

QUESTIONS IN DATAVIZ

NEIL RICHARDS

How **curiosity** will
help your **creativity**

@theneilrichards

questionsindataviz.com

<https://public.tableau.com/profile/neil.richards#!/>

<https://www.linkedin.com/in/neilrichards1/>



FIRST QUESTIONS

CHALLENGING
QUESTIONS

IDEA QUESTIONS

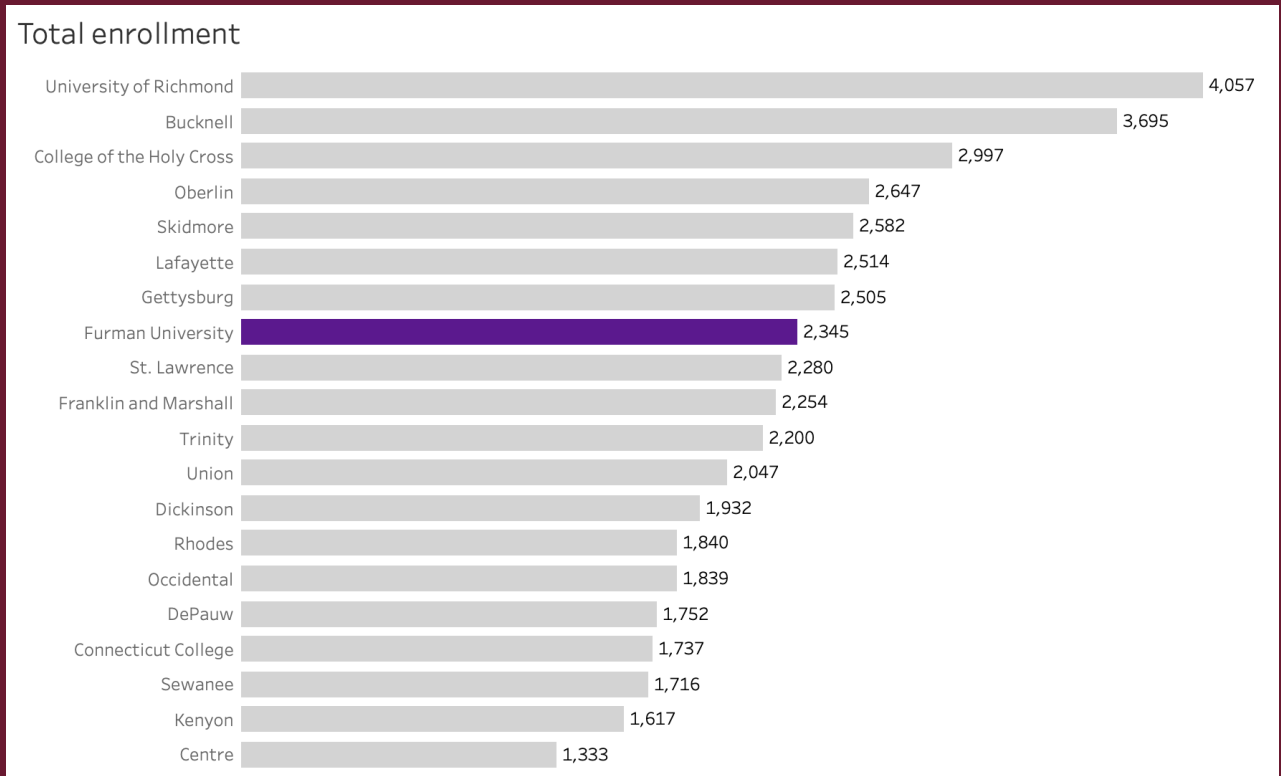


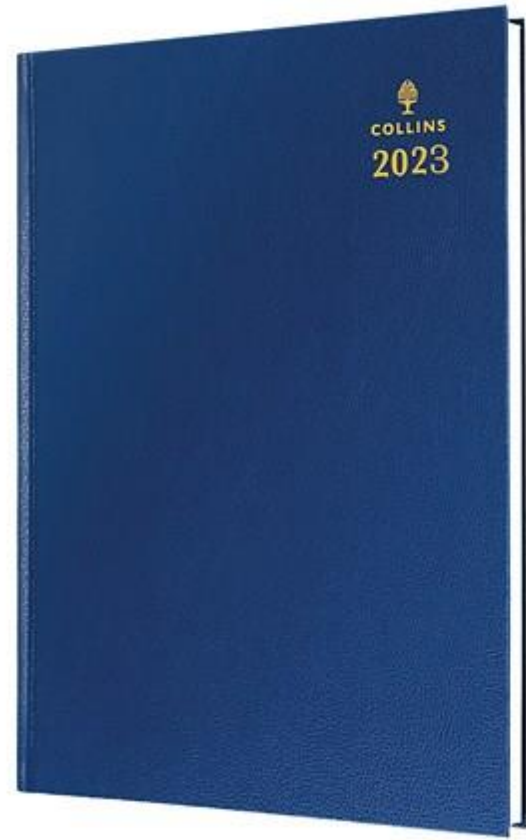
Park & Earthy waterfall #88929e meadow #598234 thunder cloud #505160 moss #a6bc3b	Autumn in Vermont warm grey #bcbabe glacier blue #1995ad overcast #f1f1f2 ice #a180e2	Summer Sun & Sea white #ffffff new growth #c6d166 deep green #0f1b07 plants #51821a	Fun & Tropical cinnamon #d62a1c caramels #c9a96b tiramisu #af4429 cream #fbdcb2	Fresh Greens cherry red #d72a15 smoke #c0b2b5 berry #a10115 chiffon #f0efea	Vineyard Neutrals steel blue #426a86 coal #2f3131 sunshine #f9ba32 bone #f8f1e5	Cosmopolitan arctic #b2c0bd brick #fa8072 dark teal #2061bd white cloud #ffffff	City Sights hazelnut #b79a77 sky #97bdc2 ginger #e35c37 oat #d6c0b9	Complementary Neutrals pool blue #5c9efc blood orange #e75c2e royal blue #344d90 orange juice #fb7451	Cheerful Blues & Pink tease #ba7970 oceanic #1b4d5a gryx #0f1f38 fireworks #ff5449
Crisp & Dramatic ocean #07575b seafoam #c4dfe5 deep aqua #003b46 wave #66a5ad	Icy Blues and Greys branch #5c535e yellow feathers #dfe166 lavender grey #9a9ead berry #ec96a4	Modern & Crisp peacock blue #1e656f candy apple #ff2a00 navy #00293c ivory #f1f3ce	Spicy Neutrals peach #ffccac butterscotch #fed475 baby blue #c1e1dc butter #ffeb94	Wintery Reds ciao! #7ae052 toast #e4b600 lime #c78b00 lip #f78b2d	Modern & Urban evergreen #304040 fog #c9d1d8 forest #04202c pine #5b7065	Cheerful & Friendly magenta #ff0038 black #020509 cyan #00c9ff yellow #ffcc38	Retro & Relaxing camouflage #524e3a grass #505f37 split pea #919c34 light #ffffae1	Pool Party paper #efeefe silver #594d46 black squeeze #080706 gold leaf #dab280	Exotic & High Impact pencil yellow #faa3d pink eraser #e4525e wood #81715e orange #e38533
Cool Blues grass #486600 earth #794427 forest green #2e4600 lime #a3c523	Birds & Berries blueberry #063852 dark navy #011a27	Timeless & Neutral pewee #c9c9c9 pewee #c9c9c9	Bohème cherry #e67e22 cherry #e67e22	Summer Flavors peach #ffccac peach #ffccac	Misty Greens steel blue #426a86 steel blue #426a86	Nightlife steel blue #426a86 steel blue #426a86	Green Fields steel blue #426a86 steel blue #426a86	Classic Metallics oatmeal #d5c9b1 faded red #d58958	Back to School watermelon #f03c3c turquoise #138c90 ultramarine #051283 sunshine #ff74c
Outdoorsy & Natural cadet blue #004445 greenery #6b998f blue black #021c1e rain #2c7873	Day & Night sunglow #29b44e mist #acd0c0 sky #76b1cb mountains #495437	Neutral & Versatile yellow pepper #f5b412 tomato #e13721 avocado #258039 blue blue #32a868	Bold & Cultured grapefruit #fad32f off white #fcd3e2 citrus #faa70b ruby red #fa4032	Chocolatey Browns moss green #7a7b15 gold #b3a545 yellow pear #e8df00 umber #563e20	Sunkissed Village mustard #e29930 shadow #211f30 celonian blue #217ca3 asphalt #32384d	Coastal lagoon #56a5a7 raspberry #ff4447 saltwater #257985 whitewash #ffffff	Distinctive & Unexpected cool grey #a550d2 cobalt #3a5199 blue black #2f2c33 white #ffffff	Subtle & Versatile gloss white #ffffff medium grey #b0c3d5 brick red #962715 matte black #1e1e20	Bright & Painterly blackish #232122 blue grey #70a4af soft grey #d0d0d0 houseplant #a5c05b
Watery Blue-Greens sunset #e6542 grass #37681c sky #375c97 sunflower #ff6600	Stylish & Retro yellow #ffcc24 lime #80ba43 orange #e68a44 olive green #807447	Cheerful Brights tangerine #ff9554 pear green #739f32 carrot #e6732f off white #fcdfe	Sunny Citrus granny smith #bbc74e red delicious #a1170c golden delicious #f4ec6a rose apple #a739c0	Naturally Elegant spicy #b53a0e peppercorn #795a3c red onion #662225 parsnip #ead39c	Sun & Sky levo aqua #128277 mist #b9c4c9 peacock blue #004047 lichen #52798b	Maritime Brights warm grey #baa196 faded rose #a38675 honeysuckle #fc825 putty #e6ccb5	Sleek & Modern sand dollar #e585d2 orange #ff9d3f wood veneer #756967 charcoal #353c3f	Professional & Traditional sage #a0c0c4 leather #d57165 stone #c0c0c4 buttermilk #faefd4	Urban Living red #e60000 fresh blue #67bacc minty #b38bc0 porcelain #d0d0d0

What's in a colour?

Colour Good Practices

- Use colour sparingly
- Reduce saturation
- Consider colour for highlighting
- Keep colour palettes to 5 colours
- Consider accessibility (red/green)



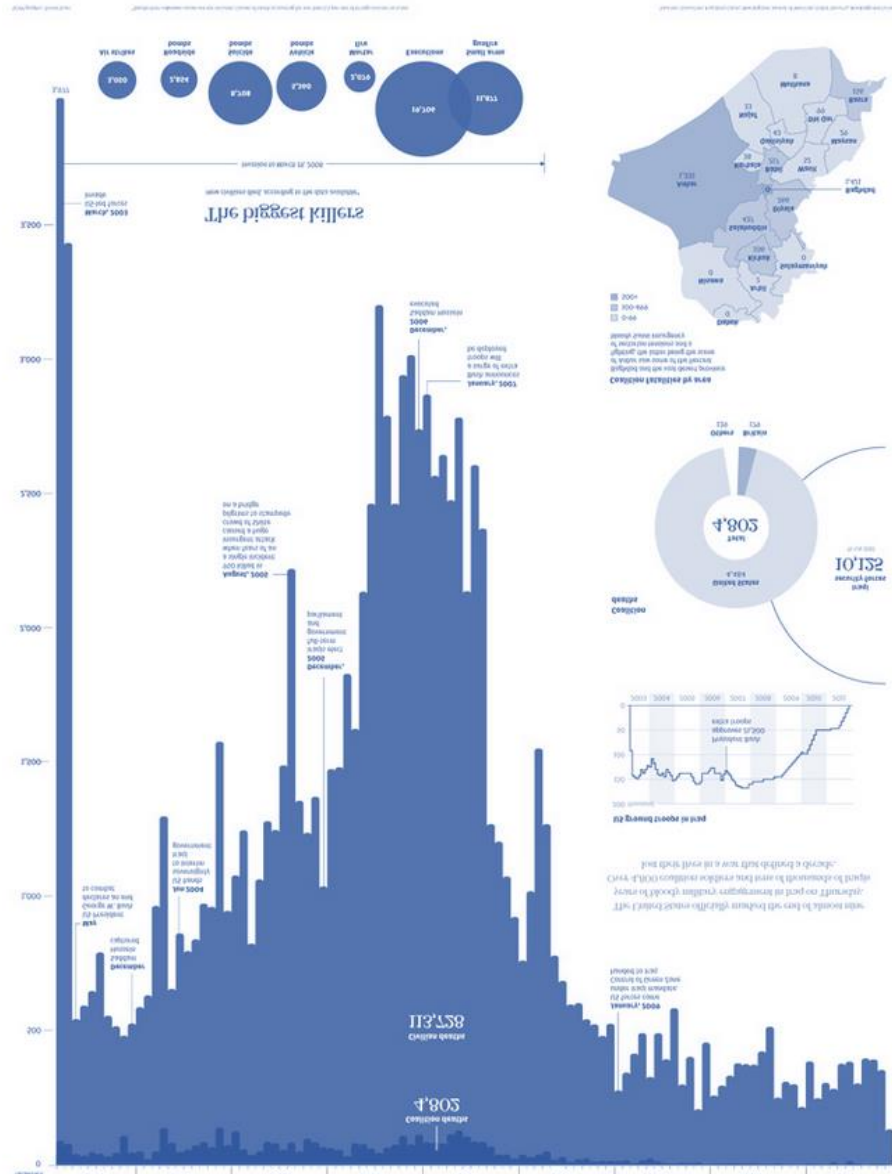




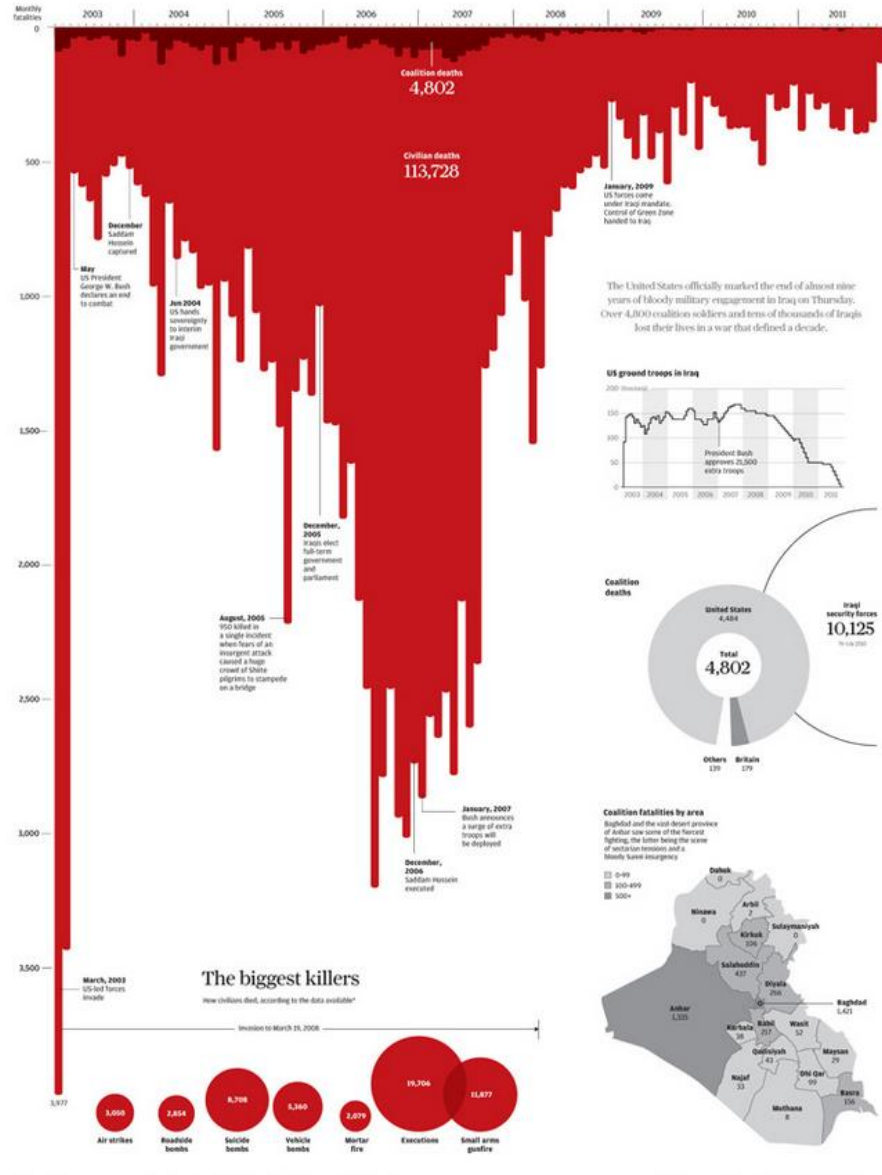
Colour associations

- **Hot / Cold**
- Does this mean **Good / Bad?**
(is hot or cold better? – we like warmer weather ...)
- **Stop / Wait / Go**
- Usually associated with **Bad / meh / Good**
- Or **down / level / up** (for stock prices, sales, profits, league positions)
- So maybe **orange / blue** should be **bad / good?**

