

# Intro to data visualization

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Palaeoverse hackathon

7<sup>th</sup> & 8<sup>th</sup> September 2023

UCL, London



# Schedule

1. 10 mins theory
2. 50 mins practical



# Theory

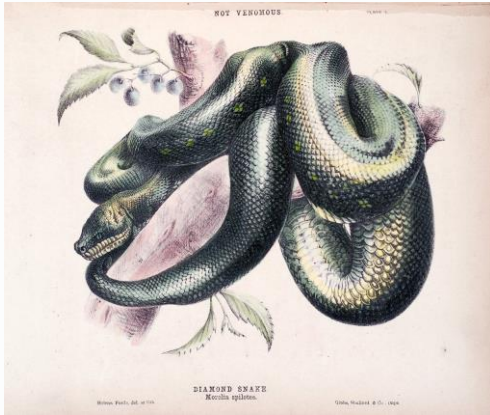
1. What is data visualization
2. Basic design principles (colour & type)
3. What graph for what data
4. Common mistakes
5. File types



# What is data visualization

The representation of data  
through the use of **graphs**.

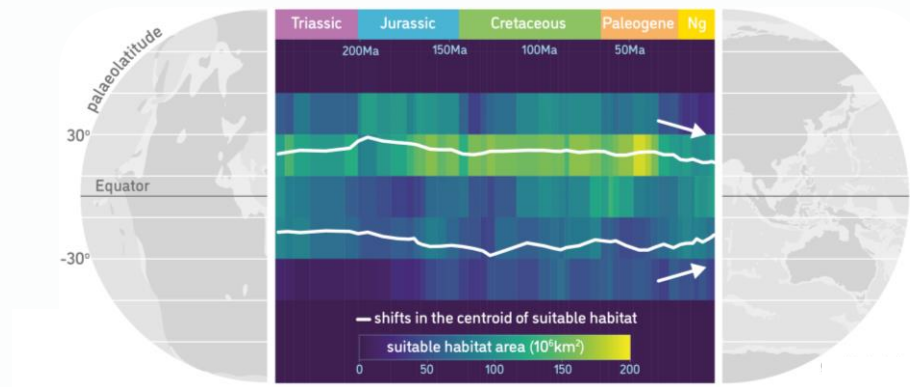
# What is data visualization



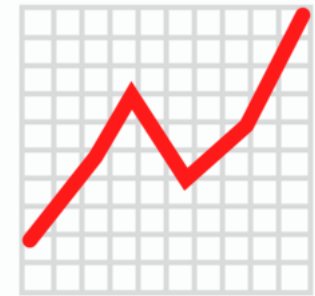
Figurative  
illustrations



figurative



Illustrated  
explanatory graphics



abstract

# Basic design principles

**Colour**

**Type**

**Positioning** (ggplot and R take care of that mostly)

# Basic design principles Colour

- Colours can be specified by an **RGB** or **HEX** code

#ffebee rgb(255, 235, 239)	#fce4ec rgb(255, 235, 239)	#f3e5f5 rgb(255, 235, 240)	#ede7f6 rgb(235, 235, 240)	#e8eaf6 rgb(235, 235, 240)	#e3f2fd rgb(235, 235, 240)	#e1f5fe rgb(235, 235, 240)	#e0f7fa rgb(235, 235, 240)	#e0f2f1 rgb(235, 235, 240)	#e8f5e9 rgb(235, 235, 240)	#f1f8e9 rgb(235, 235, 240)	#f9f7e7 rgb(235, 235, 240)	#fffde7 rgb(235, 235, 240)	#fff1e0 rgb(235, 235, 240)	#ffe0b2 rgb(235, 235, 240)	#ffccbc rgb(235, 235, 240)	#d7ccc8 rgb(235, 235, 240)	#f5f5f5 rgb(235, 235, 240)	#e0e0e0 rgb(235, 235, 240)	#ffffff rgb(235, 235, 240)
#ffccdd rgb(255, 235, 239)	#ffb3d0 rgb(255, 235, 239)	#e1bee7 rgb(235, 235, 240)	#d1c4e9 rgb(235, 235, 240)	#c5cae9 rgb(235, 235, 240)	#bbdefb rgb(235, 235, 240)	#b3e5fc rgb(235, 235, 240)	#b2ebf2 rgb(235, 235, 240)	#b2dfdb rgb(235, 235, 240)	#c8e6c9 rgb(235, 235, 240)	#dcedc8 rgb(235, 235, 240)	#f0f4c1 rgb(235, 235, 240)	#fff9c4 rgb(235, 235, 240)	#ffe0b2 rgb(235, 235, 240)	#ffccbc rgb(235, 235, 240)	#d7ccc8 rgb(235, 235, 240)	#f5f5f5 rgb(235, 235, 240)	#e0e0e0 rgb(235, 235, 240)	#ffffff rgb(235, 235, 240)	#000000 rgb(0, 0, 0)
#ef9e9e rgb(255, 235, 239)	#f48fb1 rgb(255, 235, 239)	#ce93d8 rgb(235, 235, 240)	#b39ddb rgb(235, 235, 240)	#9fa8da rgb(235, 235, 240)	#90caf9 rgb(235, 235, 240)	#81d4fa rgb(235, 235, 240)	#80deea rgb(235, 235, 240)	#80cbc4 rgb(235, 235, 240)	#a5d6a7 rgb(235, 235, 240)	#c5e1a5 rgb(235, 235, 240)	#e6ee9c rgb(235, 235, 240)	#fff176 rgb(235, 235, 240)	#ffe082 rgb(235, 235, 240)	#ffcc80 rgb(235, 235, 240)	#ffab91 rgb(235, 235, 240)	#bcaaa4 rgb(235, 235, 240)	#eeeeee rgb(235, 235, 240)	#b0bec5 rgb(235, 235, 240)	#ffffff rgb(235, 235, 240)
#e57373 rgb(255, 235, 239)	#f06292 rgb(255, 235, 239)	#ba68c8 rgb(235, 235, 240)	#9575cd rgb(235, 235, 240)	#7986cb rgb(235, 235, 240)	#64b5f6 rgb(235, 235, 240)	#4fc3f7 rgb(235, 235, 240)	#4dd0e1 rgb(235, 235, 240)	#4db6ac rgb(235, 235, 240)	#81c784 rgb(235, 235, 240)	#aed581 rgb(235, 235, 240)	#dce775 rgb(235, 235, 240)	#fff176 rgb(235, 235, 240)	#ff541f rgb(235, 235, 240)	#ff7043 rgb(235, 235, 240)	#ff8a65 rgb(235, 235, 240)	#a1887f rgb(235, 235, 240)	#e0e0e0 rgb(235, 235, 240)	#90a4ae rgb(235, 235, 240)	#ffffff rgb(235, 235, 240)
