v	with FILL unlock	ed.					
5										
6										
7				<b>a</b>						
8			Incremental Chapters	Cumulative Chapters					cor	DE FOR PETER
9		Player Level	(Chapters to Reach Th	I (Total Chapters to Rea	Unlocks Puzzle Mode	Unlock Type	Ink Reward			
10		1	0	0	FILL	Puzzle				all.append(LWPlayerRank(rank: 1, xp: 0, rewardType: .MODE, mo
11		2	2	2	REARRANGE	Puzzle				all.append(LWPlayerRank(rank: 2, xp: 2, rewardType: .MODE, mo
12		3	3	5	SWAP	Puzzle				all.append(LWPlayerRank(rank: 3, xp: 5, rewardType: .MODE, mo
13		4	3	8	SPELLCHECK	Puzzle				all.append(LWPlayerRank(rank: 4, xp: 8, rewardType: .MODE, mo
14		5	4	12		Ink	4,000			all.append(LWPlayerRank(rank: 5, xp: 12, rewardType: .INK, mode
15		6	4	16		Ink	2,000			all.append(LWPlayerRank(rank: 6, xp: 16, rewardType: .INK, mode
16		7	4	20	SEQUENCE	Puzzle				all.append(LWPlayerRank(rank: 7, xp: 20, rewardType: .MODE, m
17		8	4	24		Ink	750			all.append(LWPlayerRank(rank: 8, xp: 24, rewardType: .INK, mode
18		9	4	28	CROSSOUT	Puzzle				all.append(LWPlayerRank(rank: 9, xp: 28, rewardType: .MODE, m
19		10	4	32		Ink	500			all.append(LWPlayerRank(rank: 10, xp: 32, rewardType: .INK, mod
20		11	4	36	FILL TWO	Puzzle				all.append(LWPlayerRank(rank: 11, xp: 36, rewardType: .MODE, r
21		12	6	42		Ink	500			all.append(LWPlayerRank(rank: 12, xp: 42, rewardType: .INK, more

#### rPayoutAmounts)

odeUnlocked: .FILL, inkAmount: 0)) odeUnlocked: .REARRANGE, inkAmount: 0)) odeUnlocked: .WORD\_SWAP, inkAmount: 0)) odeUnlocked: .SPELLCHECK, inkAmount: 0)) eUnlocked: nil, inkAmount: 4000)) eUnlocked: nil, inkAmount: 2000)) odeUnlocked: .SEQUENCE, inkAmount: 0)) eUnlocked: nil, inkAmount: 750)) odeUnlocked: .CROSSOUT, inkAmount: 0)) deUnlocked: nil, inkAmount: 500)) modeUnlocked: .FILL2, inkAmount: 0))

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# ALEXANDER KING



Lossword

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1	# Campaigns	~~~~	$\sim$	~~~~	42	99	-57% 🔻	11	17	-33% 🔻	17	82	-7
8	# Delivered	$\sim$		$\sim$	6,724 K	9,185 K	-27% 🔻	4,796 K	16,516 K	-71% 🔻	7,889 K	3,603 K	+11
9	Open Rate			$\sim$	5.75%	1.57%	+267% 🔺	14.52%	3.35%	+334% 🔺	2.94%	19.06%	-1
0	Click Thru Rate	~~	~~~~~		0.46%	1.25%	-63% 🔻	1.29%	0.35%	+275% 🔺	0.50%	4.60%	-
1	Opt-Out Rate	$\sim$		$\sim$	0.10%	0.23%	-59% 🔻	0.06%	0.06%	+8%	0.01%	0.09%	-1
2	Conversion Rate			$\sum_{i=1}^{n}$	0.06%	0.12%	-45% 🔻	0.08%	0.01%	+454% 🔺	0.06%	0.48%	
3	\$ Gross Sales		$\sim \sim \sim$	$\sim$	\$180 K	\$566 K	-68% 🔻	\$4/3 K	\$519 K	-9%	\$266 K	\$157 K	*1
4	Spend Per Email		~~~~		\$0.03	\$0.06	-57% 🔻	\$0.10	\$0.03	+12%	\$0.03	\$0.04	+20
5	AUS © Not Salar		^~~		\$20.7Z	\$74.05 ¢1.094 K	-23%	\$140.90 ¢204 K	\$131.00	-40%	\$03.75 ¢251 K	\$17.44 ¢247 K	+30
7 7	\$ Gross Profit		$\sim$	$\sim$	\$340 K	\$1,000 K	-62%	\$300 K	\$313 K	+21%	\$531 K	\$207 K	
2	Gross Margin		~	· ·	4.54%	12.40%	+17%	19.38%	9.60%	+102%	15.27%	32.26%	
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7	2013-05-07 wag mise iams eat dog	5/8/2013	Miscellaneous	Wag.com	2 K	69.58%	10.03%	0.00%	4.33%	\$45 K	\$28.94	\$174.97	-\$
8	2013-04-19 Diapers ebm nondiapersbuuer	4/20/2013	Event Based Marketing	Diapers.com	19 K	36.68%	10.46%	0.13%	5.65%	\$15 K	\$18.02	\$54.43	
9	2013-04-07 Diapers ebm	4/7/2013	Event Based	Diapers.com	5 K	44.06%	2.07%	0.19%	12.54%	\$40 K	\$14.20	\$44.52	
0	2013 Diapers ebm	2/2/2013	Event Based	Diapers.com	9 K	50.68%	9.96%	0.25%	6.95%	\$12 K	\$5.45	\$98.67	
	2013-07-02 wag mise natura sub	7/2/2013	Miscellaneous	Wag.com	5 K	3.99%	14.00%	0.03%	3.95%	\$5 K	\$1.39	\$36.36	
12	2012 05 10 ELI Elve Laveral: 04	5/10/2012	Other	Yourser		4 3 9%	0.149/	0.01%	0.00%	FO K	<b>EO OO</b>	\$0.00	
33	2013-05-10 FH Plus Launch 24	5/10/2013	Uther	r oyo.com	I K	6.28%	0.14%	0.01%	0.00%	\$0 K	20.00	\$0.00	
	Campaign_Detail	Data Ca	ampaign_Sum	mary Rece	ivingSite_Sumn	nary Met	ricDefinitions						