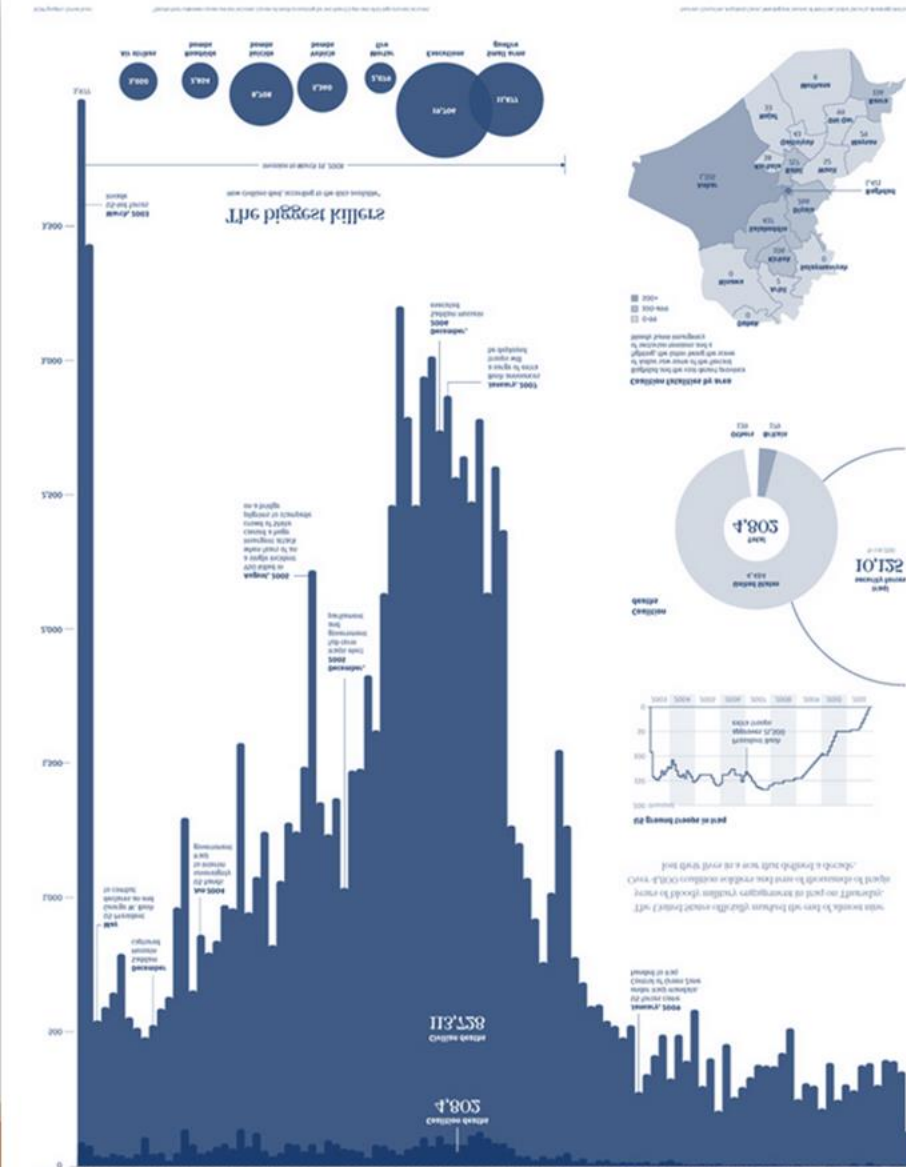
Iraq: Deaths on the decline



Iraq's bloody toll



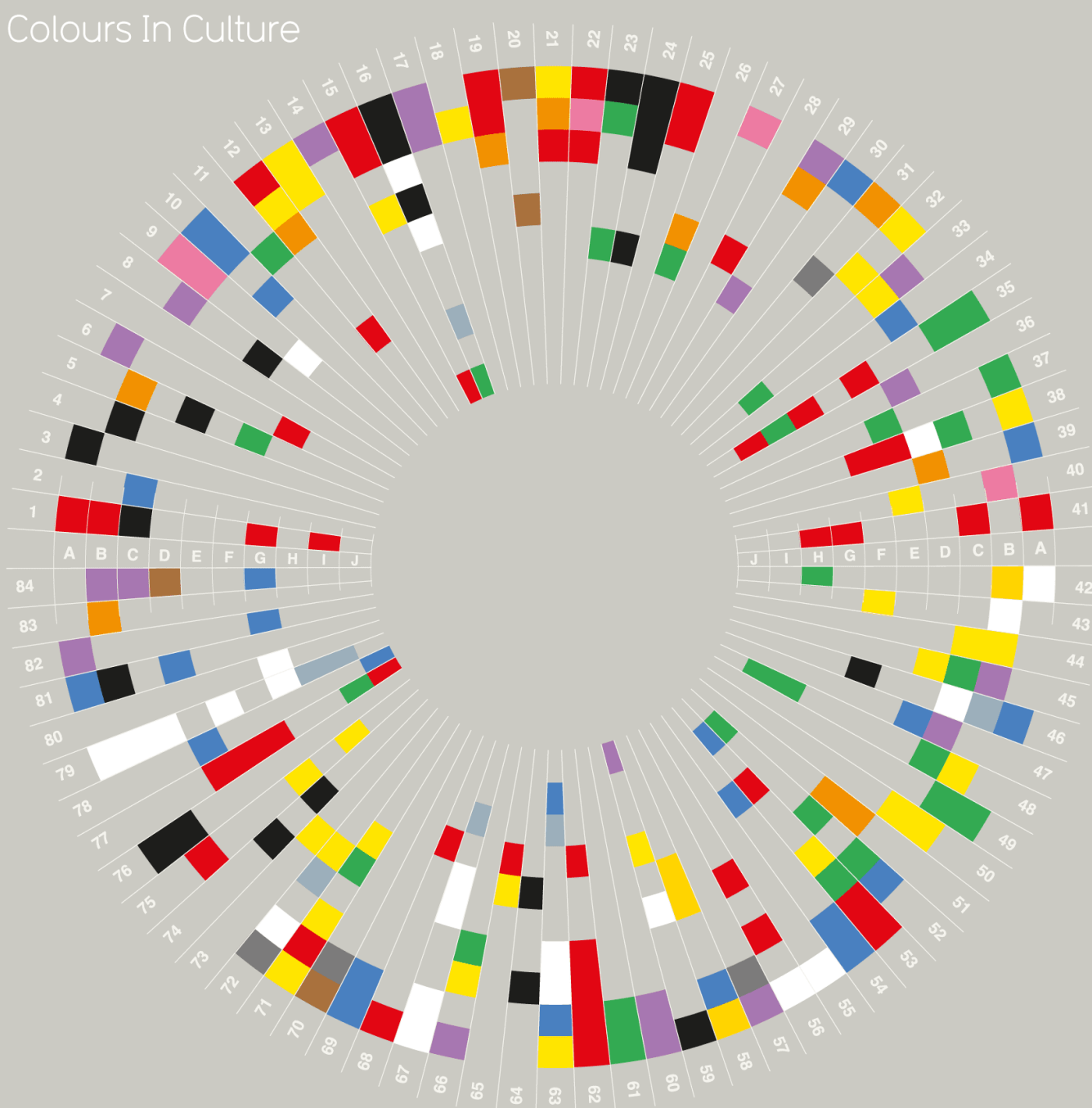
Iraq: Deaths on the decline



95	24.38	25.48	-0.57	1438500	第十品	12.18	11.85	12.08	-0.33	63791
35	11.62	11.84	-0.23	233533	众和股份	9.48	---	---	---	---
60	15.63	15.74	0.53	64002	长城影视	19.38	---	---	---	---
53	7.53	7.64	---	123258	顺瑞德	13.38	---	---	---	---
13	5.92	6.12	-0.21	516596	软控股份	12.40	11.99	12.25	-0.41	113748
41	8.90	9.21	-0.51	1332216	东源电器	14.42	15.58	15.88	1.11	100489
27	10.42	10.98	0.15	7699952	沙钢股份	4.81	4.65	4.81	-0.16	71471
84	8.69	8.83	-0.15	57335	雪莱特	11.16	10.77	11.09	-0.38	14676
62	27.70	28.80	1.00	1400415	大港股份	8.23	8.23	8.23	-0.18	9880
14	8.90	9.15	-0.24	60034	太阳纸业	4.13	4.13	4.13	-0.09	180354
36	12.02	12.30	-0.34	14223	苏州固铂	7.25	7.25	7.25	0.16	57631
64	18.54	18.91	-0.30	5163	中材科技	13.07	13.07	13.07	-0.56	26919
16	13.63	13.85	-0.53	1577645	金雄	18.5	18.5	18.5	-0.05	74377
27	17.07	17.28	-0.20	25852	栋梁	7	7	7	-0.30	17886
50	19.79	20.46	-0.71	206295	半日妖	7	7	7	-0.09	78627
				3136718	海联	7	7	7	0.18	8997
									0.25	14886
										10095



Colours In Culture



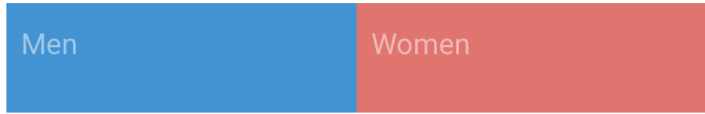
- | | | |
|----------------------|--------------------|----------------|
| A Western / American | 1 Anger | 19 Desire |
| B Japanese | 2 Art / Creativity | 20 Earthy |
| C Hindu | 3 Authority | 21 Energy |
| D Native American | 4 Bad Luck | 22 Erotic |
| E Chinese | 5 Balance | 23 Eternity |
| F Asian | 6 Beauty | 24 Evil |
| G Eastern European | 7 Calm | 25 Excitement |
| H Arab | 8 Celebration | 26 Family |
| I African | 9 Children | 27 Femininity |
| J South American | 10 Cold | 28 Fertility |
| | 11 Compassion | 29 Flamboyance |
| | 12 Courage | 30 Freedom |
| | 13 Cowardice | 31 Friendly |
| | 14 Cruelty | 32 Fun |
| | 15 Danger | 33 God |
| | 16 Death | 34 Gods |
| | 17 Decadence | 35 Good Luck |
| | 18 Deceit | 36 Gratitude |

- | | | |
|-----------------|-------------------|---------------------|
| 37 Growth | 55 Luxury | 73 Royalty |
| 38 Happiness | 56 Marriage | 74 Self-cultivation |
| 39 Healing | 57 Modesty | 75 Strength |
| 40 Healthy | 58 Money | 76 Style |
| 41 Heat | 59 Mourning | 77 Success |
| 42 Heaven | 60 Mystery | 78 Trouble |
| 43 Holiness | 61 Nature | 79 Truce |
| 44 Illness | 62 Passion | 80 Trust |
| 45 Insight | 63 Peace | 81 Unhappiness |
| 46 Intelligence | 64 Penance | 82 Virtue |
| 47 Intuition | 65 Power | 83 Warmth |
| 48 Religion | 66 Personal power | 84 Wisdom |
| 49 Jealousy | 67 Purity | |
| 50 Joy | 68 Radicalism | |
| 51 Learning | 69 Rational | |
| 52 Life | 70 Reliable | |
| 53 Love | 71 Repels Evil | |
| 54 Loyalty | 72 Respect | |

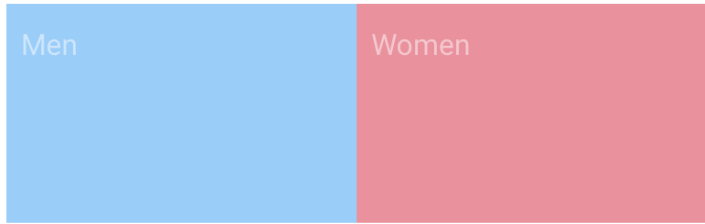
- | | |
|--------|--------|
| Yellow | Grey |
| Gold | Silver |



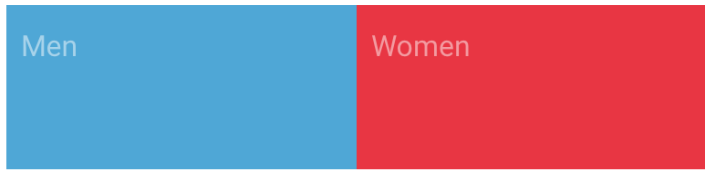
The Pudding, 2017: “Film Dialogue”



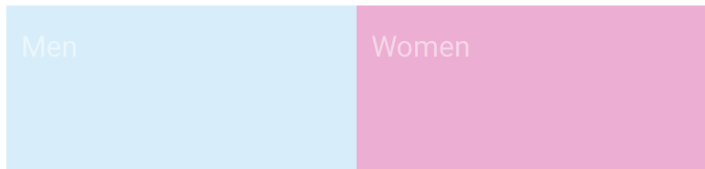
The Pudding, 2017: “She Giggles, He Gallops”



Bloomberg, 2016: “This Chart Shows Who Marries CEOs, Doctors, Chefs and Janitors”



NYT, 2015: “The Changing Nature of Middle-Class Jobs”



NYT, 2017: “The Words Men and Women Use When They Write About Love”



Wall Street Journal, 2016: “What’s Your Pay Gap?”



