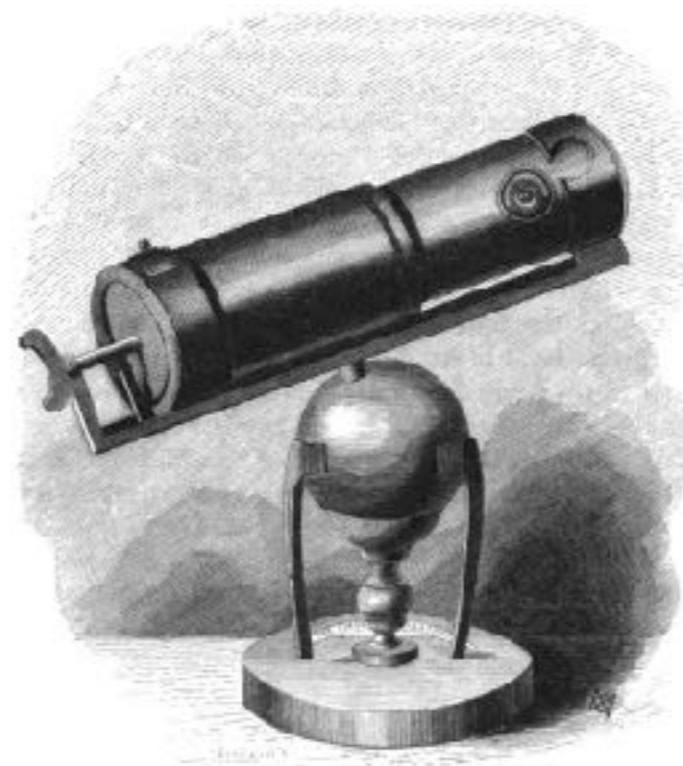


TidyBiology: An Introduction to Biological Data Science in R



Matthew Hirshey, Ph.D.