Ready 🐻



#### NUMBERS IN GAME DESIGN

#### Games are full of *numbers*



Primal Ancient dary Shoulders

and the second

190

 +210 Physical Resistance
 While channeling Siphon Blood, Whirtwind, Rapid Fire, Strafe, Tempest Rush, Firebats, Arcane Torrent, Disintegrate, or Ray of Frost, you deal 25% increased damage and take 25% reduced damage.

Stat Changes if Equipped:

Toughness

Recovery

Drawing power from the ether is a tricky thing. Even the most dedicated practitioner is not able to effectively contain all of it for their use. This armor redirects that excess energy to serve its wearer.

Required Level: 70



Durability: 44/44

If to move to your Stash.



Are you using Cinderglacier
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Feral Defender activates Same Screets



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The Observation Ring

Layer 1

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#### NUMBERS IN GAME DESIGN

#### Games are full of *numbers*

Longform Rock Paper Shotgunned

#### Arithmophobia

◎ JOEL GOODWIN ③ SEPTEMBER 14, 2016 8 MIN READ Ø 19



Tony Van was the producer in charge of localizing a Japanese RPG called *The Story of Thor: Hikari wo Tsugu Mono* (Ancient, 1994) for Western audiences, but received a badly translated copy of the story

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# NUMBERS ARE ABSTRACT REPRESENTATIONS





# NUNBERSARE ABSIRACE REPRESENTATIONS O E M E A SUR EMENT



#### Numbers Getting Bigger

Incremental games are fascinating and perplexing. Marked by minimal player agency and periods of inactivity, they seem to defy conventional logic about good game design, and yet nonetheless have attracted a substantial player base. In this series, we examine them in more detail, and explore why that is.

#### Posts in this series



#### Numbers Getting Bigger: What Are Incremental Games, and Why Are They Fun?

Incremental games are fascinating and perplexing. Marked by minimal player agency and periods of inactivity, they seem to defy conventional logic about good...



GAME DESIGN



#### Numbers Getting Bigger: The Design and Math of Incremental Games

Incremental games, despite their simple mechanics and limited player interaction, present interesting challenges to a game designer. We'll examine some core...



GAME DESIGN



#### Numbers Getting Even Bigger: The Growing Appeal of Incremental Games

Incremental games are fascinating and perplexing. Marked by minimal player agency and periods of inactivity, they seem to defy conventional logic about good...



GAME DESIGN



#### NUMBERS IN GAME DESIGN

- Games are full of *numbers*But there aren't a lot of best practices of what those numbers should be
- What are "good" numbers to use in games?



### WHAT IS "GOOD"?

- Use-case and genre agnosticAppropriate for the occasion, "feel right"
- Interesting, have some aesthetic qualities to them
- Easy to produce