DailyMail, 2018



ZEIT 2016



ZEIT 2018



Economist, 2018



Morgenpost 2017



Guardian, 2018



Financial Times, 2018



Telegraph, 2018



Information is beautiful, 2014



Washington Post, 2017



Bloomberg, 2018



BBC, 2017



BBC, 2018

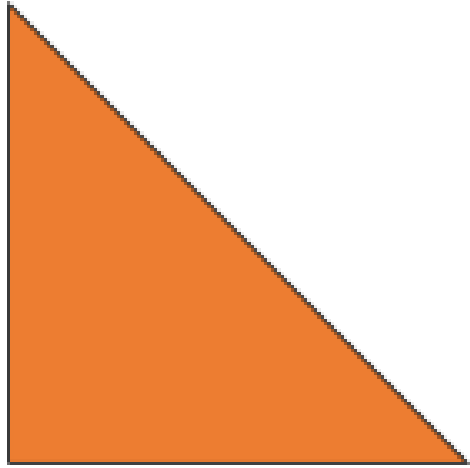
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Blackfriars	Blackhorse Road	Bond Street	Borough	Boston Manor	Bounds Green	Bow Road	Brent Cross	Brixton	Bromley-by-Bow	Buckhurst Hill	Burnt Oak	Caledonian Road	Camden Town	Canada Water	Canary Wharf	Canning Town	Cannon Street	Canons Park	Chalfont & Latimer	Chalk Farm
Chancery Lane	Charing Cross	Chesham	Chigwell	Chiswick Park	Chorleywood	Clapham Common	Clapham North	Clapham South	Cockfosters	Colindale	Colliers Wood	Covent Garden	Croxley	Dagenham East	Dagenham Heathway	Debden	Dollis Hill	Ealing Broadway	Ealing Common	Earl's Court
East Acton	East Finchley	East Ham	East Putney	Eastcote	Edgware	Edgware Road (Bakerloo)	Edgware Road	Elephant & Castle	Elm Park	Embankment	Epping	Euston	Euston Square	Fairlop	Farringdon	Finchley Central	Finchley Road	Finsbury Park	Fulham Broadway	Gants Hill
Gloucester Road	Golders Green	Goldhawk Road	Godge Street	Grange Hill	Great Portland Street	Greenford	Green Park	Gunnersbury	Hainault	Hammersmith	Hampstead	Hanger Lane	Harlesden	Harrow & Wealdstone	Harrow-on-the-Hill	Hatton Cross	Heathrow Terminals 2 & 3	Heathrow Terminal 4	Heathrow Terminal 5	Hendon Central
High Barnet	Highbury & Islington	Highgate	High Street Kensington	Hillingdon	Holborn	Holland Park	Holloway Road	Hornchurch	Hounslow Central	Hounslow East	Hounslow West	Hyde Park Corner	Ickenham	Kennington	Kensal Green	Kensington (Olympia)	Kentish Town	Kenton	Kew Gardens	Kilburn
Kilburn Park	Kingsbury	King's Cross St Pancras	Knightsbridge	Ladbroke Grove	Lambeth North	Lancaster Gate	Latimer Road	MIND THE GAP					Leicester Square	Leyton	Leytonstone	Liverpool Street	London Bridge	Loughton	Maida Vale	Manor House
Manison House	Marble Arch	Marylebone	Mile End	Mill Hill East	Monument	Moorgate	Moor Park	Morden	Mornington Crescent	Neasden	Newbury Park	North Acton	North Ealing	North Greenwich	North Harrow	North Wembley	Northfields	Northolt	Northwick Park	Northwood
Northwood Hills	Notting Hill Gate	Oakwood	Old Street	Osterley	Oval	Oxford Circus	Paddington	Park Royal	Parsons Green	Perivale	Piccadilly Circus	Pimlico	Pinner	Plaistow	Preston Road	Putney Bridge	Queen's Park	Queensbury	Queensway	Ravenscourt Park
Rayners Lane	Redbridge	Regent's Park	Richmond	Rickmansworth	Roding Valley	Royal Oak	Ruislip	Ruislip Gardens	Ruislip Manor	Russell Square	St. James's Park	St. John's Wood	St. Paul's	Seven Sisters	Shepherd's Bush	Shepherd's Bush Market	Sloane Square	Snaresbrook	South Ealing	South Harrow
South Kensington	South Kenton	South Ruislip	South Wimbledon	South Woodford	Southfields	Southgate	Southwark	Stamford Brook	Stanmore	Stepney Green	Stockwell	Stonebridge Park	Stratford	Sudbury Hill	Sudbury Town	Swiss Cottage	Temple	Theydon Bois	Tooting Bec	Tooting Broadway
Tottenham Court Road	Tottenham Hale	Totteridge & Whetstone	Tower Hill	Tufnell Park	Turnham Green	Turnpike Lane	Upminster	Upminster Bridge	Upney	Upton Park	Uxbridge	Vauxhall	Victoria	Walthamstow Central	Wanstead	Warren Street	Warwick Avenue	Waterloo	Watford	Wembley Central
Wembley Park	West Acton	West Brompton	West Finchley	West Ham	West Hampstead	West Harrow	West Kensington	West Ruislip	Westbourne Park	Westminster	White City	Whitechapel	Willesden Green	Willesden Junction	Wimbledon	Wimbledon Park	Wood Green	Wood Lane	Woodford	Woodside Park

Colours of the London Underground

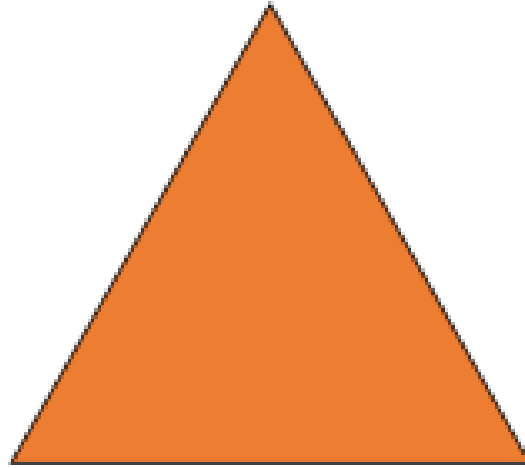




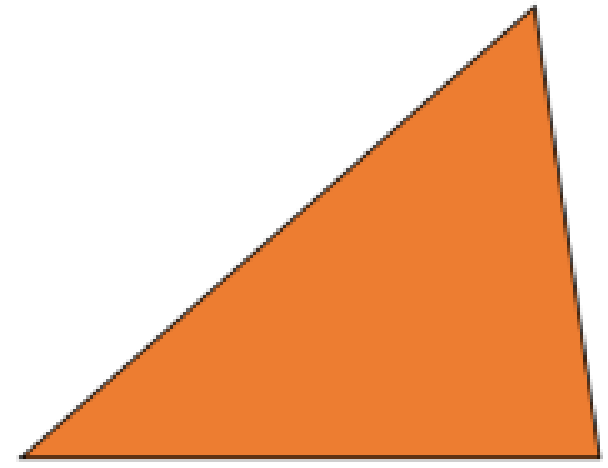
**Why visualise
using triangles?**



right angled



equilateral

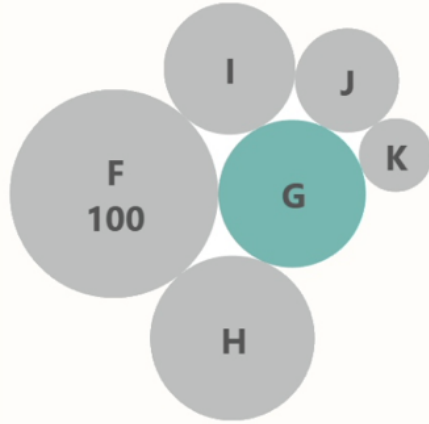


scalene

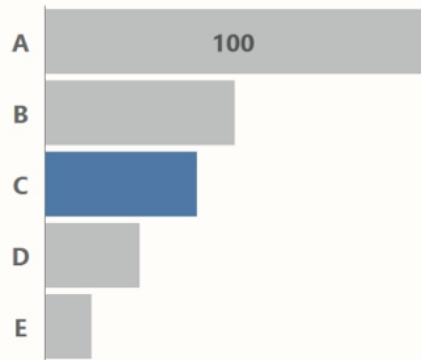
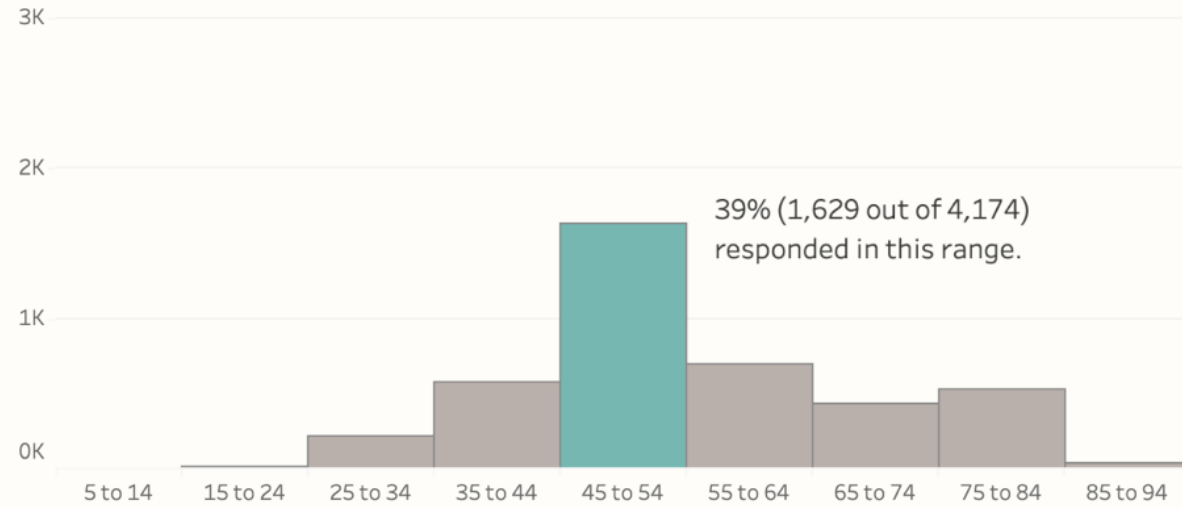
Circles and Bars: The Results

Show all responses

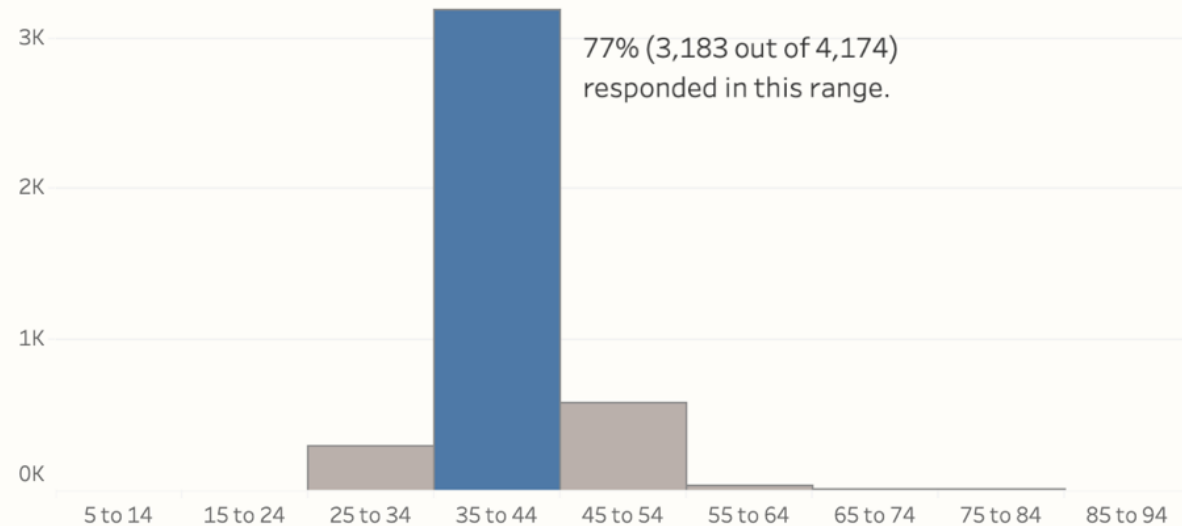
Responses: 4,174 



The circle is **50**. Here are the guesses.