#ef5350 rgb(255, 235, 239)	#ec407a rgb(255, 235, 239)	#ab47bc rgb(235, 235, 240)	#7e57c2 rgb(235, 235, 240)	#5c6bc0 rgb(235, 235, 240)	#42a5f5 rgb(235, 235, 240)	#29b6f6 rgb(235, 235, 240)	#26c6da rgb(235, 235, 240)	#26a69a rgb(235, 235, 240)	#66bb6a rgb(235, 235, 240)	#9ccc65 rgb(235, 235, 240)	#d4e157 rgb(235, 235, 240)	#ffe580 rgb(235, 235, 240)	#ffcc80 rgb(235, 235, 240)	#ffa726 rgb(235, 235, 240)	#ff7043 rgb(235, 235, 240)	#8d6e63 rgb(235, 235, 240)	#bdbdbd rgb(235, 235, 240)	#78909c rgb(235, 235, 240)	#ffffff rgb(235, 235, 240)
#f44336 rgb(255, 235, 239)	#e91e63 rgb(255, 235, 239)	#9c27b0 rgb(235, 235, 240)	#673ab7 rgb(235, 235, 240)	#3f51b5 rgb(235, 235, 240)	#2196f3 rgb(235, 235, 240)	#03a9f4 rgb(235, 235, 240)	#00bcd4 rgb(235, 235, 240)	#009688 rgb(235, 235, 240)	#4caf50 rgb(235, 235, 240)	#8bc34a rgb(235, 235, 240)	#cddc39 rgb(235, 235, 240)	#ffeb3b rgb(235, 235, 240)	#ffc107 rgb(235, 235, 240)	#ff9800 rgb(235, 235, 240)	#ff5722 rgb(235, 235, 240)	#795548 rgb(235, 235, 240)	#9e9e9e rgb(235, 235, 240)	#607d8b rgb(235, 235, 240)	#ffffff rgb(235, 235, 240)
#e53935 rgb(255, 235, 239)	#d81b60 rgb(255, 235, 239)	#8c24aa rgb(235, 235, 240)	#5e35b1 rgb(235, 235, 240)	#3949ab rgb(235, 235, 240)	#1e88e5 rgb(235, 235, 240)	#039be5 rgb(235, 235, 240)	#00acc1 rgb(235, 235, 240)	#00897b rgb(235, 235, 240)	#43a047 rgb(235, 235, 240)	#7cb342 rgb(235, 235, 240)	#c0ca33 rgb(235, 235, 240)	#fad335 rgb(235, 235, 240)	#ffb300 rgb(235, 235, 240)	#ffb800 rgb(235, 235, 240)	#ff5722 rgb(235, 235, 240)	#8d6e63 rgb(235, 235, 240)	#bdbdbd rgb(235, 235, 240)	#78909c rgb(235, 235, 240)	#ffffff rgb(235, 235, 240)
#d32f2f rgb(255, 235, 239)	#c2185b rgb(255, 235, 239)	#7b1fa2 rgb(235, 235, 240)	#512da8 rgb(235, 235, 240)	#303f9f rgb(235, 235, 240)	#1976d2 rgb(235, 235, 240)	#0288d1 rgb(235, 235, 240)	#0097a7 rgb(235, 235, 240)	#00796b rgb(235, 235, 240)	#388e3c rgb(235, 235, 240)	#689f38 rgb(235, 235, 240)	#afb42b rgb(235, 235, 240)	#ffc107 rgb(235, 235, 240)	#ffa000 rgb(235, 235, 240)	#ff5722 rgb(235, 235, 240)	#e64a19 rgb(235, 235, 240)	#5d4037 rgb(235, 235, 240)	#616161 rgb(235, 235, 240)	#455454 rgb(235, 235, 240)	#ffffff rgb(235, 235, 240)
#c62828 rgb(255, 235, 239)	#ad1457 rgb(255, 235, 239)	#6a1b9a rgb(235, 235, 240)	#4527a0 rgb(235, 235, 240)	#283593 rgb(235, 235, 240)	#1565c0 rgb(235, 235, 240)	#0277bd rgb(235, 235, 240)	#00838f rgb(235, 235, 240)	#00696c rgb(235, 235, 240)	#2e7d32 rgb(235, 235, 240)	#588b2f rgb(235, 235, 240)	#9e9e24 rgb(235, 235, 240)	#f9a825 rgb(235, 235, 240)	#ff9800 rgb(235, 235, 240)	#ff5722 rgb(235, 235, 240)	#d84315 rgb(235, 235, 240)	#4e342e rgb(235, 235, 240)	#424242 rgb(235, 235, 240)	#272727 rgb(235, 235, 240)	#ffffff rgb(235, 235, 240)
#b71c1c rgb(255, 235, 239)	#880e4f rgb(255, 235, 239)	#4a148c rgb(235, 235, 240)	#311b92 rgb(235, 235, 240)	#1a237e rgb(235, 235, 240)	#0d47a1 rgb(235, 235, 240)	#01579b rgb(235, 235, 240)	#006064 rgb(235, 235, 240)	#004d40 rgb(235, 235, 240)	#1b5e20 rgb(235, 235, 240)	#33691e rgb(235, 235, 240)	#277717 rgb(235, 235, 240)	#157117 rgb(235, 235, 240)	#ff6600 rgb(235, 235, 240)	#e65100 rgb(235, 235, 240)	#b3600c rgb(235, 235, 240)	#3e2723 rgb(235, 235, 240)	#212121 rgb(235, 235, 240)	#263238 rgb(235, 235, 240)	#ffffff rgb(235, 235, 240)