#### WHAT IS "GOOD"?

# So, here are the good numbers!Grab a pen.

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16 17 18 19 20 21 22 23 24	9,59 66 <u>1</u> 9,59 690 9,59 72 <u>0</u> 9,59 74 <u>9</u> 9,59 778 9,59 80 <u>8</u> 9,59 83 <u>7</u> 9,59 866 9,59 895	0,49 0,49 0,49 0,49 0,49 0,49 0,49 0,49	9,63 345 9,63 379 9,63 414 9,63 449 9,63 484 9,63 519 9,63 553 9,63 588 9,63 623	0,58 0,58 0,58 0,58 0,58 0,58 0,58 0,58	10,36 655 10,36 62 <u>1</u> 10,36 58 <u>6</u> 10,36 55 <u>1</u> 10,36 516 10,36 481 10,36 44 <u>7</u> 10,36 412 10,36 377	9,96 316 9,96 311 9,96 305 9,96 30 <u>0</u> 9,96 294 9,96 28 <u>4</u> 9,96 28 <u>4</u> 9,96 27 <u>3</u>	0,09 0,09 0,09 0,09 0,09 0,09 0,09 0,09	44 43 42 41 40 39 38 37 36	66
16 17 18 19 20 21 22 23	9,59 66 <u>1</u> 9,59 690 9,59 72 <u>0</u> 9,59 74 <u>9</u> 9,59 778 9,59 80 <u>8</u> 9,59 83 <u>7</u> 9,59 866	0,49 0,49 0,49 0,49 0,49 0,49 0,49 0,49	9,63 345 9,63 379 9,63 414 9,63 449 9,63 449 9,63 519 9,63 553 9,63 588	0,58 0,58 0,58 0,58 0,58 0,58 0,58 0,58	10,36 655 10,36 621 10,36 58 <u>6</u> 10,36 55 <u>1</u> 10,36 516 10,36 481 10,36 44 <u>7</u> 10,36 412	9,96 316 9,96 311 9,96 305 9,96 300 9,96 200 9,96 289 9,96 289 9,96 284 9,96 278	0,09 0,09 0,09 0,09 0,09 0,09 0,09 0,09	44 43 42 41 40 39 38 37 26	66
16 17 18 19 20 21 22	9,59 66 <u>1</u> 9,59 690 9,59 72 <u>0</u> 9,59 74 <u>9</u> 9,59 778 9,59 80 <u>8</u> 9,59 83 <u>7</u>	0,49 0,49 0,49 0,49 0,49 0,49 0,49 0,49	9,63 34 <u>5</u> 9,63 379 9,63 414 9,63 449 9,63 48 <u>4</u> 9,63 51 <u>9</u> 9,63 553	0,58 0,58 0,58 0,58 0,58 0,58 0,58 0,58	10,36 655 10,36 62 <u>1</u> 10,36 58 <u>6</u> 10,36 55 <u>1</u> 10,36 516 10,36 481 10,36 44 <u>7</u>	9,96 316 9,96 311 9,96 305 9,96 30 <u>0</u> 9,96 294 9,96 289 9,96 28 <u>4</u>	0,09 0,09 0,09 0,09 0,09 0,09 0,09	44 43 42 41 40 39 38	66
16 17 18 19 20 21	9,59 66 <u>1</u> 9,59 690 9,59 72 <u>0</u> 9,59 74 <u>9</u> 9,59 778 9,59 80 <u>8</u>	0,49 0,49 0,49 0,49 0,49 0,49	9,63 345 9,63 379 9,63 414 9,63 449 9,63 484 9,63 519	0,58 0,58 0,58 0,58 0,58 0,58 0,58	10,36 655 10,36 621 10,36 58 <u>6</u> 10,36 55 <u>1</u> 10,36 516 10,36 481	9,96 316 9,96 311 9,96 305 9,96 300 9,96 294 9,96 289	0,09 0,09 0,09 0,09 0,09 0,09	44 43 42 41 40 39	66
16 17 18 19 20	9,59 66 <u>1</u> 9,59 690 9,59 72 <u>0</u> 9,59 74 <u>9</u> 9,59 778	0,49 0,49 0,49 0,49 0,49	9,63 34 <u>5</u> 9,63 379 9,63 414 9,63 449 9,63 48 <u>4</u>	0,58 0,58 0,58 0,58 0,58 0,58	10,36 655 10,36 62 <u>1</u> 10,36 58 <u>6</u> 10,36 55 <u>1</u> 10,36 516	9,96 316 9,96 31 <u>1</u> 9,96 305 9,96 30 <u>0</u> 9,96 294	0,09 0,09 0,09 0,09 0,09	44 43 42 41 40	66
16 17 18 19	9,59 66 <u>1</u> 9,59 690 9,59 72 <u>0</u> 9,59 74 <u>9</u>	0,49 0,49 0,49 0,49	9,63 34 <u>5</u> 9,63 379 9,63 414 9,63 449	0,58 0,58 0,58 0,58 0,58	10,36 655 10,36 62 <u>1</u> 10,36 58 <u>6</u> 10,36 55 <u>1</u>	9,96 316 9,96 31 <u>1</u> 9,96 305 9,96 30 <u>0</u>	0,09 0,09 0,09 0,09 0,09	44 43 42 41	
16 17 18	9,59 66 <u>1</u> 9,59 690 9,59 72 <u>0</u>	0,49 0,49 0,49 0,49	9,63 34 <u>5</u> 9,63 379 9,63 414	0,58 0,58 0,58 0,58	10,36 655 10,36 62 <u>1</u> 10,36 58 <u>6</u>	9,96 316 9,96 31 <u>1</u> 9,96 305	0,09 0,09 0,09 0,09	44 43 42	
16 17	9,59 66 <u>1</u> 9,59 690	0,49	9,63 34 <u>5</u> 9,63 379	0,58 0,58 0,58	10,36 655 10,36 62 <u>1</u>	9,96 316 9,96 31 <u>1</u>	0,09	44	
16	9,59 661	0,49	9,63 345	0,58	10,36 655	9,96 316	0,09	44	
-				1 50		0,00002	0.00	1.0	1
15	9,59 632	0.40	9,63 310	0,00	10.36 690	9 96 322	0,05	45	
1.3	3,53 602	0,49	9,63 275	0.58	10,36 725	9,96 327	0.00	46	
13	9,59 573	0,49	9,63 240	0,58	10,36 760	9,96 333	0.09	47	
12	9,59 543	0,49	9,63 205	0,58	10,36 795	9,96 338	0,09	48	
11	9,59 514	0,49	9,63 170	0,58	10,36 830	9,96 343	0,09	49	00
10	9,59 484	0.49	9,63 135	0.50	10,36 865	9.96 349	0,09	50	66
	2102 402	0,49	9,63 101	0.58	10,36 899	9,96 354	0,09	51	
9	9.59.455	0,49	9,63 066	0,58	10,36 934	9,96 360	0,09	52	
0	9,59 396	0,49	9,63 031	0,58	10,36 969	9,96 365	0,09	53	
0 7	9,59 366	0,49	9,62 996	0,58	10,37 004	9,96 370	0,09	50	
5	9,59 336	0.49	9,62 961	0,00	10.37 039	9 96 376	0,09		
	0,00001	0,49	9,62,926	0.58	10,37 074	9,96 381	0,09	56	
4	9.59 307	0,50	9,62 890	0,58	10,37 110	9,96 387	0,09	57	
3	9 59 077	0,50	9,62 855	0.59	10,37 145	9,96 392	0,09	59	
2	9 50 047	0,50	9,62 820	0,59	10,37 180	9,96 397	0,09	0	67
1	9,59 188	0,50	9,62 785	0.50	10,37,215	9 95 402	-	-	-
	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14	0         9,59 188           1         9,59 218           2         9,59 218           2         9,59 247           3         9,59 277           4         9,59 307           5         9,59 336           6         9,59 366           7         9,59 396           8         9,59 425           9         9,59 455           10         9,59 484           11         9,59 514           12         9,59 543           13         9,59 573           14         9,59 602	0         9,59 188         0,50           1         9,59 218         0,50           2         9,59 247         0,50           3         9,59 277         0,50           4         9,59 307         0,50           5         9,59 336         0,49           6         9,59 366         0,49           7         9,59 396         0,49           9         9,59 425         0,49           9         9,59 455         0,49           10         9,59 514         0,49           11         9,59 514         0,49           12         9,59 573         0,49           13         9,59 602         0,49           14         9,59 602         0,49	0         9,59 188         0,50         9,62 785           1         9,59 218         0,50         9,62 820           2         9,59 247         0,50         9,62 855           3         9,59 277         0,50         9,62 890           4         9,59 307         0,50         9,62 926           5         9,59 366         0,49         9,62 926           6         9,59 366         0,49         9,62 996           7         9,59 396         0,49         9,63 031           8         9,59 425         0,49         9,63 031           9         9,59 455         0,49         9,63 101           10         9,59 454         0,49         9,63 101           11         9,59 514         0,49         9,63 135           11         9,59 543         0,49         9,63 205           13         9,59 573         0,49         9,63 240           14         9,59 602         0,49         9,63 275	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	O         9,59 188         0,50         9,62 785         0,59         10,37,215           1         9,59 218         0,50         9,62 820         0,59         10,37,215           2         9,59 247         0,50         9,62 855         0,59         10,37 145           3         9,59 277         0,50         9,62 890         0,59         10,37 145           4         9,59 307         0,50         9,62 926         0,58         10,37 074           5         9,59 336         0,49         9,62 996         0,58         10,37 039           6         9,59 366         0,49         9,62 996         0,58         10,37 044           7         9,59 396         0,49         9,63 031         0,58         10,36 934           9         9,59 425         0,49         9,63 031         0,58         10,36 934           9         9,59 455         0,49         9,63 101         0,58         10,36 865           11         9,59 514         0,49         9,63 135         0,58         10,36 865           12         9,59 543         0,49         9,63 205         0,58         10,36 795           13         9,59 573         0,49         9,63 240	09,59 188 9,59 2180,509,62 785 9,62 8200,5910,37 $215$ 9,96 40329,59 247 9,59 2470,509,62 820 9,62 8550,5910,37 145 9,96 3929,96 39739,59 277 9,59 3070,509,62 890 9,62 9260,5810,37 110 9,96 3819,96 382 10,37 11049,59 307 9,59 3060,499,62 926 9,62 9260,5810,37 074 9,96 38159,59 366 9,59 3660,499,62 996 9,62 9960,5810,37 004 9,96 37069,59 366 9,59 3660,499,63 031 9,63 031 9,63 01010,5810,36 969 0,589,96 36599,59 425 9,490,499,63 101 9,63 1010,5810,36 865 9,96 3439,96 360109,59 484 9,59 5140,499,63 135 9,63 2050,5810,36 865 9,96 3439,96 343119,59 514 9,59 5430,499,63 205 9,63 2400,5810,36 795 9,96 3329,96 333 9,96 333139,59 573 9,59 6020,499,63 2750,5810,36 725 9,96 3279,96 327	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $