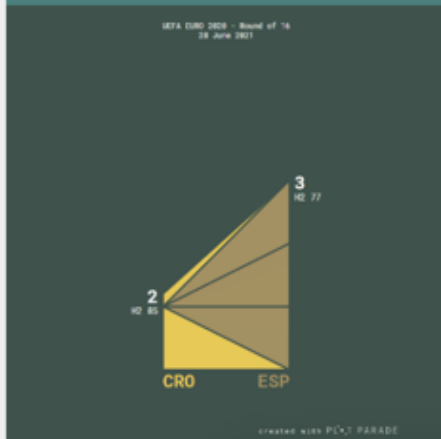
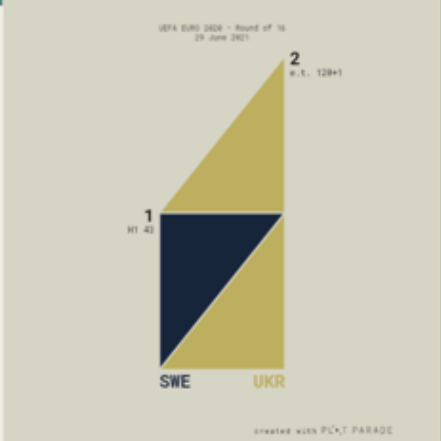
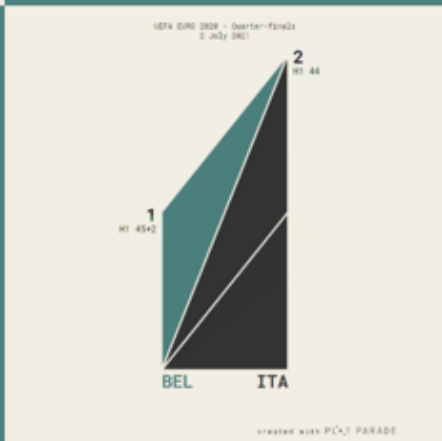
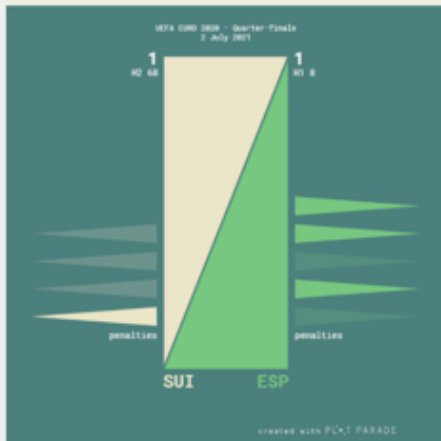
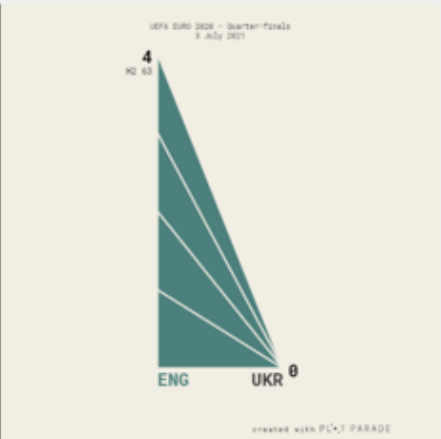
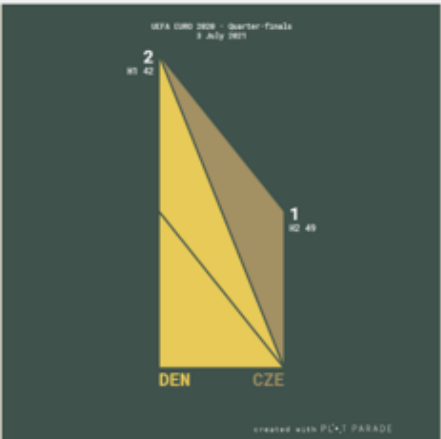
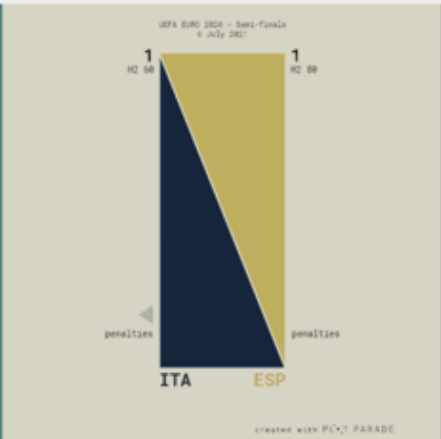
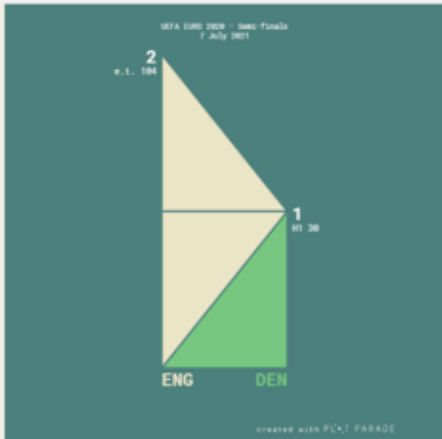
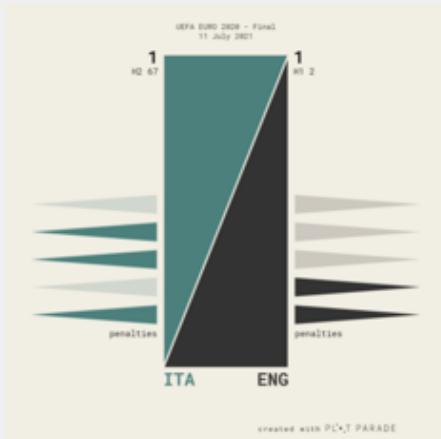
The bar is **40**. Here are the guesses.



Reservoirs in and around California running dry

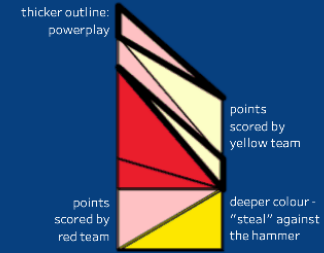


UEFA 2020 chart gallery



Olympic Curling Mixed Doubles - Beijing 2022

Each triangle represents one end



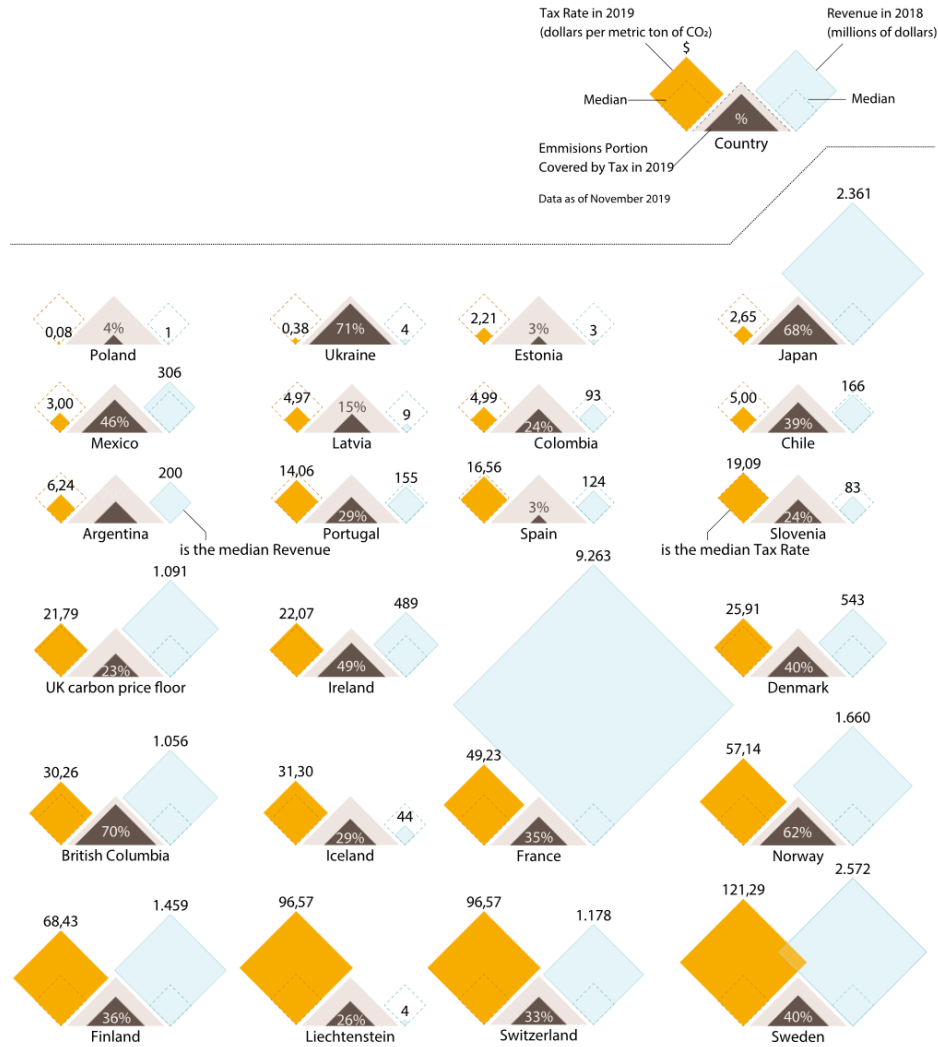
Semi Finals

Semi-Final 1	Semi-Final 2

Medal Matches

Bronze Match	Final

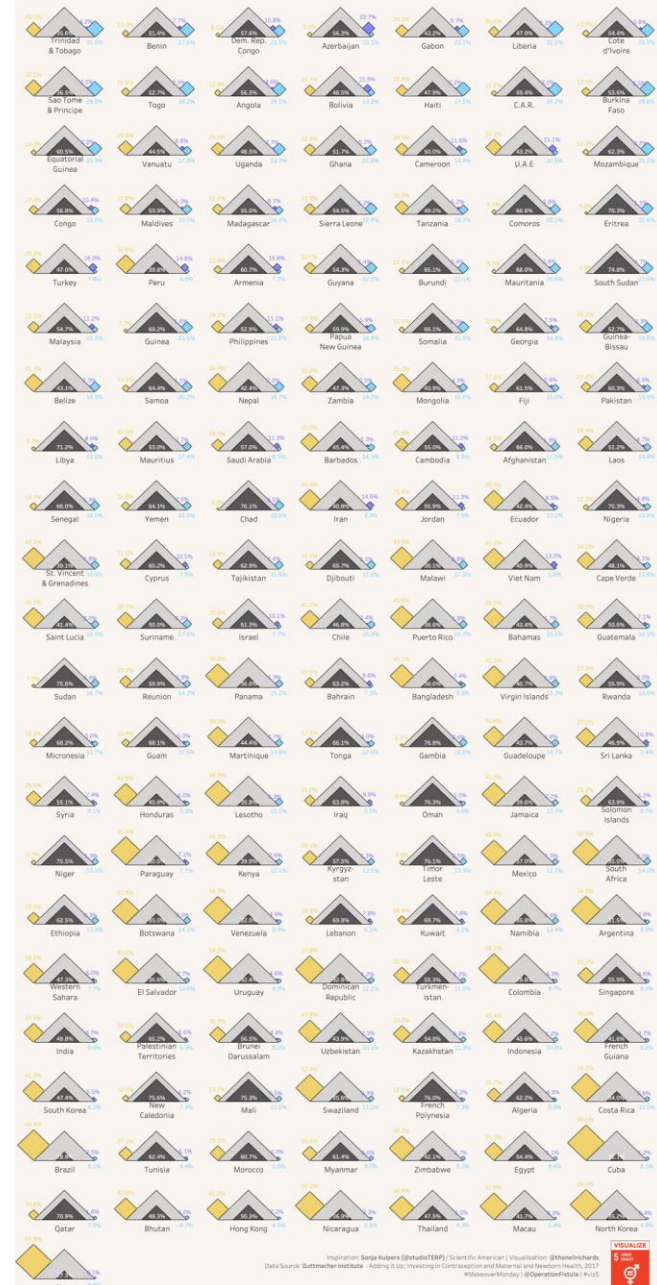
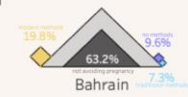
Round Robin Matches

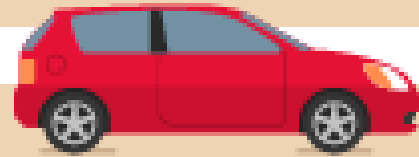


Contraceptive Choices for Women

In 2017, the Guttmacher Institute looked at 148 Lower Middle Income countries and territories, recording and comparing the contraceptive choices of women aged 15-49. In every country, to some extent, women who wanted to avoid pregnancy relied not just on **modern methods**, but had to rely on **traditional methods or no methods at all**.

Each pyramid shows those who **do not want to avoid pregnancy** in the dark central triangle as a proportion of the total, with the size of squares on the left and right indicating the percentage who had needs met via modern contraception versus traditional or no contraception.





EDINBURGH

290 BIRMINGHAM

373 102 CARDIFF

496 185 228 DOVER

193 110 208 257 LEEDS

214 90 165 270 73 LIVERPOOL

412 118 150 81 191 **198** LONDON

222 86 173 285 41 34 201 MANCHESTER

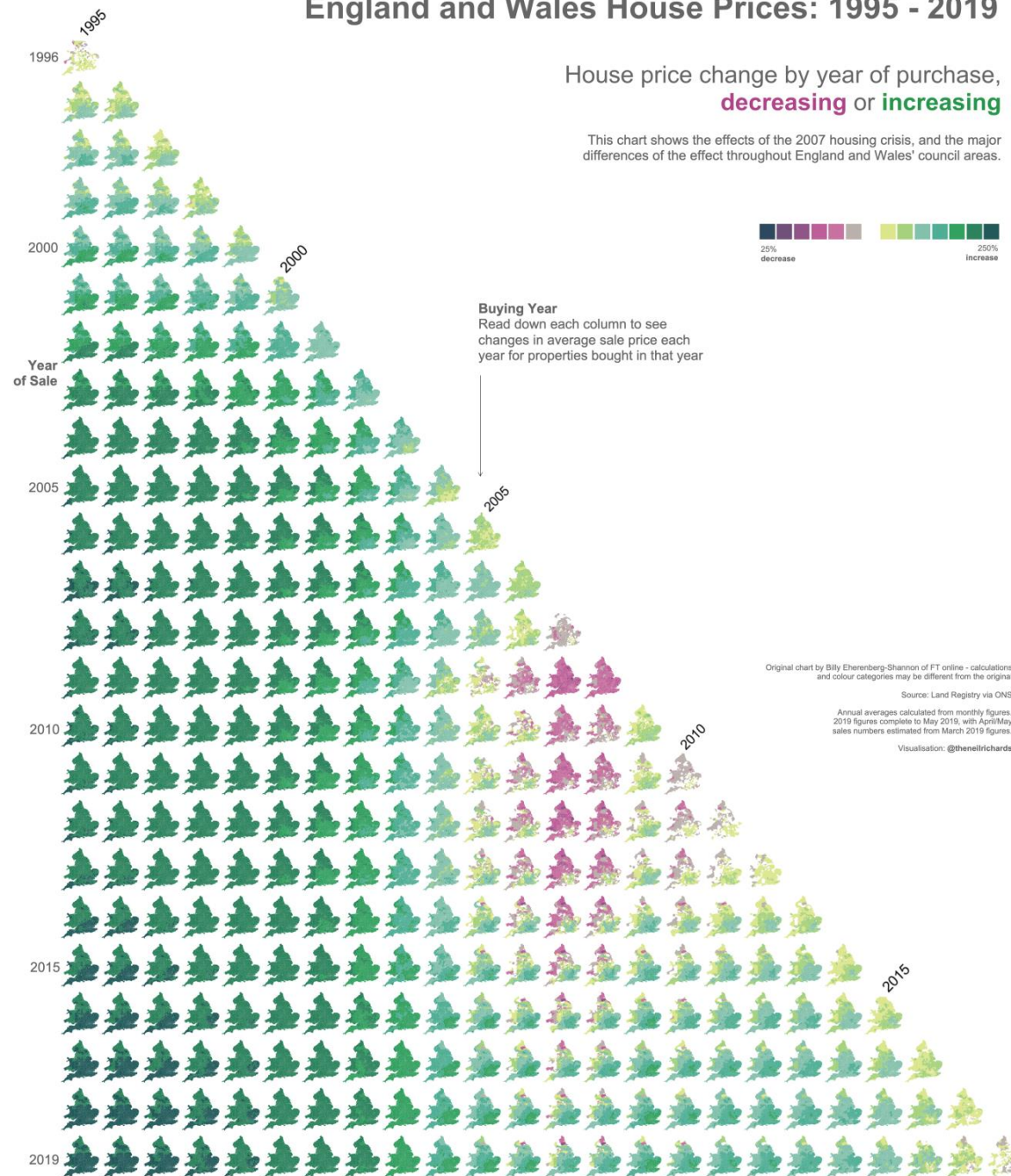
112 207 301 360 94 155 288 141 NEWCASTLE