#ff8a80 rgb(255, 235, 239)	#ff80ab rgb(255, 235, 239)	#ea80fc rgb(235, 235, 240)	#b38ff1 rgb(235, 235, 240)	#8c9eff rgb(235, 235, 240)	#82bfff rgb(235, 235, 240)	#80d8ff rgb(235, 235, 240)	#84ffff rgb(235, 235, 240)	#a7ffeb rgb(235, 235, 240)	#b9f5ca rgb(235, 235, 240)	#ccff90 rgb(235, 235, 240)	#4ff181 rgb(235, 235, 240)	#ffff8d rgb(235, 235, 240)	#ffe571 rgb(235, 235, 240)	#ffd180 rgb(235, 235, 240)	#ff9e80 rgb(235, 235, 240)
#ff5252 rgb(255, 235, 239)	#ff4081 rgb(255, 235, 239)	#e040fb rgb(235, 235, 240)	#7cdfff rgb(235, 235, 240)	#536eff rgb(235, 235, 240)	#448aff rgb(235, 235, 240)	#40caff rgb(235, 235, 240)	#18ffff rgb(235, 235, 240)	#64ffda rgb(235, 235, 240)	#69ffae rgb(235, 235, 240)	#b2ff59 rgb(235, 235, 240)	#eeff41 rgb(235, 235, 240)	#ffff00 rgb(235, 235, 240)	#ffd740 rgb(235, 235, 240)	#ffab40 rgb(235, 235, 240)	#ff6e40 rgb(235, 235, 240)
#ff1744 rgb(255, 235, 239)	#ff0057 rgb(255, 235, 239)	#d5009f rgb(235, 235, 240)	#65ffff rgb(235, 235, 240)	#3d5afe rgb(235, 235, 240)	#2979ff rgb(235, 235, 240)	#00b0ff rgb(235, 235, 240)	#00e5ff rgb(235, 235, 240)	#1de9b6 rgb(235, 235, 240)	#00e676 rgb(235, 235, 240)	#76ff03 rgb(235, 235, 240)	#c6ff00 rgb(235, 235, 240)	#ffea00 rgb(235, 235, 240)	#ffc400 rgb(235, 235, 240)	#ff9100 rgb(235, 235, 240)	#ff3d00 rgb(235, 235, 240)
#d00000 rgb(255, 235, 239)	#d51162 rgb(255, 235, 239)	#d000ff rgb(235, 235, 240)	#6200ea rgb(235, 235, 240)	#3041ff rgb(235, 235, 240)	#2962ff rgb(235, 235, 240)	#0099ff rgb(235, 235, 240)	#00b0ff rgb(235, 235, 240)	#00b0ff rgb(235, 235, 240)	#00b0ff rgb(235, 235, 240)	#64d1ff rgb(235, 235, 240)	#eeea00 rgb(235, 235, 240)	#ff6600 rgb(235, 235, 240)	#ff6600 rgb(235, 235, 240)	#ff6600 rgb(235, 235, 240)	#d4d400 rgb(235, 235, 240)