Duke University Medical Center

Department of Medicine, Pharmacology & Cancer Biology

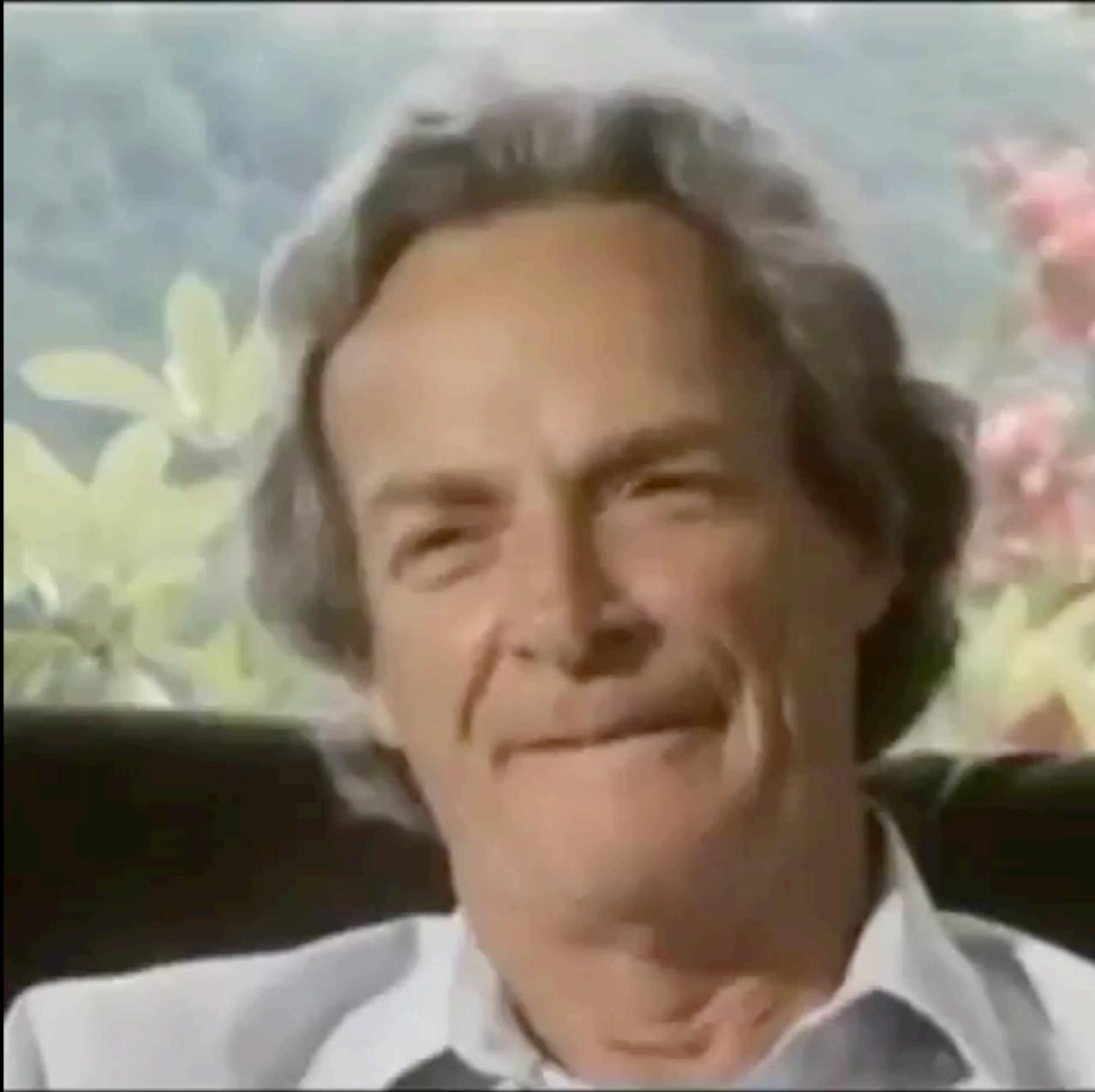
Duke Molecular Physiology Institute

Durham, NC, USA

RESULTS AND DISCUSSION

Identification of YFG as a Potential YFG-ase

Because [this metabolite is unique], we hypothesized that [enzymes] with [special] domains may have YFG-ase activity. To identify potential candidates, we first searched the Swiss-Prot database using the terms "YFG-ase" and "[metabolite]" as keywords and obtained 31 candidate proteins (Figure S1). We next excluded enzymes expressed in yeast, because yeast do not express [enzymes like YFG]. After these screening steps, we obtained nine candidates, including all YFG family members (Figure S1). Among the YFG family members, YFG1 is the most expressed isoform in the liver, where [we think it is important]...So we tested whether YFG1 is a YFG-ase.



“See that bird? It’s a brown-throated thrush, ...and even if you know the name for it, you still know nothing about the bird. You only know something about people; what they call the bird.”

-Richard Feynman

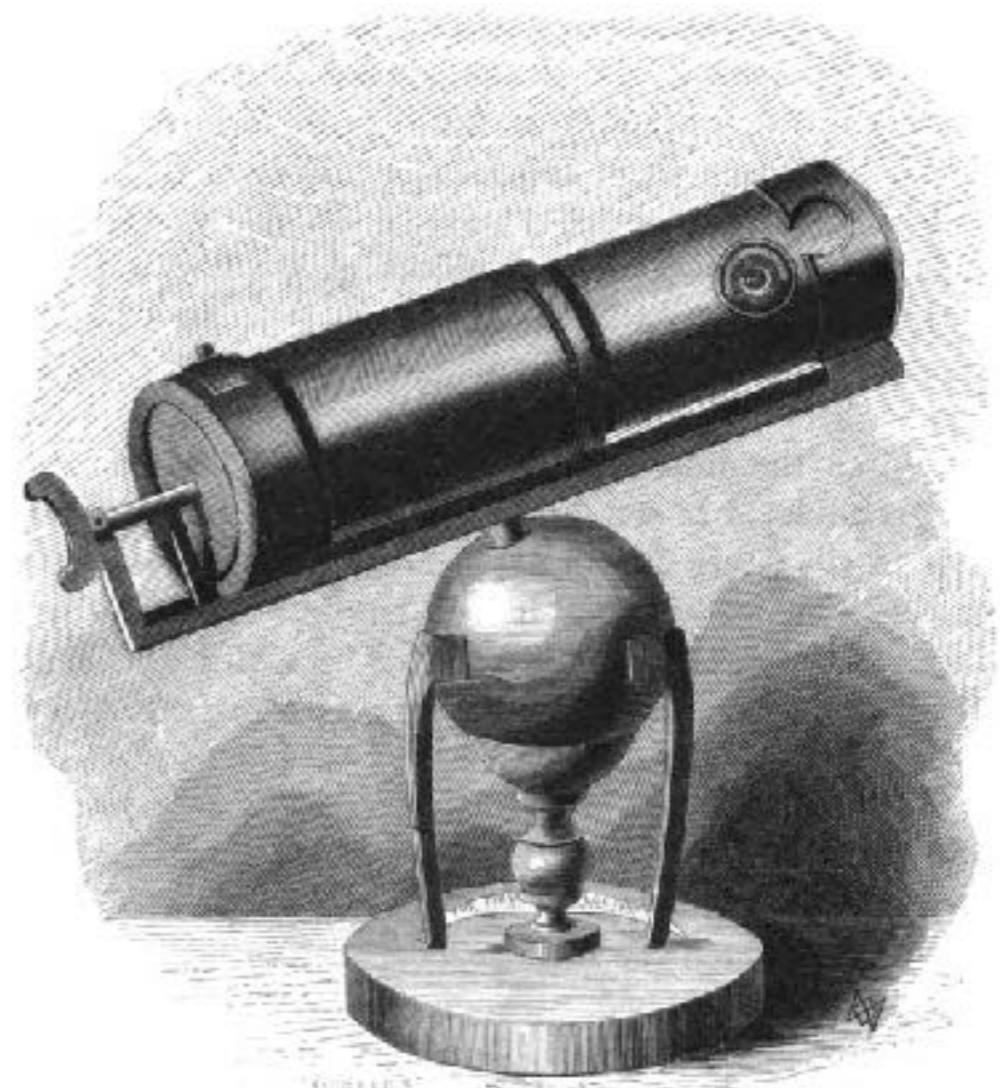
Goal of science is to know something

I don't know what I may seem to the world, but as to myself, I seem to have been only like a boy playing on the sea-shore and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