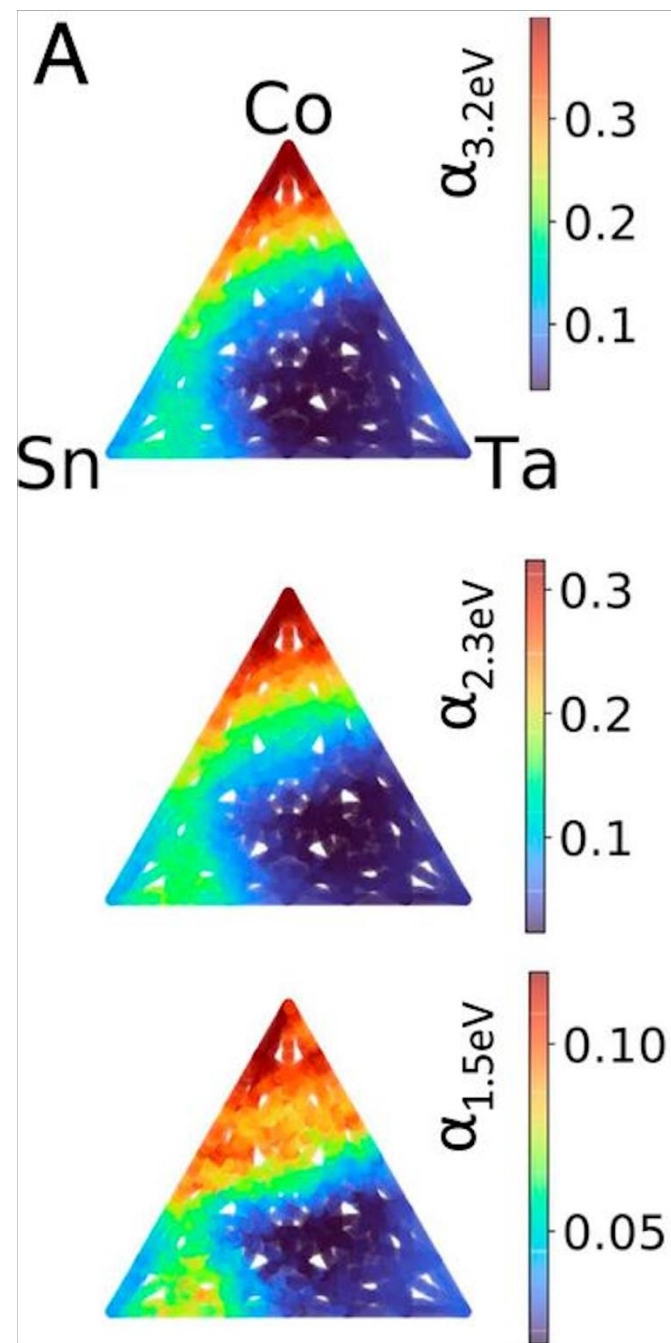
186 129 231 264 25 97 194 66 82 YORK

England and Wales House Prices: 1995 - 2019

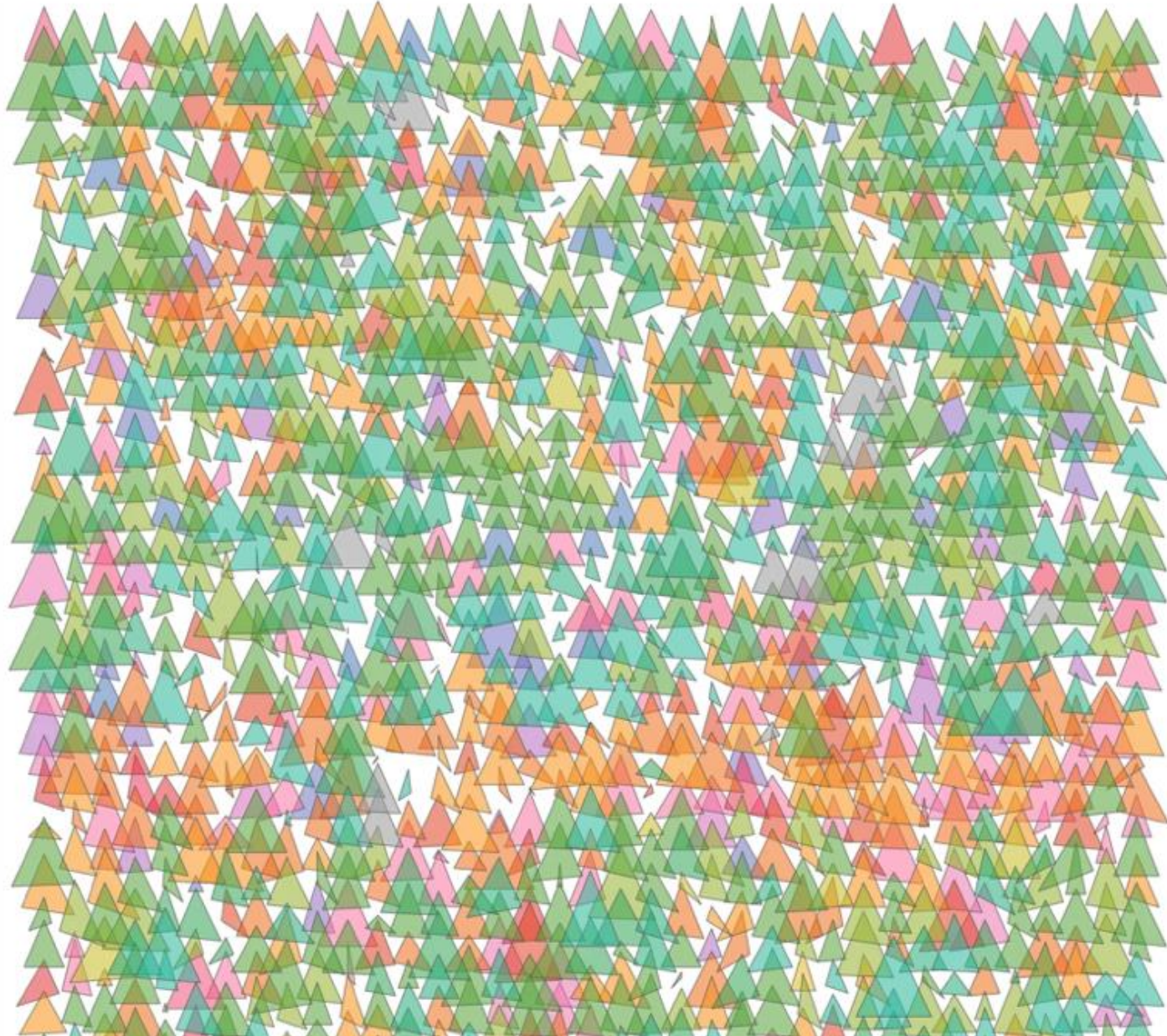
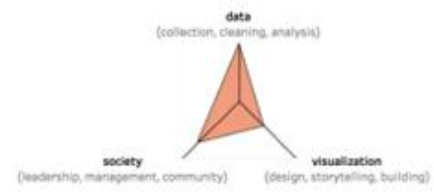
House price change by year of purchase,
decreasing or **increasing**

This chart shows the effects of the 2007 housing crisis, and the major differences of the effect throughout England and Wales' council areas.





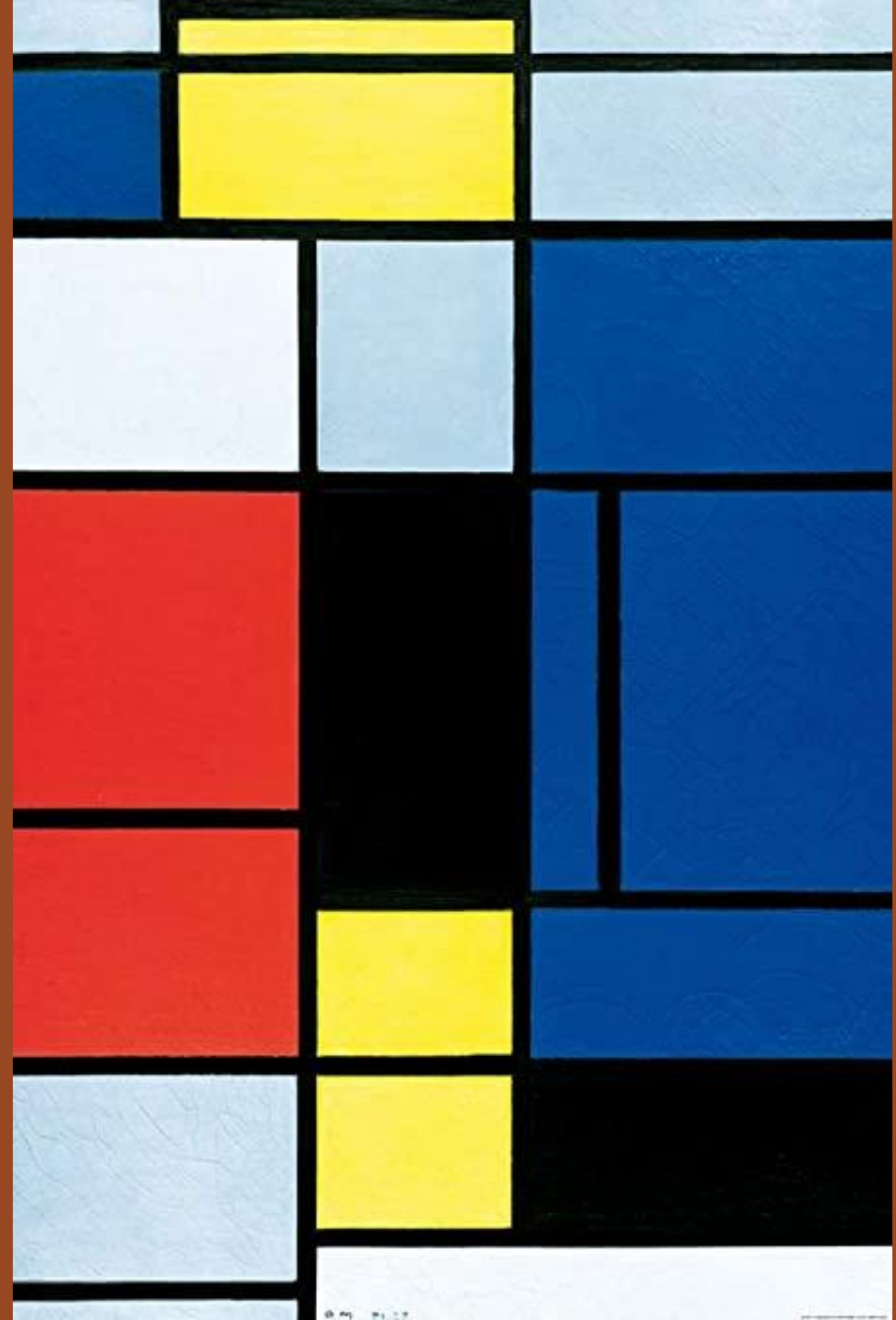
DATA VISUALIZATION SOCIETY





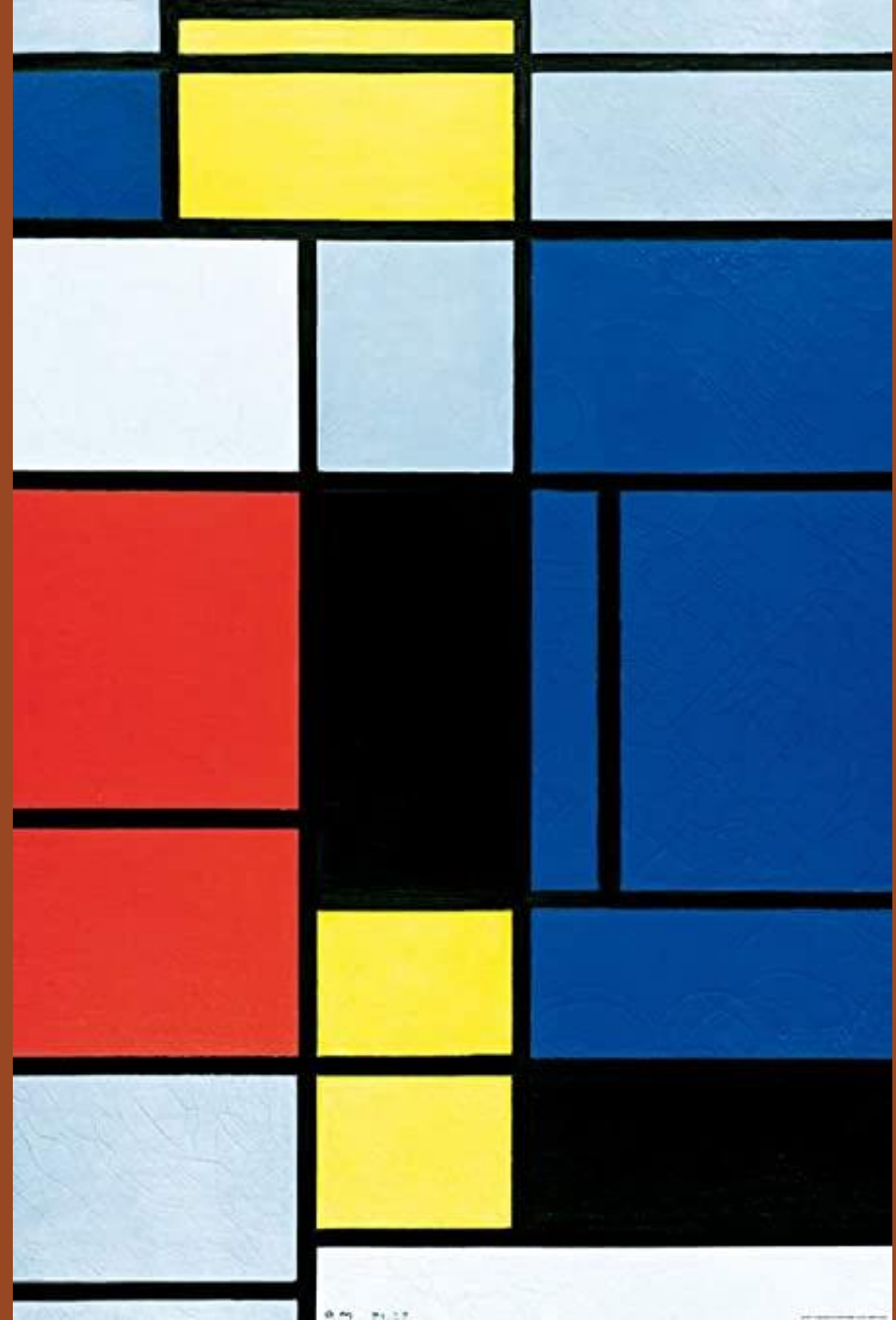
**Why visualise using
flowers?**

- Geometric art
- Resembles data viz
- Piet Mondrian 1921



- Geometric art
- Resembles data viz
- Piet Mondrian 1921

- **Tableau #1**



tableau

[**ta-bloh**, **tab-loh**]

Spell

Syllables

[Examples](#)

[Word Origin](#)

[See more synonyms on Thesaurus.com](#)

noun, plural **tableaux**  [ta-**blohz**, **tab-lohz**] ([Show IPA](#)), **tableaus**.