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-	-				C D I'	log cotg.	log cos. 1	D.1
Gr.	M	log sin.	D.1"	log tang.	G.D.1	10B COVE.		
02	20	0.60.070		9,63 830	0.58	10,36 170	9,96 240	0,09
25	20	0,00,000	0,48	9.63 865	0,00	10,36 135	9,98 234	0,09
	31	9,00 000	0,48	9,63 899	0,00	10,36 101	9,96 229	0.09
	32	9,60 120	0,48	9.63 934	0,58	10,36 066	9,96 223	0.09
	33	9,60 157	0,48	9.63 968	0,57	10,36 032	9,96 218	
	34	9,60 186	0,48	-1	0,57		0.00.010	0,09
	35	9,60 215	0.48	9,64 00 <u>3</u>	0,57	10,35 997	0.96.207	0,09
	36	9,60 244	0.48	9,64 037	0,57	10,35 505	0.06.201	0,09
	37	9,60 273	0.48	9,64 072	0.57	10,35 920	0.00 100	0,09
	38	9,60 302	0.48	9,64 106	0.57	10,35 894	9,90 190	0,09
	39	9,60 331	0.40	9,64 140	0.57	10,35 860	9,90 190	0.09
00	10	0.00.050	0,48	9 64 175	0,57	10.35 825	9,96 185	0,00
25	40	9,60 339	0,48	9 64 209	0,57	10.35 791	9.96 179	0,05
	41	9,60 388	0,48	0 64 043	0,57	10 35 757	9 96 174	0,05
	42	9,60 41/	0,48	0 64 078	0,57	10 35 722	9 96 168	0,09
	43	9,60 446	0,48	9,04 210	0,57	10 35 688	9 96 162	0,09
	44	9,60 414	0.48	9,04 512	0.57	10,00 005	0,00 -02	0,0
	45	9,60 503	0.40	9,64 346	0.57	10,35 654	9,96 157	0.0
	46	9,60 532	0,40	9,64 381	0,57	10,35 619	9,96 151	0.0
	47	9,60 561	0,40	9,64 415	0,57	10,35 585	9,96 146	0,0
	48	9,60 589	0,40	9,64 449	0,57	10,35 551	9,96 140	0.0
	49	9.60 618	0,40	9,64 483	0,57	10,35 517	9,96 135	0,0
92	50	313 03 0	0,48	0 64 517	0,57	10 25 492	0 06 100	0,0
-0	51	9 60 675	0,48	0 64 650	0,57	10,35 405	0.06 103	0,0
	52	9.60 704	0,48	0 64 586	0,57	10,35 414	0.06 110	0,0
	52	9 60 732	0,48	0,04 000	0,57	10,35 414	9,50 110	0,0
	54	9 60 761	0,48	3,04 020	0,57	10,00 000	9,96 112	0,0
		2,00 101	0,48	2103 024	0.57	10,35 340	3,30 101	0.0
	55	9,60 789	0.49	9,64 688	0,07	10,35 312	9,96 101	0,0
	56	9,60 818	0.47	9,64 722	0.57	10,35 278	9,96 095	0,0
	57	9,60 846	0.47	9,64 756	0.57	10,35 244	9,96 090	0,0
	58	9,60 875	0.47	9,64 790	0,57	10,35 210	9.96 084	0,0
	59	9,60 903	0,47	9,64 824	0.57	10,35 176	9,96 079	0,0
24	0	9,60 931	0,47	9,64 858	0,57	10,35 142	9.96 073	0,0
0		log cos.	D.1"	log cotg.	G.D.1"	log tang	log sin	D
-	-	Sector Se	-			1 . 0 . m . 6.	Prop Barry	1