— Isaac Newton (1642-1727)

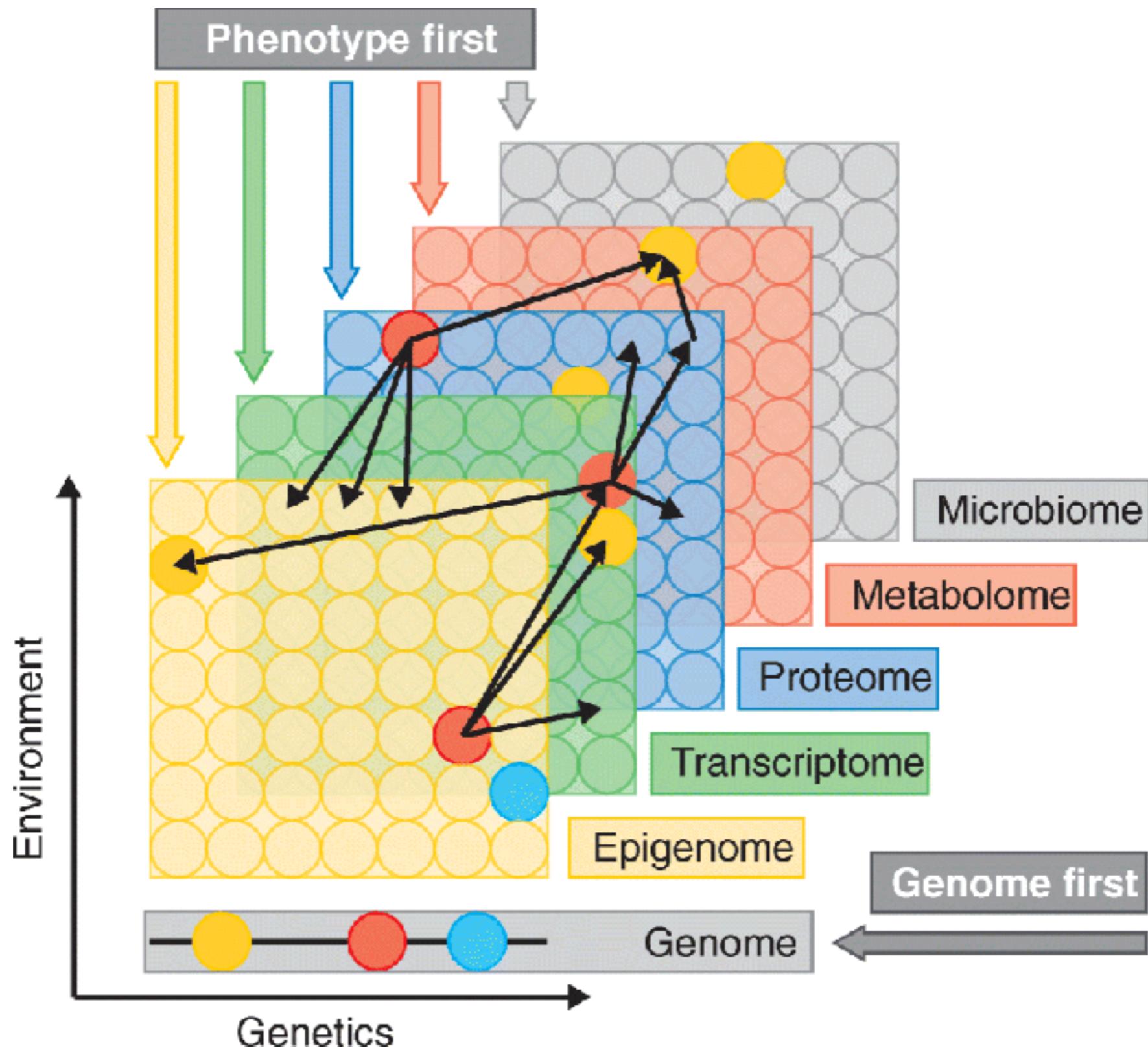
Scientific Method

1. Define a question
2. Observe (gather information and think)
3. Form a hypothesis
4. Test the hypothesis (performing an experiment and collecting data in a reproducible manner)
5. Analyze data (null-hypothesis significance test)
6. Interpret the data and draw conclusions (starting point for new hypotheses)