1. a picture, as of a scene.
2. a picturesque grouping of persons or objects; a striking scene.
3. a representation of a picture, statue, scene, etc., by one or more persons suitably costumed and posed.

tableau Edit

board

noun

table

table, tableau, liste, classement

pictureimage, photo, tableau, portrait,
illustration, dessin**board**conseil, bord, pension,
commission, planche, tableau**tableau**

tableau, tableau vivant

blackboard

tableau noir, tableau

rollrouleau, roulis, roulement,
tableau, petit pain, pellicule**canvas**

toile, canevas, tableau, tente

spreadsheet

tableur, tableau

tabletcomprimé, tablette, cachet,
tableau, plaque commémorative**drawing**

dessin, tirage, étirage, tableau

Gender & ethnic disparities in Tech companies

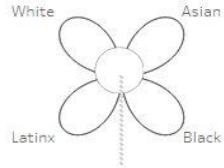


Dear Tech People is dedicated to unearthing the data behind diversity in tech, starting with a race/gender ranking of 100 top tech companies.

//Select a company on the bar chart to see its flower.
//Click on the center of a flower to look it closer.

HOW TO READ IT

A leaf of a flower means an ethnicity.



Total # of employees



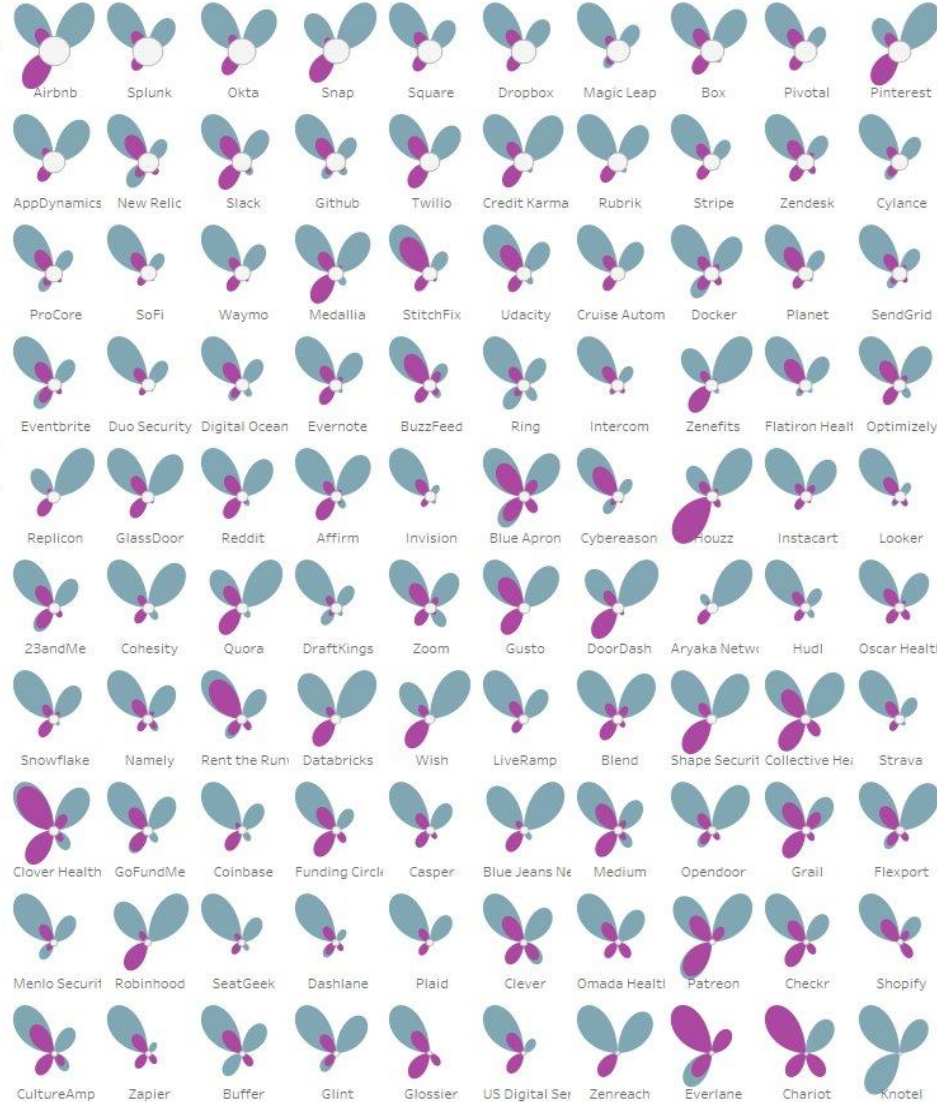
3,342

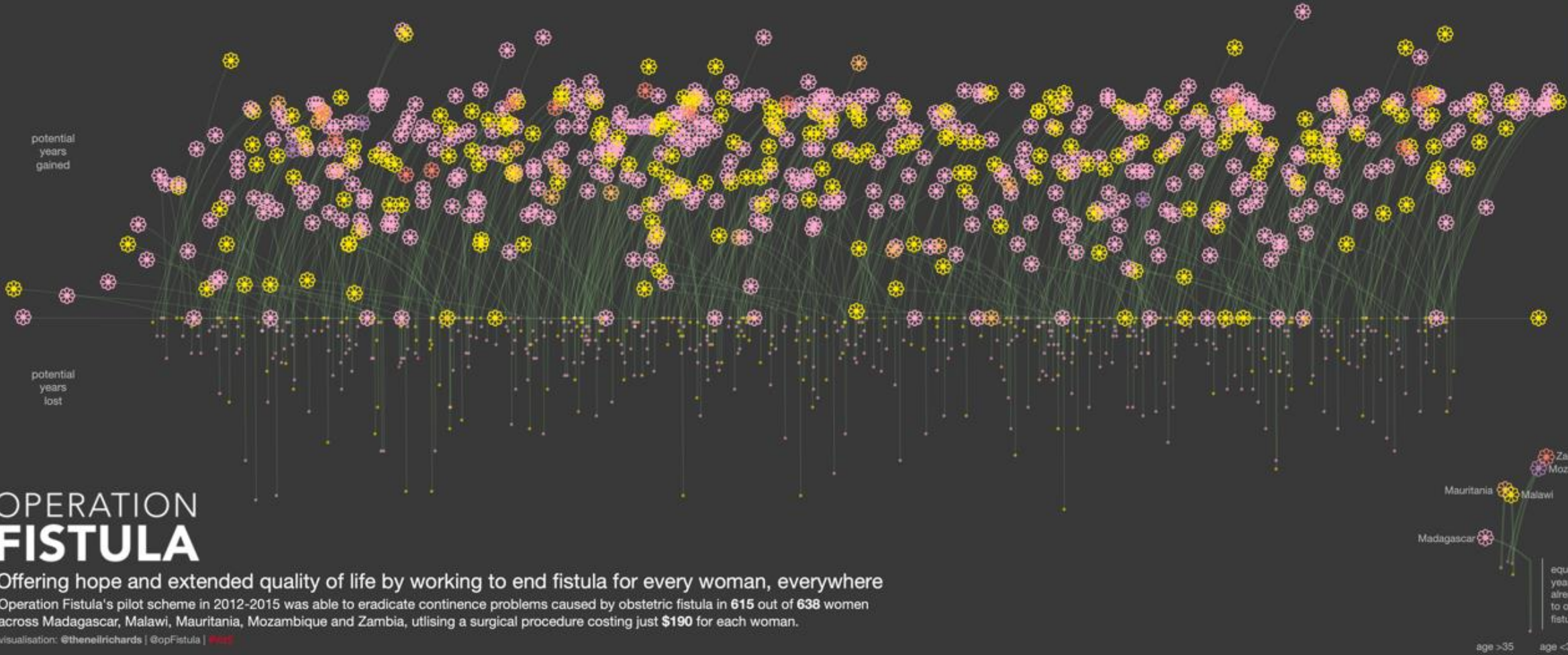
Women work in Technical position



'Most of us agree that tech could be a little more diverse.'

Dear Tech People





OPERATION FISTULA

Offering hope and extended quality of life by working to end fistula for every woman, everywhere

Operation Fistula's pilot scheme in 2012-2015 was able to eradicate continence problems caused by obstetric fistula in **615** out of **638** women across Madagascar, Malawi, Mauritania, Mozambique and Zambia, utilising a surgical procedure costing just **\$190** for each woman.

visualisation: @thenellrichards | @opFistula | [www.opfistula.org](#)

Zambia
Mozambique
Mauritania
Malawi
Madagascar

healthy years gained as a result of fistula surgery

equivalent years already lost to obstetric fistula

age >35 age <35

Even better than scatterplots

Scatterplots:

- Size
- Colour
- Position
- Shape

Flowers give you all of these plus

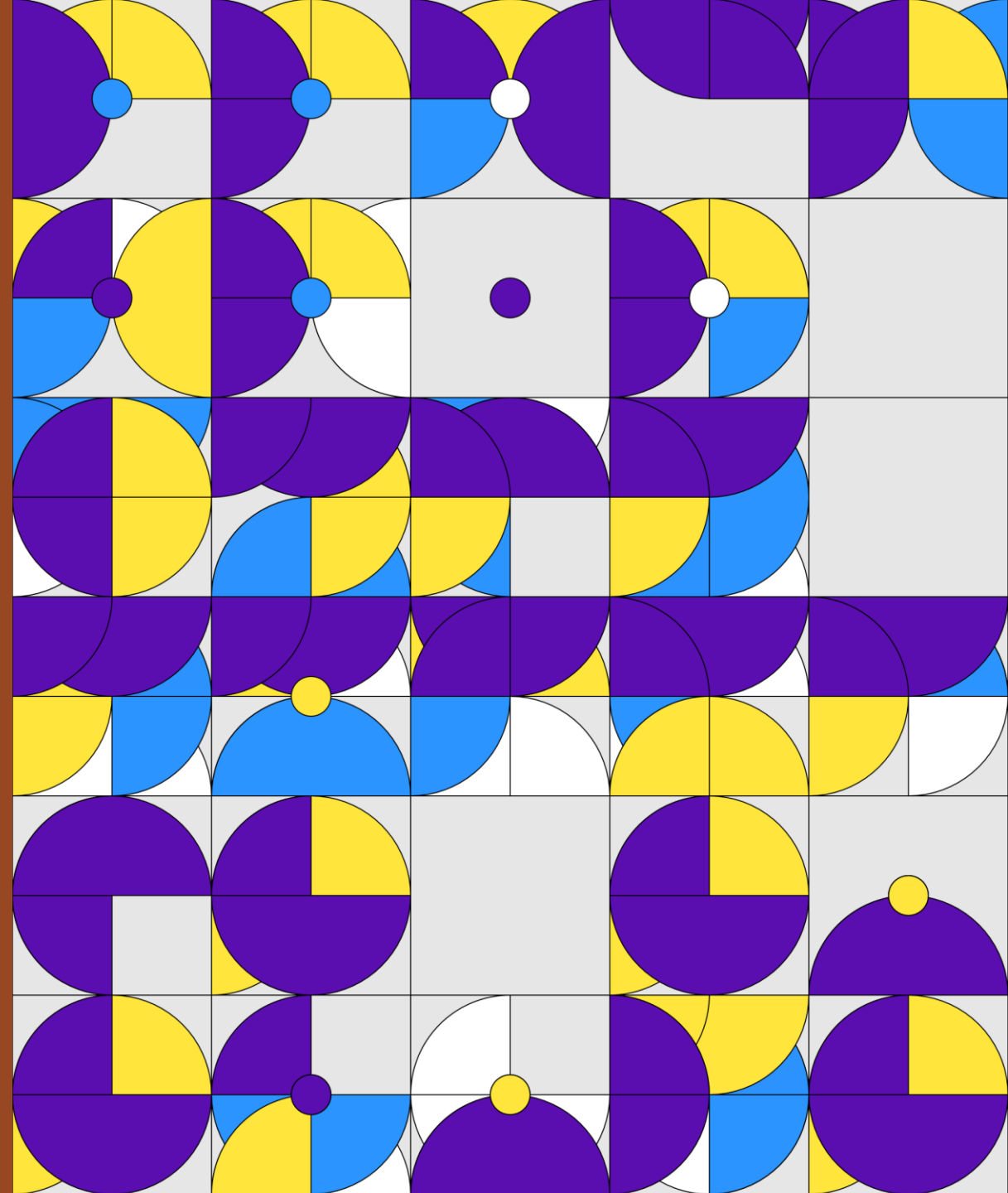
- Petal position
- Petal shape
- Stalk
- Colours of centres and petals
- ... etc



Not analytic

Geometric vizzes:

- Designed to be artistic
- Make the reader do work
- Annotations/legends low profile
- Not for clients / board meetings!





Alt Text



Design Ideas

Format Pict...

How would you describe this object and its context to someone who is blind?