30 66 28 27 26 24 23 22 21 20 66 19 18 17 16 14 13 12 11 10 66 REGNI VALENZA E. MURCIA Cos l'Itole LEARLE FITIURE, Auova Projezione VENEZIA 1775 refio Antomo Zatt Priologio dell'Eccine Si 0 66 M. Gr.

## A "GOOD NUMBERS" TOOLBOX

- What we really want are methods that produce numbers
  Find yourself some good numbers to start with
- My solution is a spreadsheet tab with interesting progressions

_														7.00000000	
														1.860596884	
		1	5	15	35	70	126	210	330	495	715	1001	1365	1820	
		0	1	2	3	4	5	6	7	8	9	10	11	12	
	2^x	1	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	
	3^x	1	3	9	27	81	243	729	2,187	6,561	19,683	59,049	177,147	531,441	1,59
	4^x	1	4	16	64	256	1,024	4,096	16,384	65,536	262,144	1,048,576	4,194,304	16,777,216	67,10
	5^x	1	5	25	125	625	3,125	15,625	78,125	390,625	1,953,125	9,765,625	48,828,125	244,140,625	1,220,70
	x^2	-	1	4	9	16	25	36	49	64	81	100	121	144	
	x^3	-	1	8	27	64	125	216	343	512	729	1,000	1,331	1,728	
	x^4		1	16	81	256	625	1,296	2,401	4,096	6,561	10,000	14,641	20,736	1
	x^5	•	1	32	243	1,024	3,125	7,776	16,807	32,768	59,049	100,000	161,051	248,832	37
ar^	2. ar^3. ar^	4. w	23,131	26.6	30,59023	35 1787629	40.45557736	46 52391396	53 50250105	61.52787621	70,75705764	81.37061629	93,57620874	107.61264	123.7
Am	+ (n-m)d	or for r	1	3	5	7	9	11	13	15	17	19	21	23	
			1	3	6	10	15	21	28	36	45	55	66	78	
ram	nid)		1	4	10	20	35	56	84	120	165	220	286	364	
her	powers an	e pasc	1	5	15	35	70	126	210	330	495	715	1001	1365	

## A "GOOD NUMBERS" TOOLBOX

- What we really want are methods that produce numbers
- Find yourself some good numbers to start with
- My solution is a spreadsheet tab with interesting progressions
- When I need good numbers, I "play" around with them till I find a good set

		-	_												
														7.860596884	
		1	5	15	35	70	126	210	330	495	715	1001	1365	1820	
		0	1	2	3	4	5	6	7	8	9	10	11	12	
:	2^x	1	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	
:	3^x	1	3	9	27	81	243	729	2,187	6,561	19,683	59,049	177,147	531,441	1,5
4	4^x	1	4	16	64	256	1,024	4,096	16,384	65,536	262,144	1,048,576	4,194,304	16,777,216	67,1
	5^x	1	5	25	125	625	3,125	15,625	78,125	390,625	1,953,125	9,765,625	48,828,125	244,140,625	1,220,7
3	x^2	-	1	4	9	16	25	36	49	64	81	100	121	144	
)	x^3	-	1	8	27	64	125	216	343	512	729	1,000	1,331	1,728	
3	x^4		1	16	81	256	625	1,296	2,401	4,096	6,561	10,000	14,641	20,736	
3	x^5		1	32	243	1,024	3,125	7,776	16,807	32,768	59,049	100,000	161,051	248,832	3
ar^2.	ar^3, ar^4,	wl	23.131	26.6	30.59023	35.1787629	40.45557736	46.52391396	53.50250105	61.52787621	70.75705764	81.37061629	93.57620874	107.61264	123.7
Am +	(n-m)d, or	for r	1	3	5	7	9	11	13	15	17	19	21	23	
			1	3	6	10	15	21	28	36	45	55	66	78	
ramid	i)		1	4	10	20	35	56	84	120	165	220	286	364	
her p	owers are p	asc	1	5	15	35	70	126	210	330	495	715	1001	1365	