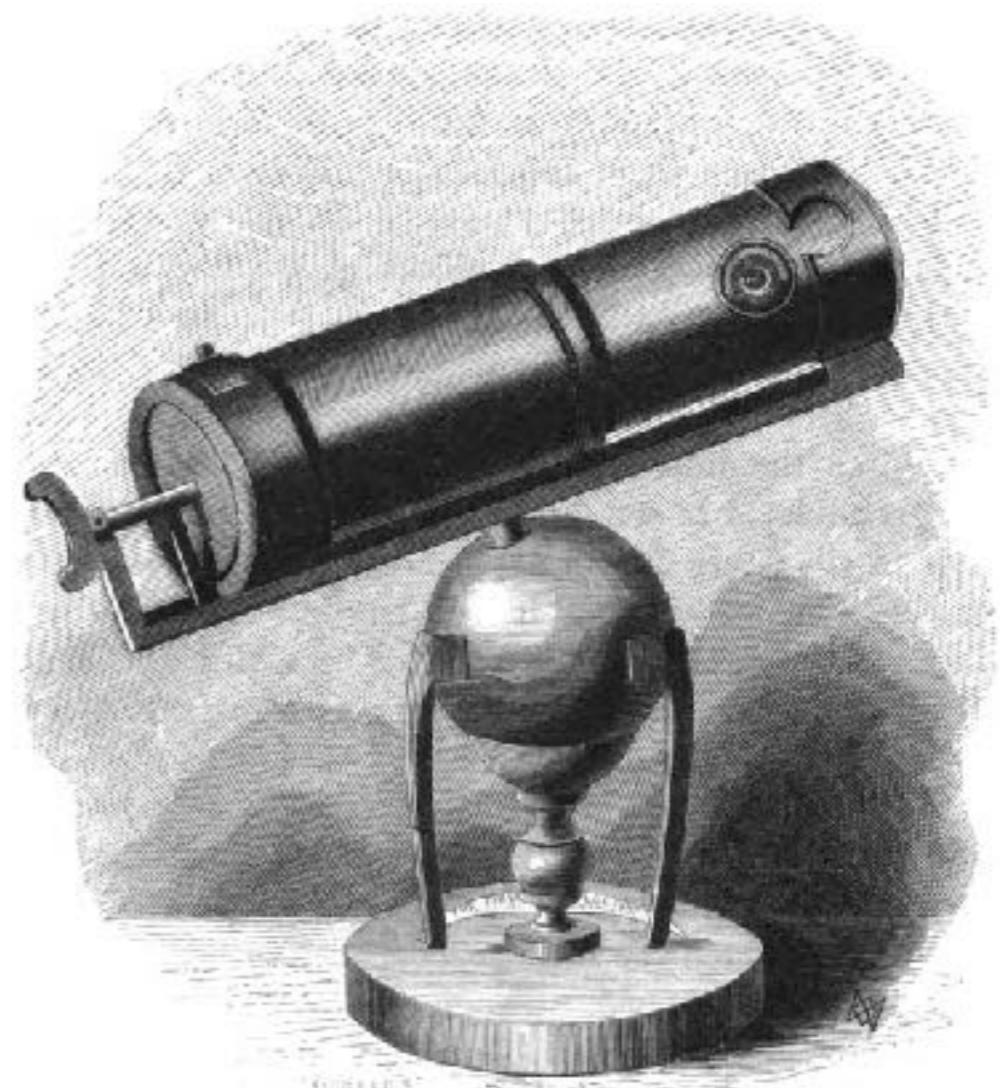
Is there enough evidence to reject the null hypothesis?