(1-2 sentences recommended)

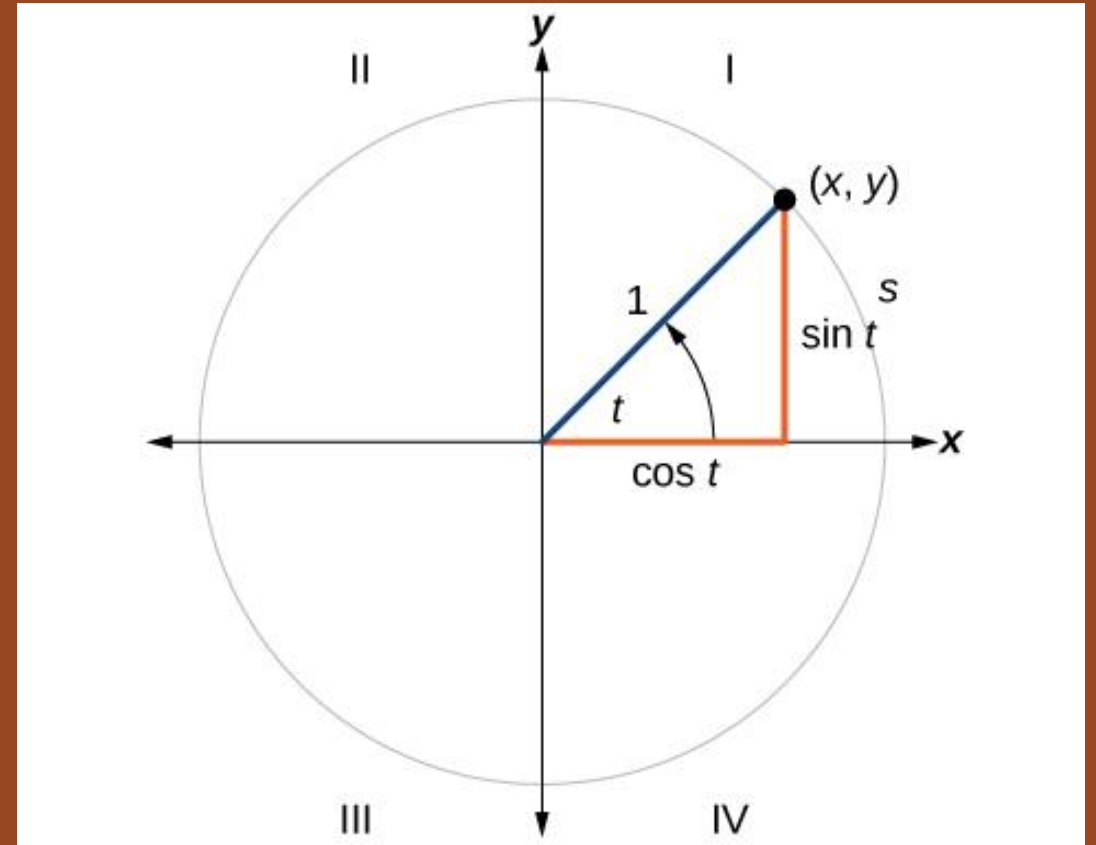
A group of colorful flowers

Description automatically generated with low confidence

Mark as decorative

Trigonometry

- Use to calculate points round a circle
- Use unit circle (radius 1) centred at $(0,0)$
- $x = \cos t$, $y = \sin t$



Shapes file

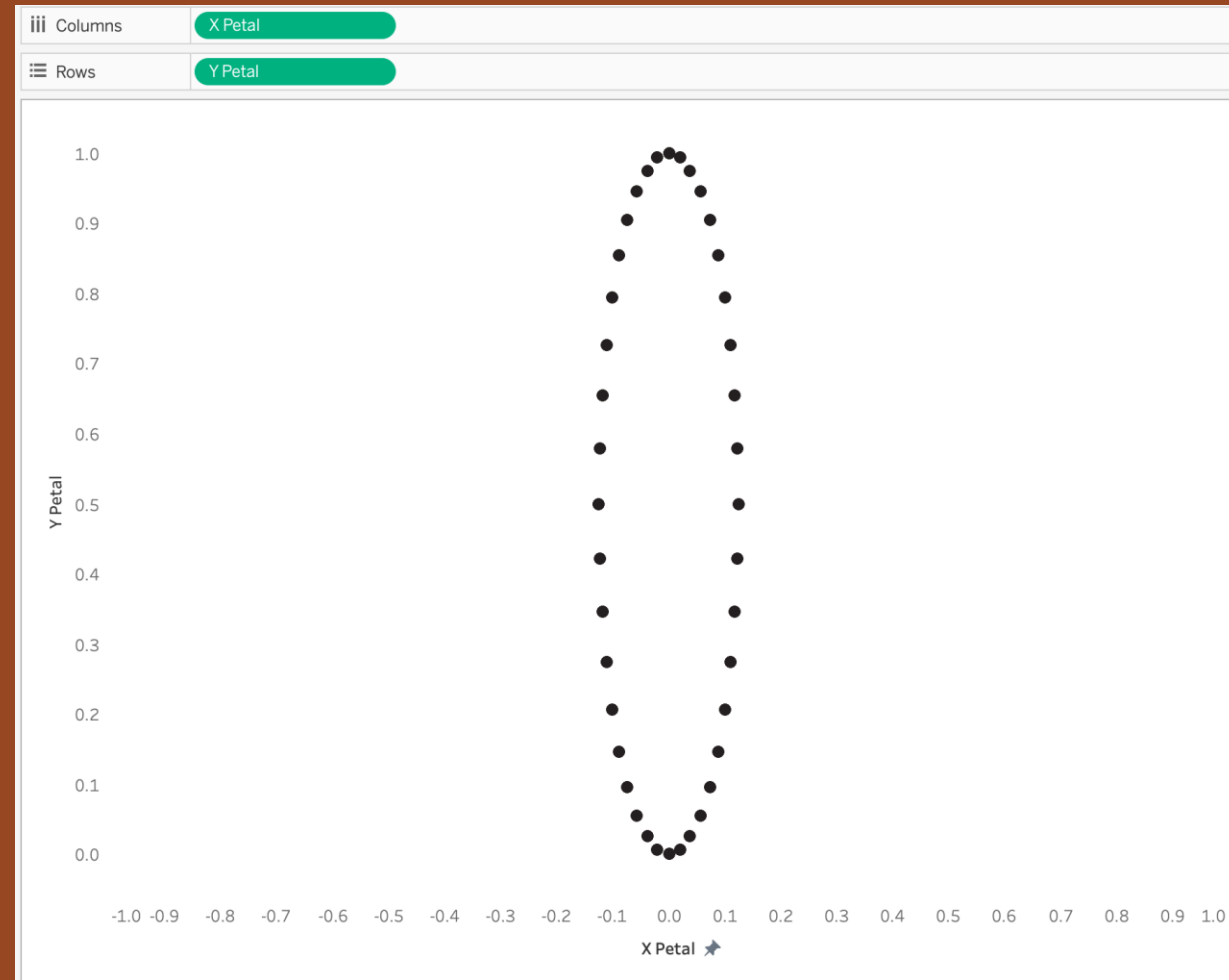
- All rows have constant col **Join=1**
- Re-use / add columns as often as you like
- Makes several copies of the data with **path id** as identifier (scaffolds)
- Don't need loads of points for a circle – 30 or so will do

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	join	path id	degrees	radians	x semi	y semi	degrees/2	x quarter	y quarter	degrees circl	rad circle	x tiny circle	y tiny circle	x box	y box
2	1	1	0	-90	-1.5707963	-100	0	-90	-100	0	0	0	10	-100	0
3	1	1	-85	-1.5271631	-99.61947	4.35778714	-87.5	-99.904822	4.361938737	10	0.17453293	1.73648178	9.84807753	-100	0
4	1	2	-80	-1.4835299	-98.480775	8.68240888	-85	-99.61947	8.715574275	20	0.34906585	3.42020143	9.39692621	-100	0
5	1	3	-75	-1.4398966	-96.592583	12.9409523	-82.5	-99.144486	13.05261922	30	0.52359878	5	8.66025404	-100	0
6	1	4	-70	-1.3962634	-93.969262	17.1010072	-80	-98.480775	17.36481777	40	0.6981317	6.4278761	7.66044443	-100	0
7	1	5	-65	-1.3526302	-90.630779	21.1309131	-77.5	-97.629601	21.64396139	50	0.87266463	7.66044443	6.4278761	-100	0
8	1	6	-60	-1.3089969	-86.60254	25	-75	-96.592583	25.88190451	60	1.04719755	8.66025404	5	-100	0
9	1	7	-55	-1.2653637	-81.915204	28.6788218	-72.5	-95.317695	30.07057995	70	1.22173048	9.39692621	3.42020143	-100	0
10	1	8	-50	-1.2217305	-76.604444	32.1393805	-70	-93.969262	34.20201433	80	1.3962634	9.84807753	1.73648178	-100	0
11	1	9	-45	-1.1780972	-70.710678	35.3553391	-67.5	-92.387953	38.26834324	90	1.57079633	10	0	-100	0
12	1	10	-40	-1.134464	-64.278761	38.3022222	-65	-90.630779	42.26182617	100	1.74532925	9.84807753	-1.7364818	-100	0
13	1	11	-35	-1.0908308	-57.357644	40.9576022	-62.5	-88.701083	46.17486132	110	1.91986218	9.39692621	-3.4202014	-100	0
14	1	12	-30	-1.0471976	-50	43.3012702	-60	-86.60254	50	120	2.0943951	8.66025404	-5	-100	0
15	1	13	-25	-1.0035643	-42.261826	45.3153894	-57.5	-84.339145	53.72996083	130	2.26892803	7.66044443	-6.4278761	-100	0
16	1	14	-20	-0.9599311	-34.202014	46.984631	-55	-81.915204	57.35764364	140	2.44346095	6.4278761	-7.6604444	-100	0
17	1	15	-15	-0.9162979	-25.881905	48.2962913	-52.5	-79.335334	60.8761429	150	2.61799388	5	-8.660254	-100	0
18	1	16	-10	-0.8726646	-17.364818	49.2403877	-50	-76.604444	64.27876097	160	2.7925268	3.42020143	-9.3969262	-100	0
19	1	17	-5	-0.8290314	-8.7155743	49.8097349	-47.5	-73.727734	67.55902076	170	2.96705973	1.73648178	-9.8480775	-100	0
20	1	18	0	-0.7853982	0	50	-45	-70.710678	70.71067812	180	3.141592653	0	-10	-100	0
21	1	19	5	-0.7417649	8.71557427	49.8097349	-42.5	-67.559021	73.72773368	190	3.31612558	-1.7364818	-9.8480775	-100	30
22	1	20	10	-0.6981317	17.3648178	49.2403877	-40	-64.278761	76.60444431	200	3.4906585	-3.4202014	-9.3969262	-100	30
23	1	21	15	-0.6544985	25.8819045	48.2962913	-37.5	-60.876143	79.33533403	210	3.66519143	-5	-8.660254	-100	30
24	1	22	20	-0.6108652	34.2020143	46.984631	-35	-57.357644	81.91520443	220	3.83972435	-6.4278761	-7.6604444	-100	30
25	1	23	25	-0.567232	42.2618262	45.3153894	-32.5	-53.729961	84.33914458	230	4.01425728	-7.6604444	-6.4278761	-100	30
26	1	24	30	-0.5235988	50	43.3012702	-30	-50	86.60254038	240	4.1887902	-8.660254	-5	-100	30
27	1	25	35	-0.4799655	57.3576436	40.9576022	-27.5	-46.174861	88.70108332	250	4.36332313	-9.3969262	-3.4202014	-100	30
28	1	26	40	-0.4363323	64.278761	38.3022222	-25	-42.261826	90.63077787	260	4.53785606	-9.8480775	-1.7364818	-100	30
29	1	27	45	-0.3926991	70.7106781	35.3553391	-22.5	-38.268343	92.38795325	270	4.71238898	-10	0	-100	30
30	1	28	50	-0.3490659	76.6044443	32.1393805	-20	-34.202014	93.96926208	280	4.88692191	-9.8480775	1.73648178	-100	30
31	1	29	55	-0.3054326	81.9152044	28.6788218	-17.5	-30.07058	95.37169507	290	5.06145483	-9.3969262	3.42020143	-100	30
32	1	30	60	-0.2617994	86.6025404	25	-15	-25.881905	96.59258263	300	5.23598776	-8.660254	5	-100	30
33	1	31	65	-0.2181662	90.6307787	21.1309131	-12.5	-21.643961	97.62960071	310	5.41052068	-7.6604444	6.4278761	-100	30
34	1	32	70	-0.1745329	93.9692621	17.1010072	-10	-17.364818	98.48077753	320	5.58505361	-6.4278761	7.66044443	-100	30
35	1	33	75	-0.1308997	96.5925826	12.9409523	-7.5	-13.052619	99.14448614	330	5.75958653	-5	8.66025404	-100	30
36	1	34	80	-0.0872665	98.4807753	8.68240888	-5	-8.7155743	99.61946981	340	5.93411946	-3.4202014	9.39692621	-100	30
37	1	35	85	-0.0436332	99.6194698	4.35778714	-2.5	-4.3619387	99.90482216	350	6.10865238	-1.7364818	9.84807753	-100	30
38	1	36	90	0	100	0	0	0	100	360	6.28318531	0	10	-100	30
39	1	37	0	-1.5707963	-100	0	-90	0	0	0	0	0	10	-100	0
40	1	38	0	-1.5707963	-100	0	-90	-100	0	0	0	0	10	-100	0

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	join	path id	degrees	radians	x semi	y semi	degrees/2	x quarter	y quarter	degrees circle	rad circle	x tiny circle	y tiny circle	x box	y box
2	1	0	-90	-1.5707963	-100	0	-90	-100	0	0	0	0	10	-100	0
3	1	1	-85	-1.5271631	-99.61947	4.35778714	-87.5	-99.904822	4.361938737	10	0.17453293	1.73648178	9.84807753	-100	0
4	1	2	-80	-1.4835299	-98.480775	8.68240888	-85	-99.61947	8.715574275	20	0.34906585	3.42020143	9.39692621	-100	0
5	1	3	-75	-1.4398966	-96.592583	12.9409523	-82.5	-99.144486	13.05261922	30	0.52359878	5	8.66025404	-100	0
6	1	4	-70	-1.3962634	-93.969262	17.1010072	-80	-98.480775	17.36481777	40	0.6981317	6.4278761	7.66044443	-100	0
7	1	5	-65	-1.3526302	-90.630779	21.1309131	-77.5	-97.629601	21.64396139	50	0.87266463	7.66044443	6.4278761	-100	0
8	1	6	-60	-1.3089969	-86.60254	25	-75	-96.592583	25.88190451	60	1.04719755	8.66025404	5	-100	0
9	1	7	-55	-1.2653637	-81.915204	28.6788218	-72.5	-95.371695	30.07057995	70	1.22173048	9.39692621	3.42020143	-100	0
10	1	8	-50	-1.2217305	-76.604444	32.1393805	-70	-93.969262	34.20201433	80	1.3962634	9.84807753	1.73648178	-100	0
11	1	9	-45	-1.1780972	-70.710678	35.3553391	-67.5	-92.387953	38.26834324	90	1.57079633	10	0	-100	0
12	1	10	-40	-1.134464	-64.278761	38.3022222	-65	-90.630779	42.26182617	100	1.74532925	9.84807753	-1.7364818	-100	0
13	1	11	-35	-1.0908308	-57.357644	40.9576022	-62.5	-88.701083	46.17486132	110	1.91986218	9.39692621	-3.4202014	100	0
14	1	12	-30	-1.0471976	-50	43.3012702	-60	-86.60254	50	120	2.0943951	8.66025404	-5	100	0
15	1	13	-25	-1.0035643	-42.261826	45.3153894	-57.5	-84.339145	53.72996083	130	2.26892803	7.66044443	-6.4278761	100	0
16	1	14	-20	-0.9599311	-34.202014	46.984631	-55	-81.915204	57.35764364	140	2.44346095	6.4278761	-7.6604444	100	0
17	1	15	-15	-0.9162979	-25.881905	48.2962913	-52.5	-79.335334	60.8761429	150	2.61799388	5	-8.660254	100	0
18	1	16	-10	-0.8726646	-17.364818	49.2403877	-50	-76.604444	64.27876097	160	2.7925268	3.42020143	-9.3969262	100	0
19	1	17	-5	-0.8290314	-8.7155743	49.8097349	-47.5	-73.727734	67.55902076	170	2.96705973	1.73648178	-9.8480775	100	0
20	1	18	0	-0.7853982	0	50	-45	-70.710678	70.71067812	180	3.14159265	0	-10	100	0
21	1	19	5	-0.7417649	8.71557427	49.8097349	-42.5	-67.559021	73.72773368	190	3.31612558	-1.7364818	-9.8480775	100	30
22	1	20	10	-0.6981317	17.3648178	49.2403877	-40	-64.278761	76.60444431	200	3.4906585	-3.4202014	-9.3969262	100	30
23	1	21	15	-0.6544985	25.8819045	48.2962913	-37.5	-60.876143	79.33533403	210	3.66519143	-5	-8.660254	100	30
24	1	22	20	-0.6108652	34.2020143	46.984631	-35	-57.357644	81.91520443	220	3.83972435	-6.4278761	-7.6604444	100	30
25	1	23	25	-0.567232	42.2618262	45.3153894	-32.5	-53.729961	84.33914458	230	4.01425728	-7.6604444	-6.4278761	100	30
26	1	24	30	-0.5235988	50	43.3012702	-30	-50	86.60254038	240	4.1887902	-8.660254	-5	100	30
27	1	25	35	-0.4799655	57.3576436	40.9576022	-27.5	-46.174861	88.70108332	250	4.36332313	-9.3969262	-3.4202014	100	30
28	1	26	40	-0.4363323	64.278761	38.3022222	-25	-42.261826	90.6307787	260	4.53785606	-9.8480775	-1.7364818	-100	30
29	1	27	45	-0.3926991	70.7106781	35.3553391	-22.5	-38.268343	92.38795325	270	4.71238898	-10	0	-100	30
30	1	28	50	-0.3490659	76.6044443	32.1393805	-20	-34.202014	93.96926208	280	4.88692191	-9.8480775	1.73648178	-100	30
31	1	29	55	-0.3054326	81.9152044	28.6788218	-17.5	-30.07058	95.37169507	290	5.06145483	-9.3969262	3.42020143	-100	30
32	1	30	60	-0.2617994	86.6025404	25	-15	-25.881905	96.59258263	300	5.23598776	-8.660254	5	-100	30
33	1	31	65	-0.2181662	90.6307787	21.1309131	-12.5	-21.643961	97.62960071	310	5.41052068	-7.6604444	6.4278761	-100	30
34	1	32	70	-0.1745329	93.9692621	17.1010072	-10	-17.364818	98.4807753	320	5.58505361	-6.4278761	7.66044443	-100	30
35	1	33	75	-0.1308997	96.5925826	12.9409523	-7.5	-13.052619	99.14448614	330	5.75958653	-5	8.66025404	-100	30
36	1	34	80	-0.0872665	98.4807753	8.68240888	-5	-8.7155743	99.61946981	340	5.93411946	-3.4202014	9.39692621	-100	30
37	1	35	85	-0.0436332	99.6194698	4.35778714	-2.5	-4.3619387	99.90482216	350	6.10865238	-1.7364818	9.84807753	-100	30
38	1	36	90	0	100	0	0	0	100	360	6.28318531	0	10	-100	30
39	1	37	0	-1.5707963	-100	0	-90	0	0	0	0	0	10	-100	0
40	1	38	0	-1.5707963	-100	0	-90	-100	0	0	0	0	10	-100	0