<b>#ffebee</b> rgb(255, 235, 238)	<b>#fce4ec</b> rgb(252, 228, 236)	<b>#f3e5f5</b> rgb(243, 229, 245)	<b>#ede7f6</b> rgb(227, 231, 246)	<b>#e8eaf6</b> rgb(232, 234, 246)	<b>#e3f2fd</b> rgb(227, 242, 253)	<b>#e1f5fe</b> rgb(225, 245, 254)	<b>#e0f7fa</b> rgb(224, 247, 250)	<b>#e0f2f1</b> rgb(224, 242, 249)	<b>#e8f5e9</b> rgb(232, 245, 233)	<b>#fff8e9</b> rgb(241, 248, 233)	<b>#f9fbe7</b> rgb(249, 251, 239)	<b>#ffde7</b> rgb(255, 253, 239)	<b>#fff8e1</b> rgb(255, 248, 229)	<b>#fff3e0</b> rgb(255, 243, 224)	<b>#fbe9e7</b> rgb(251, 233, 231)	<b>#efebe9</b> rgb(239, 235, 233)	<b>#fafafa</b> rgb(250, 250, 250)	<b>#eceff1</b> rgb(236, 239, 249)
<b>#ffcd2</b> rgb(255, 205, 210)	<b>#f8bbd0</b> rgb(248, 187, 208)	<b>#e1bee7</b> rgb(225, 190, 239)	<b>#d1c4e9</b> rgb(209, 196, 233)	<b>#c5cae9</b> rgb(197, 202, 233)	<b>#bbdefb</b> rgb(187, 222, 259)	<b>#b3e5fc</b> rgb(179, 229, 252)	<b>#b2ebf2</b> rgb(178, 235, 242)	<b>#c5dcd8</b> rgb(178, 223, 219)	<b>#c8e6c9</b> rgb(200, 230, 209)	<b>#dcedc8</b> rgb(220, 237, 200)	<b>#f0f4c3</b> rgb(240, 244, 195)	<b>#fff9c4</b> rgb(255, 249, 196)	<b>#ffecb3</b> rgb(255, 236, 179)	<b>#ffe0b2</b> rgb(255, 224, 178)	<b>#ffccbc</b> rgb(255, 204, 188)	<b>#d7ccc8</b> rgb(215, 204, 200)	<b>#f5f5f5</b> rgb(245, 245, 245)	<b>#cfd8dc</b> rgb(207, 226, 220)
<b>#ef9a9a</b> rgb(239, 154, 154)	<b>#f48fb1</b> rgb(244, 143, 177)	<b>#ce93d8</b> rgb(206, 147, 216)	<b>#b39ddb</b> rgb(179, 157, 219)	<b>#9fa8da</b> rgb(159, 168, 218)	<b>#90caf9</b> rgb(144, 202, 249)	<b>#81d4fa</b> rgb(129, 212, 250)	<b>#80deea</b> rgb(128, 222, 234)	<b>#80cbc4</b> rgb(128, 203, 196)	<b>#a5d6a7</b> rgb(165, 214, 167)	<b>#c5e1a5</b> rgb(197, 225, 165)	<b>#e6ee9c</b> rgb(230, 238, 156)	<b>#fff59d</b> rgb(255, 245, 157)	<b>#ffe082</b> rgb(255, 224, 130)	<b>#ffcc80</b> rgb(255, 204, 128)	<b>#ffab91</b> rgb(255, 171, 145)	<b>#bcaaa4</b> rgb(188, 170, 164)	<b>#eeeeee</b> rgb(238, 238, 238)	<b>#b0bec5</b> rgb(176, 190, 197)
<b>#e57373</b> rgb(229, 115, 115)	<b>#f06292</b> rgb(240, 98, 146)	<b>#ba68c8</b> rgb(186, 104, 200)	<b>#9575cd</b> rgb(149, 117, 205)	<b>#7986cb</b> rgb(121, 134, 203)	<b>#64b5f6</b> rgb(100, 181, 246)	<b>#4fc3f7</b> rgb(79, 195, 247)	<b>#4dd0e1</b> rgb(77, 208, 229)	<b>#4db6ac</b> rgb(77, 182, 172)	<b>#81c784</b> rgb(129, 199, 132)	<b>#aed581</b> rgb(174, 213, 129)	<b>#dce775</b> rgb(220, 231, 117)	<b>#fff176</b> rgb(255, 241, 118)	<b>#ffd54f</b> rgb(255, 213, 79)	<b>#ff7f4d</b> rgb(255, 133, 77)	<b>#ff8a65</b> rgb(255, 138, 103)	<b>#a1887f</b> rgb(161, 136, 127)	<b>#e0e0e0</b> rgb(224, 224, 224)	<b>#90a4ae</b> rgb(144, 164, 174)
<b>#ef5350</b> rgb(239, 83, 80)	<b>#ec407a</b> rgb(236, 64, 122)	<b>#ab47bc</b> rgb(171, 71, 188)	<b>#7e57c2</b> rgb(126, 87, 194)	<b>#5c6bc0</b> rgb(92, 107, 192)	<b>#42a5f5</b> rgb(66, 165, 245)	<b>#29b6f6</b> rgb(41, 182, 246)	<b>#26c6da</b> rgb(38, 198, 218)	<b>#26a69a</b> rgb(38, 166, 154)	<b>#66bb6a</b> rgb(102, 187, 106)	<b>#9ccc65</b> rgb(156, 204, 103)	<b>#d4e157</b> rgb(212, 225, 87)	<b>#ffee58</b> rgb(255, 238, 88)	<b>#ffca28</b> rgb(255, 202, 40)	<b>#ffa726</b> rgb(255, 167, 36)	<b>#ff7043</b> rgb(255, 112, 67)	<b>#8d6e63</b> rgb(141, 110, 99)	<b>#bdbdbd</b> rgb(189, 189, 189)	<b>#78909c</b> rgb(120, 144, 156)
<b>#f44336</b> rgb(244, 67, 54)	<b>#e91e63</b> rgb(233, 30, 99)	<b>#9c27b0</b> rgb(156, 39, 176)	<b>#673ab7</b> rgb(103, 58, 183)	<b>#3f51b5</b> rgb(63, 81, 181)	<b>#2196f3</b> rgb(33, 160, 243)	<b>#03a9f4</b> rgb(3, 169, 246)	<b>#00bcd4</b> rgb(0, 188, 212)	<b>#009688</b> rgb(0, 150, 136)	<b>#4caf50</b> rgb(76, 175, 80)	<b>#8bc34a</b> rgb(139, 195, 74)	<b>#cddc39</b> rgb(205, 220, 57)	<b>#ffeb3b</b> rgb(255, 253, 59)	<b>#ffc107</b> rgb(255, 193, 7)	<b>#ff9800</b> rgb(255, 162, 0)	<b>#ff5722</b> rgb(255, 87, 34)	<b>#795548</b> rgb(121, 85, 72)	<b>#9e9e9e</b> rgb(158, 158, 158)	<b>#607d8b</b> rgb(96, 125, 138)
<b>#e53935</b> rgb(229, 57, 53)	<b>#d81b60</b> rgb(216, 27, 96)	<b>#8e24aa</b> rgb(142, 36, 170)	<b>#5e35b1</b> rgb(94, 53, 177)	<b>#3949ab</b> rgb(57, 73, 171)	<b>#1e88e5</b> rgb(30, 138, 226)	<b>#039be5</b> rgb(3, 161, 229)	<b>#00acc1</b> rgb(0, 172, 193)	<b>#00897b</b> rgb(0, 137, 123)	<b>#43a047</b> rgb(67, 160, 71)	<b>#7cb342</b> rgb(124, 178, 66)	<b>#c0ca33</b> rgb(192, 202, 51)	<b>#fdd835</b> rgb(252, 216, 53)	<b>#ffb300</b> rgb(255, 179, 0)	<b>#fb8c00</b> rgb(255, 140, 0)	<b>#f4511e</b> rgb(245, 81, 30)	<b>#6d4c41</b> rgb(109, 76, 66)	<b>#757575</b> rgb(117, 117, 117)	<b>#546e7a</b> rgb(84, 110, 122)
<b>#d32f2f</b> rgb(211, 47, 47)	<b>#c2185b</b> rgb(194, 24, 91)	<b>#7b1fa2</b> rgb(123, 31, 162)	<b>#512da8</b> rgb(81, 45, 168)	<b>#3039f</b> rgb(48, 63, 159)	<b>#1976d2</b> rgb(25, 118, 210)	<b>#0288d1</b> rgb(2, 136, 209)	<b>#0097a7</b> rgb(0, 151, 167)	<b>#00796b</b> rgb(0, 121, 107)	<b>#388e3c</b> rgb(56, 142, 60)	<b>#689f38</b> rgb(104, 159, 56)	<b>#afb42b</b> rgb(175, 180, 43)	<b>#fbc02d</b> rgb(251, 192, 45)	<b>#ffa000</b> rgb(255, 160, 0)	<b>#f57c00</b> rgb(245, 124, 0)	<b>#e64a19</b> rgb(230, 74, 25)	<b>#5d4037</b> rgb(93, 64, 55)	<b>#616161</b> rgb(97, 97, 97)	<b>#455a64</b> rgb(69, 90, 100)
<b>#c62828</b> rgb(198, 40, 40)	<b>#ad1457</b> rgb(173, 20, 87)	<b>#6a1b9a</b> rgb(106, 27, 154)	<b>#4527a0</b> rgb(69, 39, 160)	<b>#283593</b> rgb(40, 53, 147)	<b>#1565c0</b> rgb(21, 101, 192)	<b>#0277bd</b> rgb(2, 119, 189)	<b>#00838f</b> rgb(0, 131, 143)	<b>#00695c</b> rgb(0, 105, 92)	<b>#2e7d32</b> rgb(46, 125, 50)	<b>#558b2f</b> rgb(85, 139, 47)	<b>#9e9d24</b> rgb(157, 157, 36)	<b>#f9a825</b> rgb(249, 168, 37)	<b>#ff8f00</b> rgb(255, 143, 0)	<b>#ef6c00</b> rgb(239, 108, 0)	<b>#d84315</b> rgb(216, 67, 21)	<b>#4e342e</b> rgb(78, 52, 46)	<b>#424242</b> rgb(66, 66, 66)	<b>#37474f</b> rgb(55, 71, 79)
<b>#b71c1c</b> rgb(183, 28, 28)	<b>#880e4f</b> rgb(136, 14, 79)	<b>#4a148c</b> rgb(74, 20, 140)	<b>#311b92</b> rgb(19, 27, 146)	<b>#1a237e</b> rgb(26, 35, 126)	<b>#0d47a1</b> rgb(13, 71, 163)	<b>#01579b</b> rgb(1, 87, 155)	<b>#006064</b> rgb(0, 96, 100)	<b>#004d40</b> rgb(0, 77, 64)	<b>#1b5e20</b> rgb(27, 94, 32)	<b>#33691e</b> rgb(51, 105, 30)	<b>#827717</b> rgb(130, 119, 23)	<b>#f57f17</b> rgb(245, 127, 23)	<b>#ff6f00</b> rgb(255, 111, 0)	<b>#e65100</b> rgb(230, 81, 0)	<b>#bf360c</b> rgb(191, 54, 12)	<b>#3e2723</b> rgb(62, 39, 35)	<b>#212121</b> rgb(33, 33, 33)	<b>#263238</b> rgb(38, 50, 56)