Screen

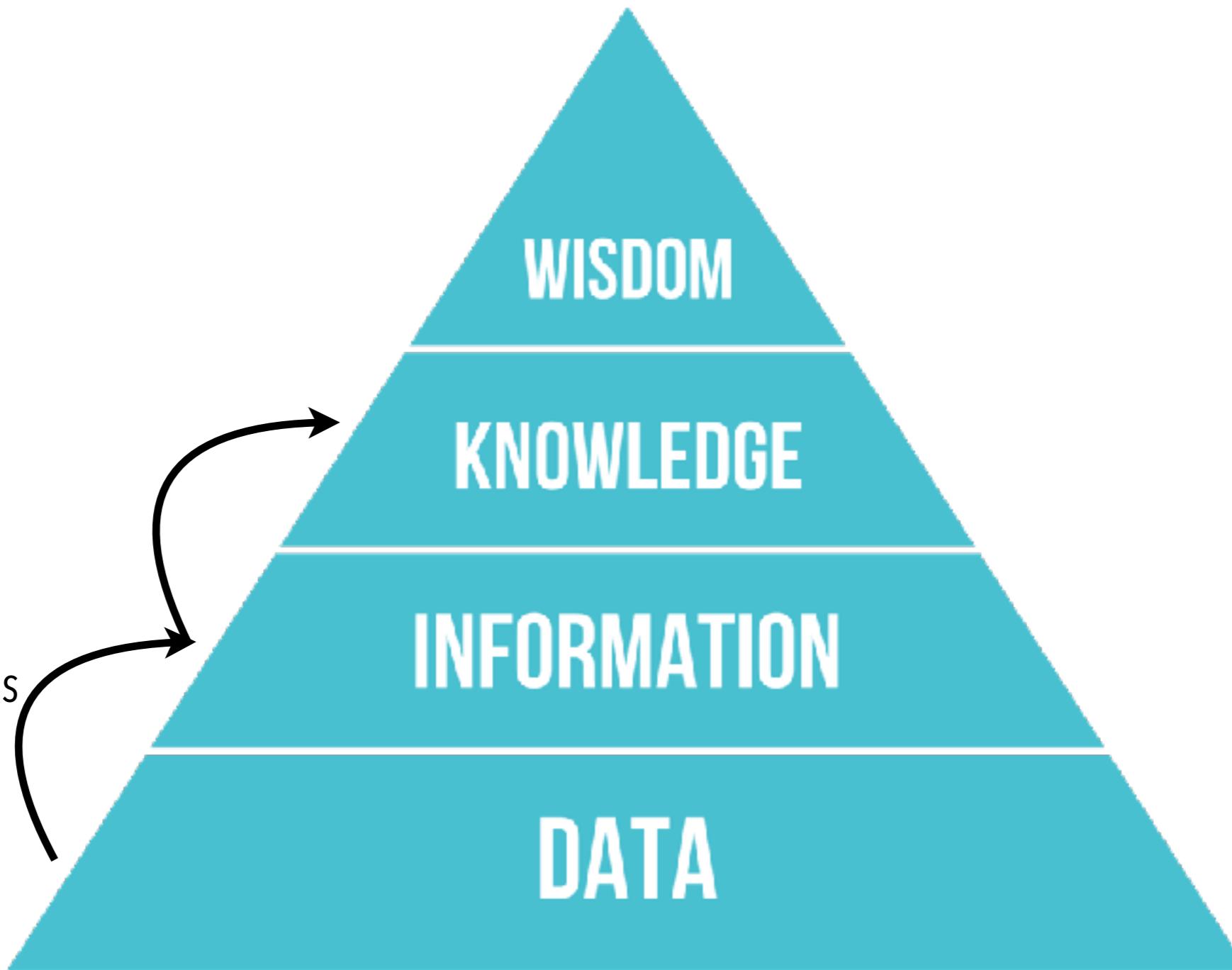


Scientific Method

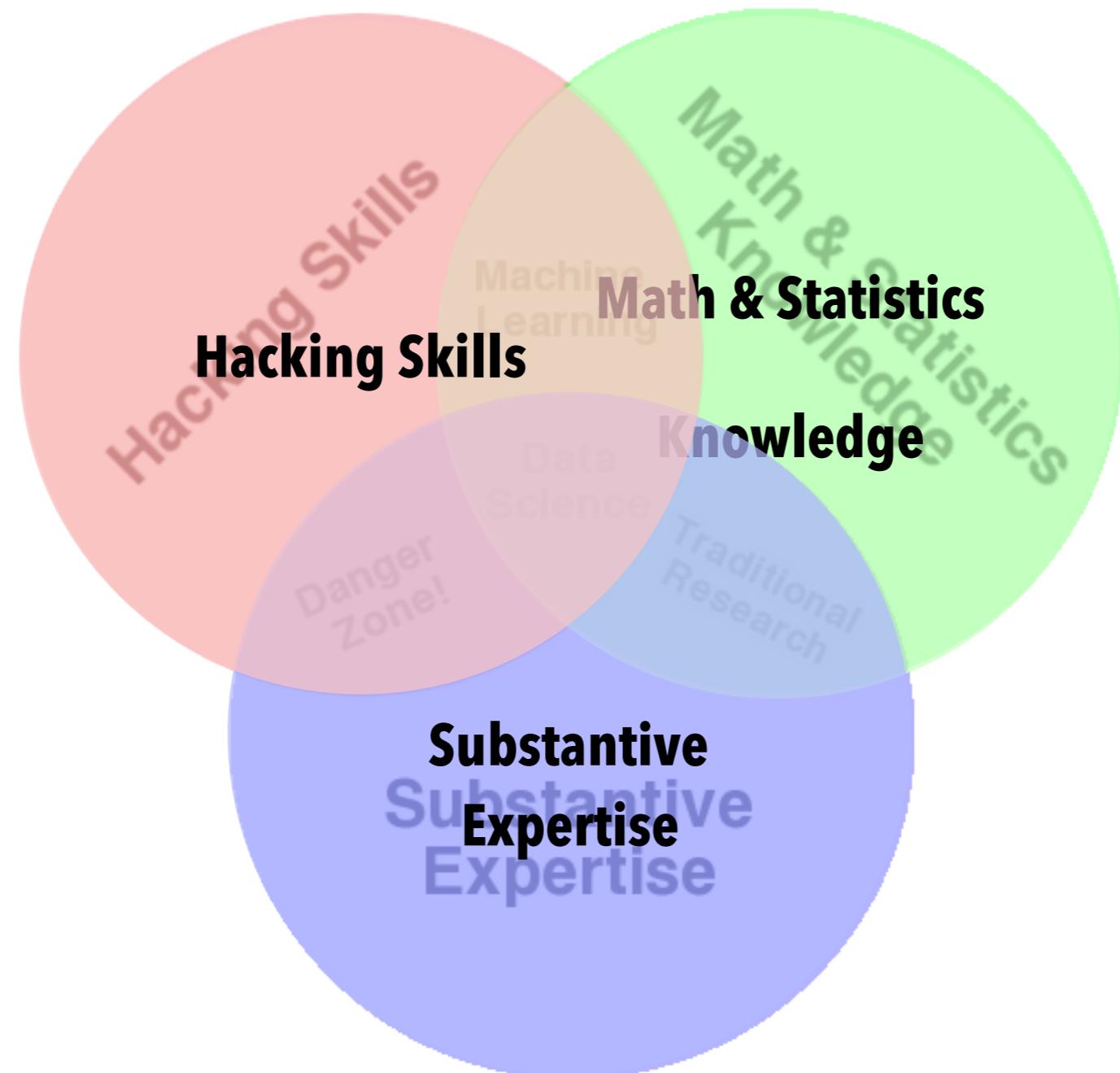
1. Define a question
2. Observe (gather information and think, **screen**)
3. Form a hypothesis
4. Test the hypothesis (performing an experiment and collecting data in a reproducible manner)
5. Analyze data (null-hypothesis significance test)
6. Interpret the data and draw conclusions (starting point for new hypotheses)