### **A "GOOD NUMBERS" TOOLBOX**

A 'toolbox' of good numbers let's you reuse what 'feels right'
How to build your own

														7.860596884	
		1	5	15	35	70	126	210	330	495	715	1001	1365	1820	
	01	0	1	2	3	4	5	6	7	8	9	10	11	12	
	2*x	1	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	
	3^x	1	3	9	27	81	243	729	2,187	6,561	19,683	59,049	177,147	531,441	1,58
	4^x	1	4	16	64	256	1,024	4,096	16,384	65,536	262,144	1,048,576	4,194,304	16,777,216	67,10
	5^x	1	5	25	125	625	3,125	15,625	78,125	390,625	1,953,125	9,765,625	48,828,125	244,140,625	1,220,70
	x^2	•	1	4	9	16	25	36	49	64	81	100	121	144	
	x^3	-	1	8	27	64	125	216	343	512	729	1,000	1,331	1,728	
	x^4		1	16	81	256	625	1,296	2,401	4,096	6,561	10,000	14,641	20,736	
	x^5	-	1	32	243	1,024	3,125	7,776	16,807	32,768	59,049	100,000	161,051	248,832	37
ar^2	2, ar^3, ar^4	w	23.131	26.6	30.59023	35.1787629	40.45557736	46.52391396	53.50250105	61.52787621	70.75705764	81.37061629	93.57620874	107.61264	123.7
Am	+ (n-m)d,	or for r	1	3	5	7	9	11	13	15	17	19	21	23	
			1	3	6	10	15	21	28	36	45	55	66	78	
ami	d)		1	4	10	20	35	56	84	120	165	220	286	364	
ner p	oowers are	pasc	1	5	15	35	70	126	210	330	495	715	1001	1365	

#### **INTERESTING SETS**

Why are they interesting
Why are they useful
What is aesthetically pleasing about them.





Never use a complex solution when the most basic will do
Simplest series actually has great proportions















#### 1,2,3,4,5,6?

Never use a complex solution when the most basic will do
Simplest series actually has great proportions
The holy tetractys?
Limitations of 1-6









#### → Friedemann Friese, Creating Structures (2018)

#### → Reiner Knizia, Dice Games Properly Explained (1999)

Linear sets have *constant difference*The distance between each term is the same

x	1	2	3	4	5	6	7	8	9	10
y = 1x + 0	1	2	3	4	5	6	7	8	9	10
# difference		1	1	1	1	1	1	1	1	1
% difference		100%	50%	33%	25%	20%	17%	14%	13%	11%
Cumulative	1	3	6	10	15	21	28	36	45	55
Current / Total	100%	67%	50%	40%	33%	29%	25%	22%	20%	18%
Diff / Total	0%	33%	17%	10%	7%	5%	4%	3%	2%	2%

 $\square$ 

- Linear sets have *constant difference*
- The distance between each term is the same
- Which means the difference is *falling proportionally*

- Fixed distance is regular and easy to understood (maybe too easy)
- Proportional falloff can be good for making something cheaper/easier over time
  Works great for small sets

3,7,11,15 50,100,150,200 10,20,30,40 9,18,27,36

- The distance between each term 2,4,8,16,32,64 g Cube is increasing
- But the proportional increase is the same



x	1	2	3	4	5	6	7	8	9	10
y = 2^x	2	4	8	16	32	64	128	256	512	1,024
# difference		2	4	8	16	32	64	128	256	512
% difference		100%	100%	100%	100%	100%	100%	100%	100%	100%
Cumulative	2	6	14	30	62	126	254	510	1022	2 0 4 6
Current / Total	100%	67%	57%	53%	52%	51%	50%	50%	50%	50%
Diff / Total	0%	33%	29%	27%	26%	25%	25%	25%	25%	25%

 $\square$ 





 $\square$ 

- Being proportionally constant is good for cost treadmills
- Or where the degree of change is more important than the nominal amounts
- Exponential progressions can grow very large very fast though



- Very versatile, splits the difference between linear and exponential
- The difference between terms rises nominally (like an exponential)
- But the proportional difference decreases (like a linear)

x	1	2	3	4	5	6	7	8	9	10
y = x^2	1	4	9	16	25	36	49	64	81	100
# difference		3	5	7	9	11	13	15	17	19
% difference		300%	125%	78%	56%	44%	36%	31%	27%	23%
Cumulative	1	5	14	30	55	91	140	204	285	385
Current / Total	100%	80%	64%	53%	45%	40%	35%	31%	28%	26%
Diff / Total	0%	60%	36%	23%	16%	12%	9%	7%	6%	5%

 $\square$ 

- 
$$f(x)=7500*x$$
 -  $f(x)=x^4$  -  $f(x)=1.6^x$ 



 $\square$ 

- Polynomial curves have a "just right" steepness for lots of uses
  Have them increasing steepness
- that linear sets don't, but don't go to the moon like
  - exponentials
- They're also much easier to fine-tune by changing terms than exponentials

## TRIANGULAR NUMBERS

- Actually a polynomial
- But, much easier to calculate and makes intuitive sense
- Easy enough to mentally calculate
- The difference between terms is itself just the basic linear series
- So the distance to the next term is always 1 plus whatever the difference to the last one was