<b>#ff8a80</b> rgb(255, 138, 128)	<b>#ff80ab</b> rgb(255, 128, 171)	<b>#ea80fc</b> rgb(236, 128, 252)	<b>#b388ff</b> rgb(179, 136, 255)	<b>#8c9eff</b> rgb(140, 158, 255)	<b>#82b1ff</b> rgb(130, 177, 255)	<b>#80d8ff</b> rgb(128, 216, 255)	<b>#84ffff</b> rgb(132, 255, 255)	<b>#a7ffeb</b> rgb(167, 255, 239)	<b>#b9f6ca</b> rgb(185, 246, 202)	<b>#ccff90</b> rgb(204, 255, 144)	<b>#f4ff81</b> rgb(244, 255, 129)	<b>#ffff8d</b> rgb(255, 255, 141)	<b>#ffe57f</b> rgb(255, 229, 127)	<b>#ffd180</b> rgb(255, 209, 128)	<b>#ff9e80</b> rgb(255, 158, 128)
<b>#ff5252</b> rgb(255, 82, 82)	<b>#ff4081</b> rgb(255, 64, 129)	<b>#e040fb</b> rgb(224, 64, 255)	<b>#7c4dff</b> rgb(124, 77, 255)	<b>#536dfe</b> rgb(83, 109, 256)	<b>#448aff</b> rgb(68, 138, 255)	<b>#40c4ff</b> rgb(64, 196, 255)	<b>#18ffff</b> rgb(24, 255, 255)	<b>#64ffda</b> rgb(100, 255, 218)	<b>#69f0ae</b> rgb(105, 240, 174)	<b>#b2ff59</b> rgb(178, 255, 89)	<b>#eef41</b> rgb(238, 255, 65)	<b>#ffff00</b> rgb(255, 255, 0)	<b>#ffd740</b> rgb(255, 215, 64)	<b>#ffab40</b> rgb(255, 171, 64)	<b>#ff6e40</b> rgb(255, 110, 64)
<b>#ff1744</b> rgb(255, 23, 68)	<b>#f50057</b> rgb(245, 0, 87)	<b>#d500f9</b> rgb(213, 0, 246)	<b>#651fff</b> rgb(101, 31, 255)	<b>#3d5afe</b> rgb(61, 90, 254)	<b>#2979ff</b> rgb(41, 121, 255)	<b>#00b0ff</b> rgb(0, 176, 255)	<b>#00e5ff</b> rgb(0, 226, 255)	<b>#1de9b6</b> rgb(29, 233, 182)	<b>#00e676</b> rgb(0, 230, 118)	<b>#76ff03</b> rgb(118, 255, 3)	<b>#c6ff00</b> rgb(198, 255, 0)	<b>#ffea00</b> rgb(255, 234, 0)	<b>#ffc400</b> rgb(255, 196, 0)	<b>#ff9100</b> rgb(255, 145, 0)	<b>#ff3d00</b> rgb(255, 61, 0)
<b>#d50000</b> rgb(213, 0, 0)	<b>#c51162</b> rgb(197, 17, 98)	<b>#aa00ff</b> rgb(170, 0, 255)	<b>#6200ea</b> rgb(100, 0, 234)	<b>#304ffe</b> rgb(48, 78, 254)	<b>#2962ff</b> rgb(41, 98, 255)	<b>#0091ea</b> rgb(0, 145, 234)	<b>#00b8d4</b> rgb(0, 184, 212)	<b>#00bfa5</b> rgb(0, 191, 165)	<b>#00c853</b> rgb(0, 200, 83)	<b>#64dd17</b> rgb(100, 221, 23)	<b>#aeaa00</b> rgb(174, 234, 0)	<b>#ffd600</b> rgb(255, 214, 0)	<b>#ffab00</b> rgb(255, 171, 0)	<b>#ff6d00</b> rgb(255, 108, 0)	<b>#dd2c00</b> rgb(221, 44, 0)