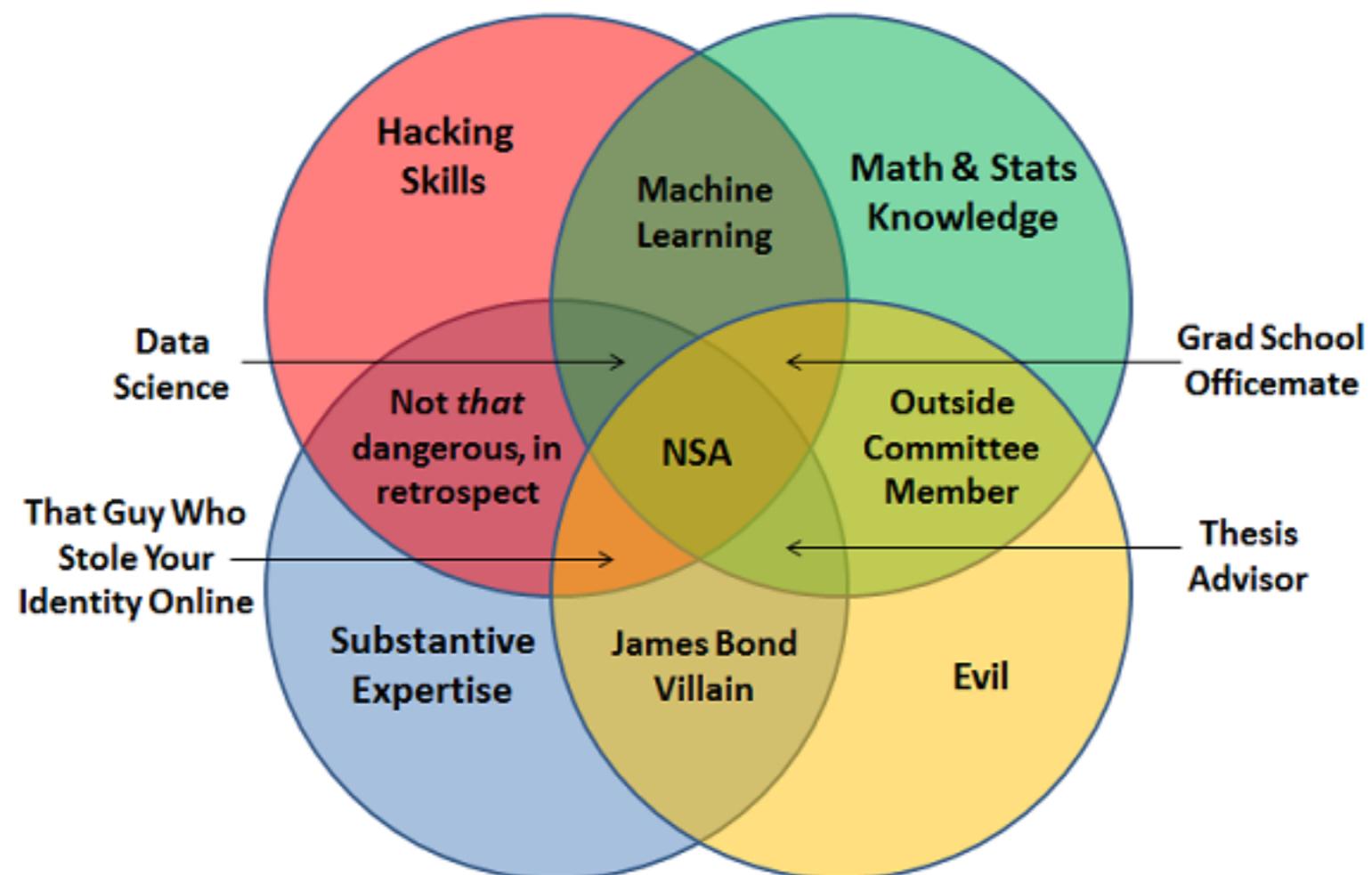
Hierarchy of Knowledge Gathering



Emerging field of Data Science



Venn Diagram of Data Science v2.0



Overall goal is to generate knowledge



Several approaches in data science

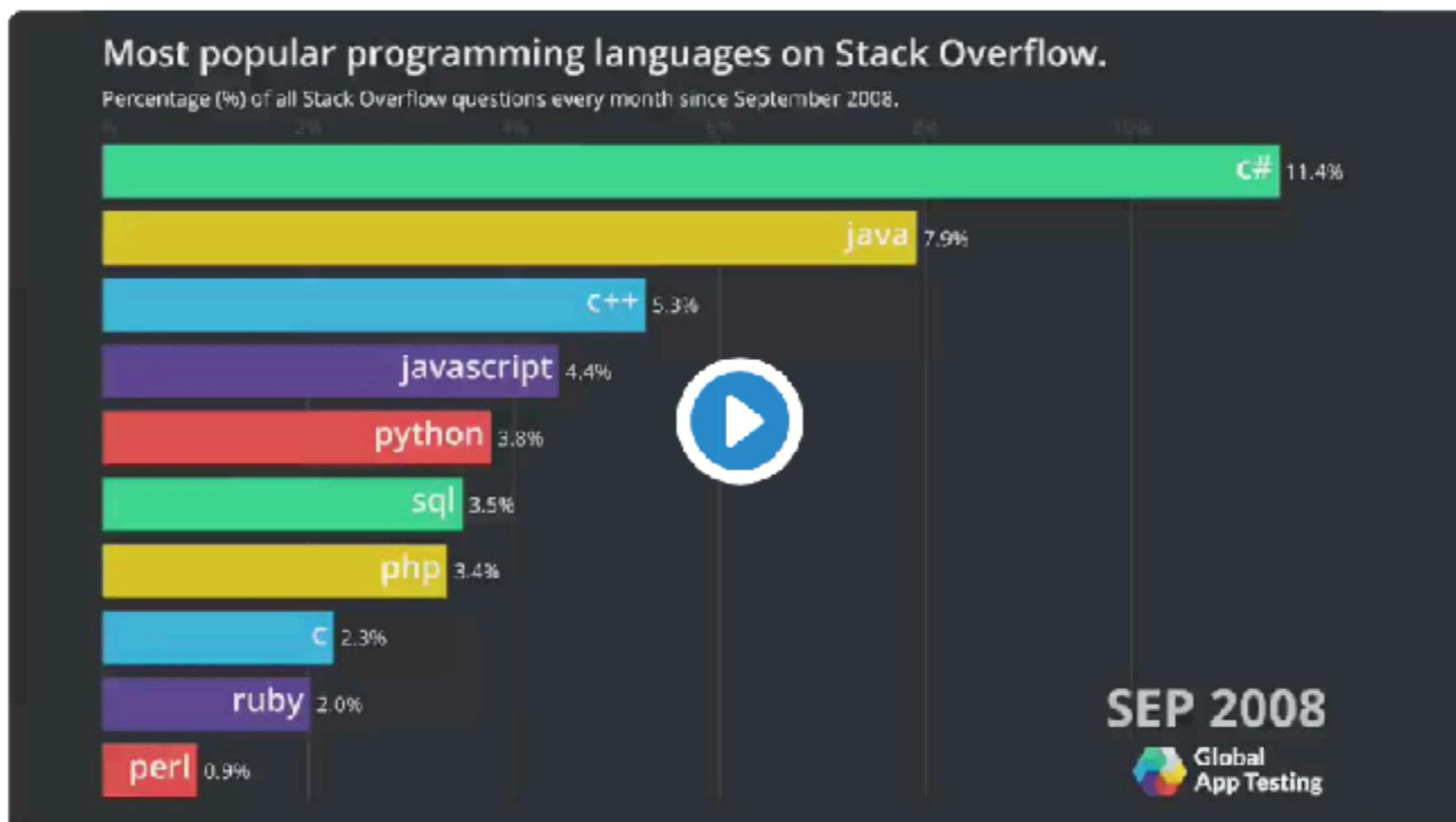


Veronika Romashkina

@vronnie911



StackOverflow language popularity through the years



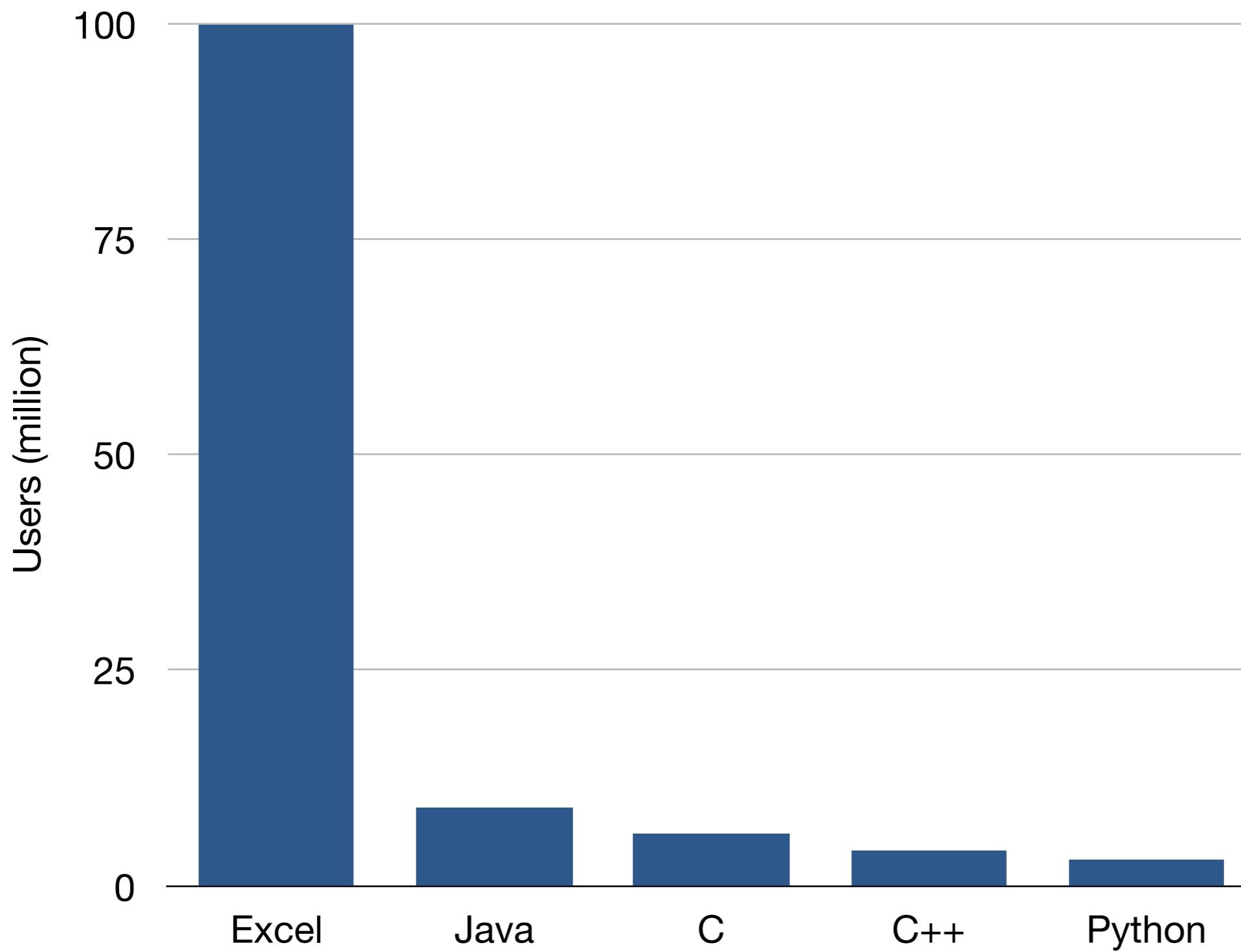
8,301 1:18 PM - May 6, 2019



4,838 people are talking about this



World's most popular programming languages



R
Language

R the language

Values: 1, "Florida", "2010-01-25"

R the language

Values: 1, "Florida", "2010-01-25"

Objects: x <- 22/7

A name without
quotes

< followed by -