Petals

- Include in shapes file
- Design your own shape
- This is an elongated circle
 - Y values translated so range from 0 to 1 (not -1 to 1)
- Gives a long, thin, vertical petal
- Petals need to rotate depending on where they start around the flower
- Deliberately chose (0,0) at bottom



Positioning of Petals

- Use trigonometry to determine start
- Central circle radius proportional to team score
- Position based on player number
- Petals will all be vertical pointing up

X Petal Start

Sheet2 (premier league

[X1 circle centre]

```
+ ([Total Team Score] * [centre slider]  
* sin(radians(9 * [Player Number numeric])))
```

X

She

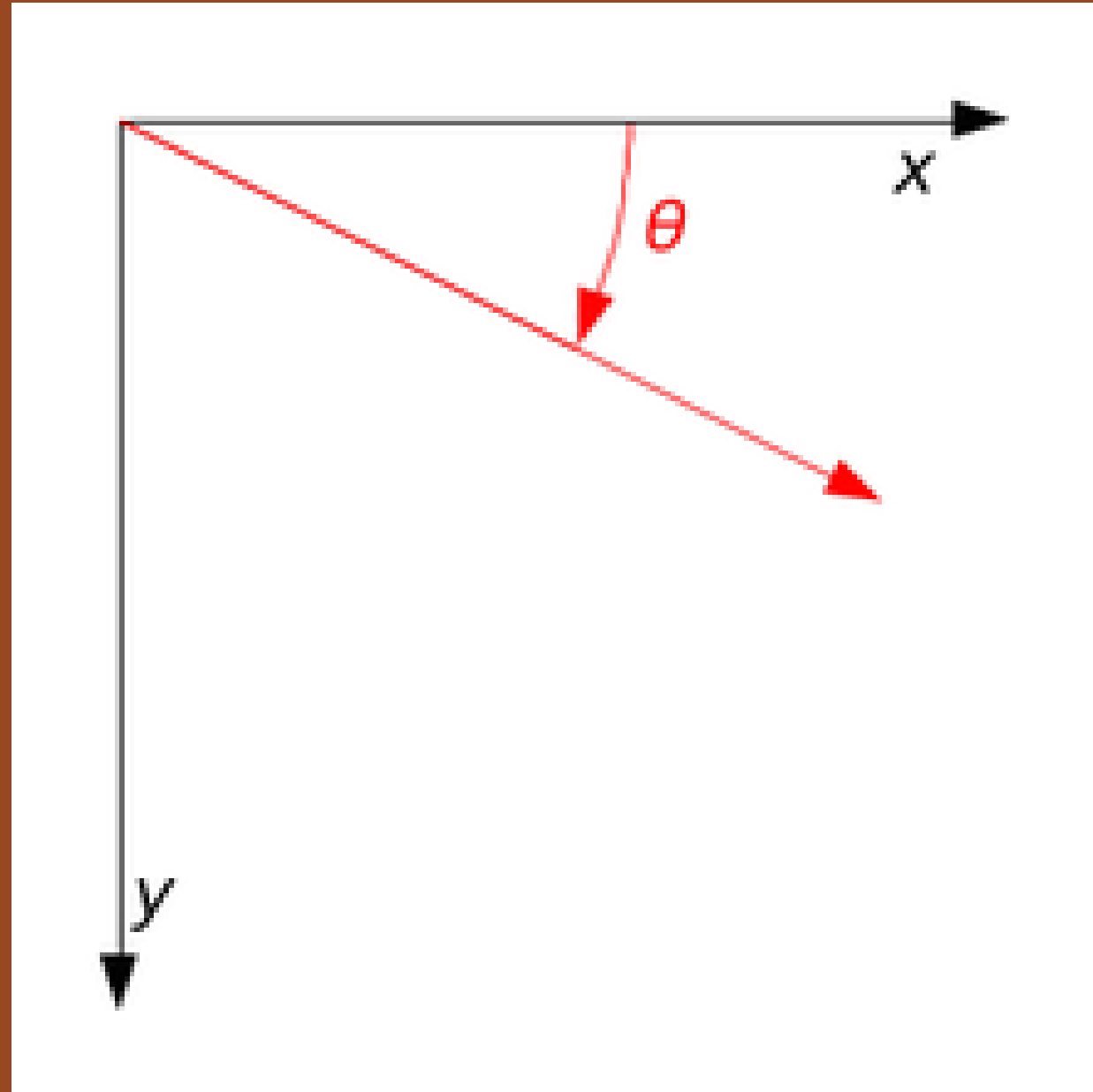
```
[X Petal Start] +  
([X Petal]*3*[Matches Played])
```



Formula to rotate

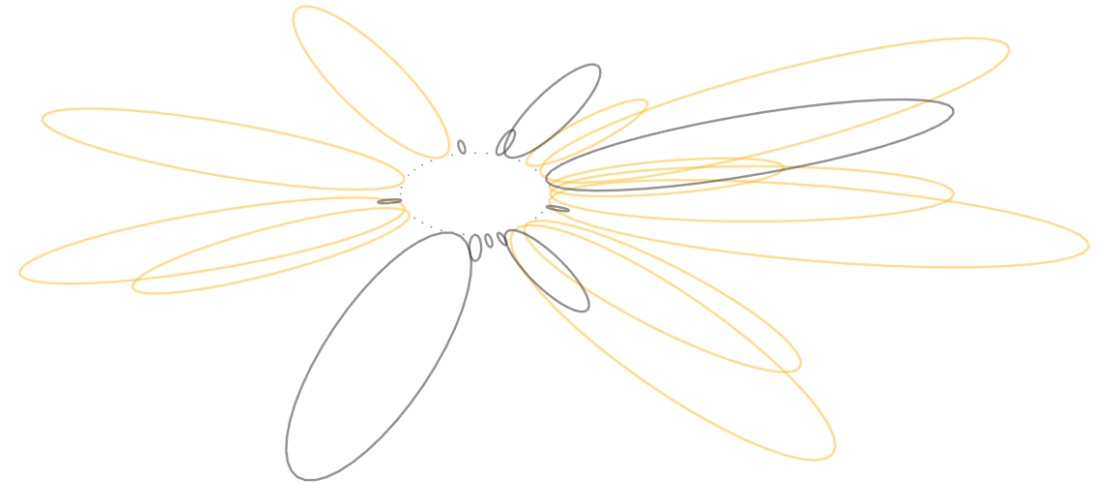
- Rotate point (x,y) through angle θ
- Rotation is relative to $(0,0)$
- Easy to google!

$$\begin{aligned}x' &= x \cos \theta - y \sin \theta \\y' &= x \sin \theta + y \cos \theta.\end{aligned}$$



Rotating petals

- Use formula to rotate
- Create X rotated / Y rotated
- Then add *rotated* petals to your petal start points



X petal rotated

Sheet2 (premier league lineups)

```
-( [X Petal] * cos(RADIANS([Player Number numeric]*9)))  
+ ([Y Petal] * sin(RADIANS([Player Number numeric]*9)))
```

Y petal rotated

Sheet2 (premier league lineups)

```
( [X Petal] * sin(RADIANS([Player Number numeric]*9)))  
+ ([Y Petal] * cos(RADIANS([Player Number numeric]*9)))
```

X

Sheet2 (premier league lineups)

```
[X Petal Start] +  
( [X petal rotated]*3*[Matches Played])
```

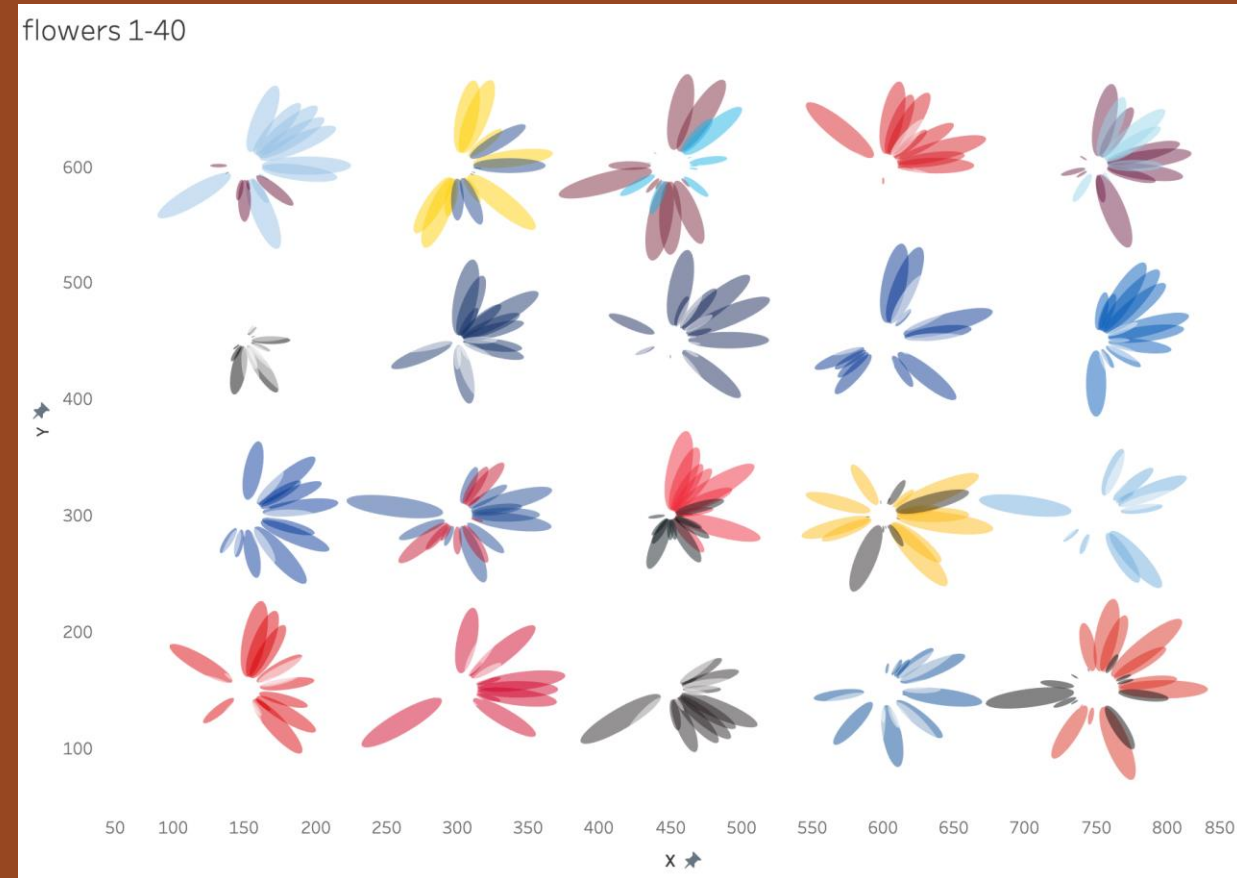
Y

Sheet2 (premier league lineups)

```
[Y Petal Start ] +  
( [Y petal rotated]*3*[Matches Played])
```

Worksheet

- **Fix your axes!**
- Squares:
 - Use **exact** ratio of rows/cols
 - Example (before stalks):
 - X 50 – 850 (800 wide)
 - Y 50 – 690 (640 tall)
 - Ratio 5:4
- Other shapes:
 - Multiply ratio above by width/height ratio of shape ...



Summary

- Question your basic principles
 - Which do you need to apply, and which could you bend/break?
 - Which are more complex than they might seem?
- Think about questions you might not have thought of before
 - Does it suggest a technique you haven't used?
 - Do it make you consider things differently / widen your scope
- Think of a brand new idea in data visualisation
 - What are the pros and cons of this idea?
 - Will you enjoy the process and flex your creative muscle?
 - Will it suit an audience disposed to creative/artistic output?
- Tableau is your blank canvas ... of graph paper.
 - Questions lead to ideas, improving creativity and skills, increasing fun

QUESTIONS IN DATAVIZ

NEIL RICHARDS

ANY QUESTIONS?



@theneilrichards

questionsindataviz.com

<https://public.tableau.com/profile/neil.richards#!/>

<https://www.linkedin.com/in/neilrichards1/>