#####  
rgb(255, 255, 255)

#####  
rgb(0, 0, 0)



# Basic design principles   Colour

You will use these HEX codes to **define colours in R and ggplot2.**

# Basic design principles    Colour

You can **find HEX codes** for your preferred colours

- In software, e.g. PowerPoint (Colour>More Colours>Custom)
- Online, through websites (e.g. [HTML color codes](#), [colors](#)) Or browser extensions (eg. [Color Picker](#))

# Basic design principles    Colour

You can pick your own **colour palettes**  
or use already made ones e.g. [RColorBrewer](#), or [wesanderson](#) palettes.

But first, let's talk **colour accessibility**.



# Basic design principles

## Colour

### Accessibility

To have an accessible colour palette, colours must be **contrasting enough**.

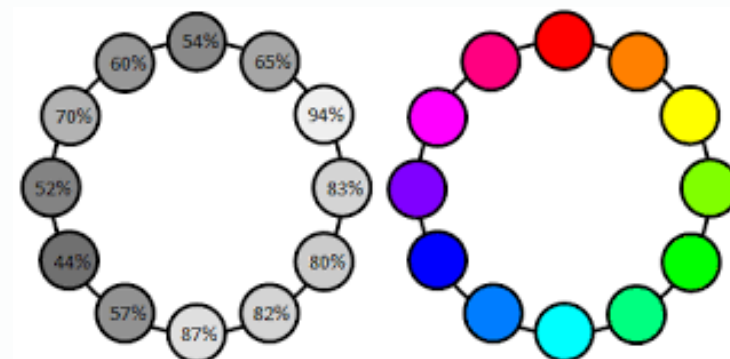
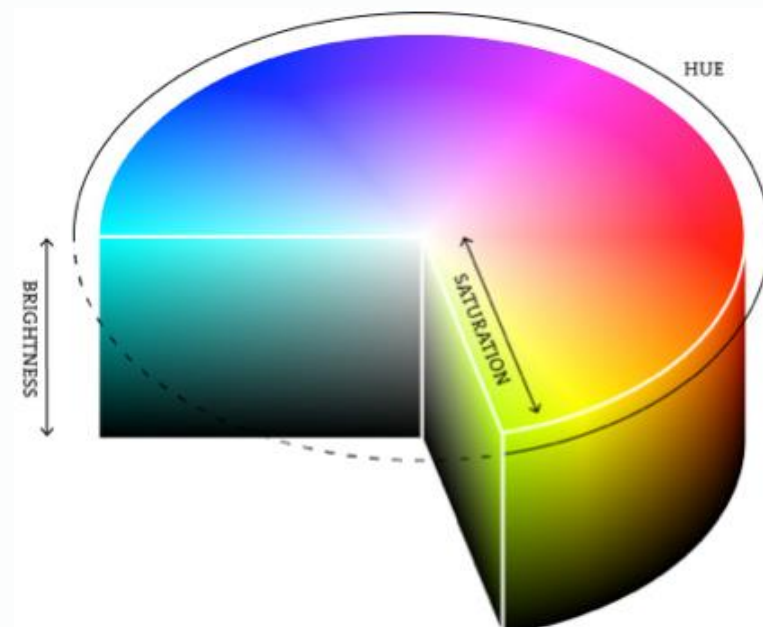