#### 1,3,6,10,15,21

#### **TRIANGULAR NUMBERS**

x	1	2	3	4	5	6	7	8	9	10
f(x)=C(x+1,2)	1	3	6	10	15	21	28	36	45	55
# difference		2	3	4	5	6	7	8	9	10
% difference		200%	100%	67%	50%	40%	33%	29%	25%	22%
Cumulative	1	4	10	20	35	56	84	120	165	220
Current / Total	100%	75%	60%	50%	43%	38%	33%	30%	27%	25%
Diff / Total	0%	50%	30%	20%	14%	11%	8%	7%	5%	5%

 $\square$ 

#### **TRIANGULAR NUMBERS**



## OTERNIERESINGSES

- Figurate & Polygonal numbers
  - Triangular numbers' wider family
  - All similar to triangulars, but with different steepness
- Fibonacci series
  - Iterative calculation
  - But actually a polynomial raising inputs to the golden mean
- Primes
  - Great formal qualities proportionally
  - All the numbers are sort of ugly though since none are easily divisible
  - No known way to produce them



# 



1	A	B	С	D	E	F	G	н	1	J	K	L	M	N	0	P	Q
25																	
26																7.860596884	
27																	
28																	
29																	
30																	
31																	
32				1	5	15	35	70	126	210	330	495	715	1001	1365	1820	23
33																	
34																	
35																	
36																	
37		2		Λr	bd	Ha	ro'c	One		adal	Earlie	r					
38		3			IU					auei		-					
39		4	1														
40		5					_										
41		>		You're	: wei	come	e to m	аке уог	ur own t	rom scra	aton, put	rve gor	ie anea	a and se	et up a g	loogle si	neet tha
42		,		to do	νομ	can f	find th	at here									
43		>		to go.	Tou	ourr	inna an	luc nore	**								
44		>															
45																	
46																	
47	Constant	a, ar, ar^2,							GC		IMBERS	(Part	1) Shre	adshe	et		
48	Constant	An = Am +									IN DEIXO	(Leane	i/ opio	ausno			
49	Triangular	r	l														
50	Tetrahedr	(a pyramid															
51	Pentatope	e (further po	weise	ire pase	-	5	15	35	10	120	210	550	480	110	1001	1303	10
52	Square N	umbers			1	4	9	16	25	36	49	64	81	100	121	144	1(
53	Pentagon	al Number			1	5	12	22	35	51	70	92	117	145	176	210	24
54	Hexagona	al Number			1	6	15	28	45	66	91	120	153	190	231	276	33
55	Septogon	al Numbers	;		1	7	18	34	55	81	112	148	189	235	286	342	4
56	Pronic				2	6	12	20	30	42	56	72	90	110	132	156	1
57	Fibonacc	Binet's form	nula		1	1	2	3	5	8	13	21	34	55	89	144	2
58				0	5	5	15	40	100	245	610	1525	3815	9535	23840	59605	1490
59																	
60					1	5	3,834	*****	******	****	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
61																	
62																	
63																	
64					50%	120%	220%	350%	510%	700%	920%	1170%	1450%	1760%	2100%	2470%	2870
65																	
<u></u>																	

	R	5	S	T	
2380	3060		3876	4845	
			15	16	
			32,768	65,536	
			48,907	43,046,721	
			41,824	4,294,967,296	
hat	'e ready		78,125	152,587,890,625	7
Rat	sicauy		225	256	
			3,375	4,096	
			50,625	65,536	
			59,375	1,048,576	
		77			
			653739	188.21518	
			29	31	
			120	136	
			680	816	
1020	2000		3060	3876	
169	196		225	256	
247	287		330	376	
325	378		435	496	
403	469		540	616	
182	210		240	272	
233	377		610	987	
9010	372530		931325	2328305	
	#NUM!	#NI	JM!	#NUM!	
70%	3300%		3760%	4250%	

# Grab your favorite spreadsheet software

Populate a spreadsheet tab with useful numbers

Use as a starting point

	Poly
main term:	
offset:	
index	f(x)=x^2+0
1	
2	
3	
4	1
5	2
6	3
7	4
8	6-
9	8
10	10

#### nomial m f(x)=x^3+6 14 33 70 131 222 349 518 735 1006

	A 👻	В	С	D						
1	1 GOOD NUMBERS									
2	Spreadsheet	Example from Pa	rt 1							
3										
4		Lin	ear	Polyr						
5	main term:	1	5	2						
6	offset:	0	0	0						
7	index	f(x)=1x+0	f(x)=5x+0	f(x)=x^2+0						
8	1	1	?	=(\$A8^\$D\$5)+\$D\$6						
9	2	2	10	4						
10	3	3	15	9						



A	4 >	D	E	• •	Н	1	J	К	L	М

#### GOOD NUMBERS 1

_	
_	
	-

4	Polynomial		
5	main term:	2	3
6	offset:	5	50
7	index	f(x)=x^2+5	f(x)=x^3+50
8	1	6	51
9	2	9	58
10	3	14	77
11	4	21	114
12	5	30	175
13	6	41	266
14	7	54	393
15	8	69	562
16	9	86	779
17	10	105	1050
18	11	126	1381
19	12	149	1778
20	13	174	2247
21	14	201	2794
22	15	230	3425
23	16	261	4146
24	17	294	4963
25	18	329	5882
26	19	366	6909
27	20	405	8050
28	21	446	9311
29	22	489	10698
30	23	534	12217
31	24	581	13874



## PLAYING AROUND

- This enables you to "play around"
- Play Around is a technical term
- There is no absolute 'best numbers' to use in every case
- Instead you need to rely on your own instincts and taste
- Choosing numbers is an aesthetic choice you are making!
- So make the choice thoughtfully, by playing around



## LITERALLYAKING.COM/BLOG

#### Idea: Aesthetic Qualities of Rounding

You: Why am I looking at this pile of the roofing material? Perception (Sight): Because it's nice and orderly. Well laid pallet. Easy on the eyes. Conceptualization: Rhythmic pattern — calms your mind. Mammals like this stuff.

- Disco Elysium (2019)

Back in Part 1, I made an assertion you might have felt is unfounded: that numbers themselves have aesthetic properties. This is actually quite a claim I think, and I don't begrudge in the least if at the time you read that and thought, "Sure thing grandpa, let's get you back to bed."

After all, you might feel numbers are mere data, dry vessels of fact, without emotional valence of any kind. Oh, if only that it were so. In fact, that we ascribe cultural connotations to numbers at all, like objectivity, precision, and scientificity, is maybe a clue that they are distinct from, say, the universal constants of physics.

The truth is, numbers are actually quite peculiar. You might think numbers are simple because you learned to count when you were very young, but how our minds perceive and work with numbers is extremely complex and poorly understood. Numbers are like words, though also obviously distinct from them in some way (and evolutionarily, numeracy almost certainly predates language, as number sense can be observed in certain animals). But in the same way that words can be carefully chosen for their own sake, so it is with numbers.



Distribution of numerals in text, from On Round Numbers: Pragmatic Aspects of Numerical Expressions by Jansen & Pollmann (2010)

#### **Roundness and N-ness**



(or 2/3) 3,46410161 5137 7545 8705 4892 6830 1174 4733 8856 1050 7620 7612 5611 1613 9589 0386 6034 9 x5 )2v3 ( 769 8003 5891 9501 0193 4553 1707 3359 4327 4196 8023 3502 6 835 8346 9146 9768 6453 0356 9x9x9)213( 4751854067404327279910689551456439964177792191523677991922652892872244 93x 13)2V3( 3655272359541 7902 1531 5915 0395 8187 6895 5213 7860 8864 3676 8609 4348 3791 3250 94x 17)2v/3( 3105 7869 7215 9691 0326 2136 5719 9061 6991 1227 3151 5785 8613 0666 1611 3001 8773 9'x 21)2/3 279 3565 0014 1347 8706 5906 4641 4730 4173 8046 9013 6340 5272 0747 7499 4291 1741 9°x 25)2V3( 26 C732 7334 6525 8012 6151 2693 8708 1722 8884 3774 6058 4492 0603 1233 2800 5096 97x 29)2v/3 ( 24974 3997 5720 8621 8980 0067 0374 3460 0467 8522 4718 2422 6111 4102 8046 0258 98 x33)2V3( 2438 5777 5407 0875 5388 6201 8319 3805 8631 5411 2851 2761 8037 8144 7182 9453 9°x 37) 213( 241 6608 5851 1528 2065 5389 3707 3260 0404 9274 9922 1985 4039 7834 1612 7243 91°x41)2√3( 24 2315 7659 8716 9204 4036 3325 6668 3509 4371 7471 8735 6638 1354 6448 9724 91\*x45)2√3( 24530 7318 6536 7746 6186 3941 6107 1663 9183 3126 7822 6227 5643 3097 3034 0 912x49)2V3( 2503 1359 0462 9361 8998 6116 4908 8945 2977 8890 4879 8594 6494 2152 7861 913x53)2V3( 257 1355 5414 4316 0022 9181 7778 9011 1521 8376 5910 0903 8528 7558 6719 914257)213( 26 5656 6153 9276 3121 2761 4702 3036 2398 9422 9226 5785 3883 0878 3813 915x61)213( 27581 8343 8504 0679 8046 2728 6544 7462 1852 6531 7212 6905 8943 6571 916x65)2V3(-28760545256196577232175461183410586839631367477138385694 917x69)2V3( 301 0363 0300 3667 8776 3146 6179 8585 6491 8611 2784 0354 4926 7423 918x73)2V3( 316156847903395487923457631814931193062073209202434478 9' 2x77)2v/3( 33303 6795 0497 5282 2776 5138 1129 1341 6608 0131 8099 1598 5161 92°x81)2V3( 3517 6725 9517 5715 6863 9116 0469 7439 3798 1029 0114 7260 7486 921x85)2V3( 3724594 5125 3899 3079 70828808 5611 2284 5050 1306 2651 1381 922x89)2v/3( 395244 1118 1749 6144 5383 3269 3229 6559 5292 4608 0306 3005 923x93)2V3( 42027 1516 7473 9733 4096 9128 9961 0984 2271 2413 5181 9125 924x97)2V3( 4477 1192 5057 3648 5762 9013 7418 5362 5808 9638 5534 8429 925x101)2 13( 4777563996761759206 82225885 1463 3337 1501 5838 1515 3.5462 3317 2182 1216 8216 8891 2068 8337 2605 8456 6289 2593 5926 3028 6006 8370 3313 5867

## YOUR DAYS ARE NUMBERED

- The numbers you use, for anything, are never neutral or natural
- Numbers have intrinsic and extrinsic qualities
  Be thoughtful in what you pick





 $\sum_{i=1}^{n}$ 

## YOUR DAYS ARE NUMBERED

- The numbers you use, for anything, are never neutral or natural
- Numbers have intrinsic and extrinsic qualities
- Be thoughtful in what you pick
  If comedians can do it, then so can we!





# **"GOOD NUMBERS"** IN GAME DESIGN

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**#GDC23** Game Developer's Conference, March 24<sup>th</sup> 2023