# Basic design principles Colour

## Accessibility

For this, we look at each colour's **relative luminance**, i.e. relative brightness or perceived brightness.

Insane functions and extensive info on that at [Web Content Accessibility Guidelines](#).



# Basic design principles   Colour

## Accessibility

Then we compare these to each other.

**The larger the contrast ratio, the better.**

Contrast ratio	Verdict	
< 3:1	Fail	The colours are not contrasting enough
3-4.5:1	AA Large	Minimum contrast for large text
4.5-7:1	AA	Minimum contrast for normal text Enhanced contrast for large text
>7:1	AAA	Enhanced contrast

# Basic design principles    Colour

## Accessibility

- There are different ways to check if your chosen colours are contrasting enough (e.g. [ColourContrast](#) and [Colors Contrast Checker](#))
- or you can use **already made accessible colour palettes** online e.g. [venngage](#), or in R e.g. [RColorBrewer](#) and [viridis](#).

# Basic design principles   Colour

## Tips

- Colour is a powerful tool to guide the viewer's attention
- Too many colours can confuse
- Your graph **should be legible even in grayscale**, so use colours in combination with symbols etc.
- Avoid the combination of pure white and pure black



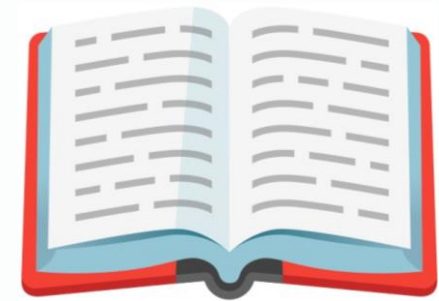
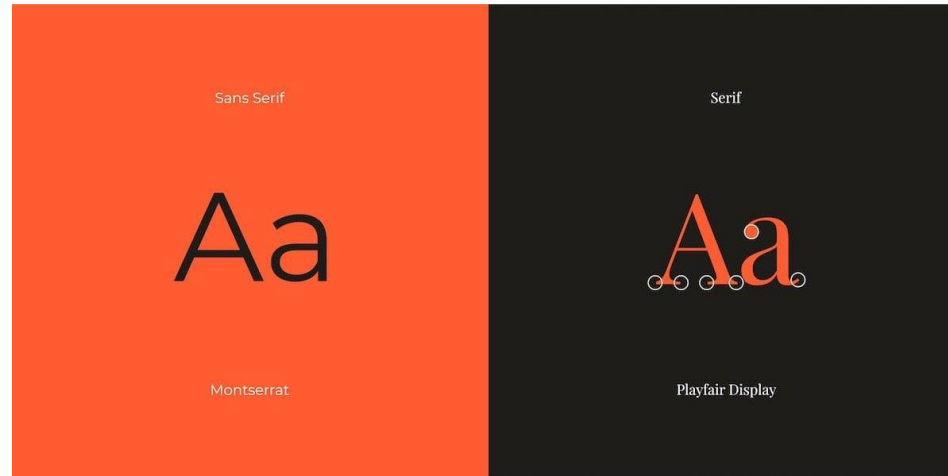
# Basic design principles

# Type

There are two main group types:

**Sans Serif**

**Serif**



# Basic design principles

# Type

- You can access fonts for free at [Google Fonts](#)
- You can use these in any software, as well as R  
(using `sysfonts` and `font_add_google()`, tutorial [here](#))

# Basic design principles

## Type

We want easily readable fonts, like:

Tahoma

Calibri

Helvetica

Arial

Verdana

**Font size** is important in  
accessibility.

# Basic design principles

## Type

### Tips

- One font is enough (max two)
- You can use **Bold** for emphasis, but *Italics* and Underline decrease accessibility
- Align text to the left (center and right-aligned is difficult to read)
- Use size as a tool to hierarchise content (e.g. larger = titles)
- Use 1.5 line spacing for better readability and accessibility

# What graph for what data?

How many variables?

One variable

+1 variables

Class?

(continous, quantitative, qualitative)

Histograms  
Density plots  
Barplots  
Boxplots

Scatterplots  
Correlation plots  
Boxplots  
Violin plots

# What graph for what data?

Most important: remember why you are plotting.

There is no golden rule. For example:

**Time**

line chart

**Distribution**

histogram, box and whiskers

**Geospatial**

map

**Relationship**

scatterplot

**Comparing categories**

bar charts

**Part of a whole**

stacked bars or pie charts

# Common mistakes

- Our brains cannot compare angles and volumes well, so best to avoid piecharts and 3D plots
- Never truncate your X/Y scales or zooming on one part of them without showing the overall pattern as well (to avoid risk of exaggerating results)
- Do not overcomplicate your graphs (sometimes two graphs are better than one combined)

Mistakes happen, even the Economist got it wrong.

# Common mistakes

If in doubt, ask yourself:

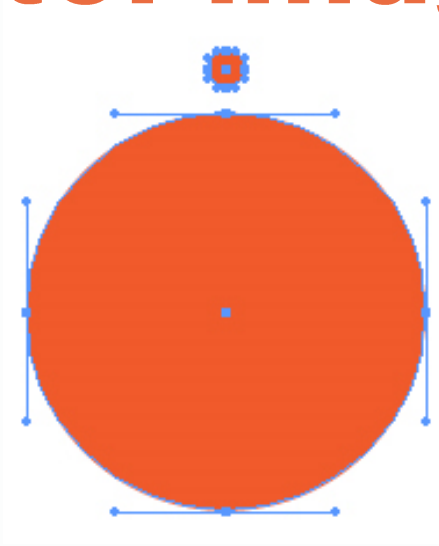
**Is it clear what is the main point of the graph?**

If not, rethink

1. The amount of data you chose to show
2. The type of graph
3. Your use of colour, symbols, text

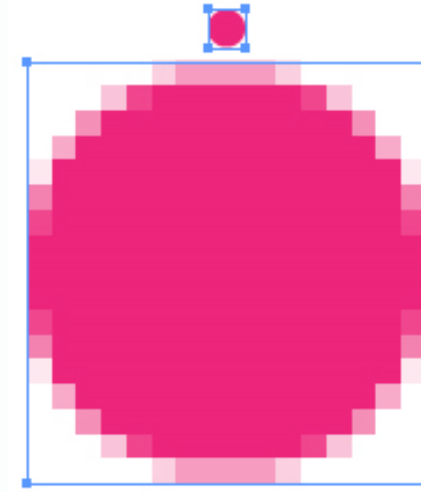


# Vector images



- Not scale-dependant
- Smaller size files
- Easily editable
- Usually have less details/textures etc.
- Can easily be converted to raster files

# Pixel/Raster images



- Scale-dependant
- Large size files
- Not easily editable
- Can have lots of details/textures etc.
- Can't be converted easily to vector files

# File Types

You can **export your plots from R** in many file formats

e.g. using `ggsave()` and you can export in .png or .svg

File name	File type	
.jpg	Raster	Can't have transparent parts!
.png	Raster	Can also have transparent parts!
.svg	Vector	Vector image format – you can edit it in inkscape/illustrator!
.pdf	Vector	Not actually an image file type, but can be used

# Visualization resources in R

- Base R (package *{graphics}*)
- Ggplot (package *{ggplot2}*)

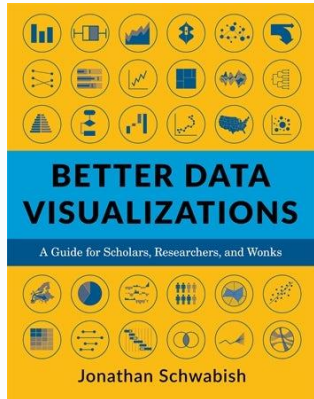
More?

- *{Lattice}* package: emphasis on multivariate data.
- *{Scatterplot3d}* package: 3D plots
- *{highcharter}* package: R wrapper for Highcharts javascript library .
- *{plotly}* package: contour plots, candlestick charts, 3D charts...
- *{rgl}* package : 3D plots

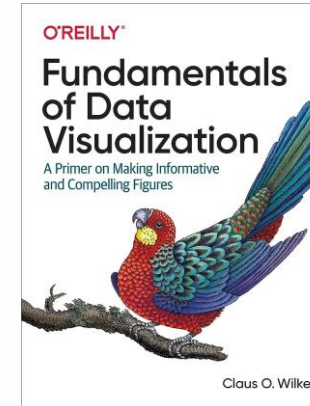
Spatial  
data

- Packages with specific object classes (*{sp}* - *spatialobject*, *{sf}* - *sf*, *{raster}* - *raster*, *{terra}* - *rast*).
- Plotting: *{graphics}*, *{ggplot3}*, *{sp}*, *{sf}*, *{raster}*, *{terra}*, *{utils}*, *{maps}*, *{tmap}*, *{maps}*, *{spatstat}*, *{rasterVis}* packages...

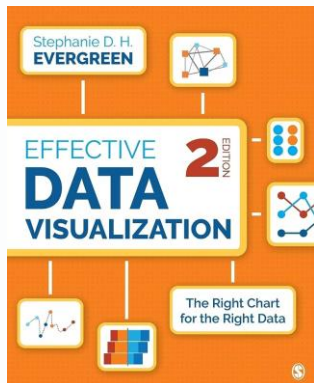
# Data Visualization books



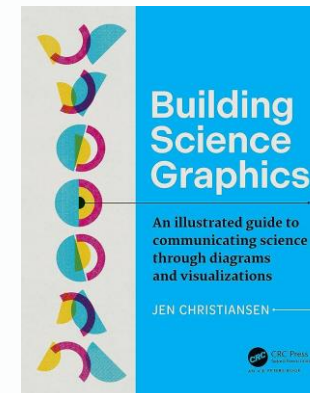
Better Data Visualizations  
by Jonathan Schwabish  
(Columbia University Press).



Fundamentals of Data  
Visualization by Claus O  
Wilke (O'Reilly Media Inc.).



Effective Data Visualization  
by Stephanie DH Evergreen  
(Sage Publishing).



(For science graphics)  
Building Science Graphics  
by Jen Christiansen  
(CRC Press).

# Practical

**1. Data visualization  
using ggplot2**

**2. Data visualization  
of spatial data**