(it looks like an
arrow)

A value, object,
or function
result

R the language

Values - 1, "Florida", "2010-01-25"

Objects - x <- c(22/7, 0.99, 3)

To put multiple values in an object,
combine the values with c()

R the language

Values - 1, "Florida", "2010-01-25"

Objects - x <- c(22/7, 0.99, 3)

Functions - round(x, digits = 3)

A name
without
quotes

followed by
() to run the
function

Arguments:
values, objects, or
function results

Which of these are numbers?

1

"1"

"one"

one

Which of these are numbers?

1
—
number

"1"

"one"

one

Which of these are numbers?

1
number

"1"
"one"
words (strings)

one

Which of these are numbers?

1
number

"1"
words (strings)

one
object

Which of these will work?

Suppose `one <- 1.`

`log(1)`

`log("1")`

`log("one")`

`log(one)`

Data are stored in a dataframe

Data stored in a dataframe are conceptually equivalent to a spreadsheet with rows and columns
(`data$entry_name`)

	entry_name	protein_names	gene_name	gene_name_alt	sequence
1	AARD_HUMAN	Alanine and argini...	AARD	C8orf85	MGP GDF RRCRERISQGLQGLP GRAELWF FPPRPAC
2	ABHD1_HUMAN	Protein ABHD1 (EC...	ABHD1	LABH1	MLSSFLSPQNGTWADTF SLLLAL AVALYLGYYWA
3	AAKG2_HUMAN	5'-AMP-activated ...	PRKAG2	NA	MGS AVM DTK KKK DVSS PGG SGK KNAS QK RRS
4	ABCG8_HUMAN	ATP-binding casse...	ABCG8	NA	MAG KAA EER GLPKA TPQ DTSG LQD RLFS SED
5	ABCA7_HUMAN	ATP-binding casse...	ABCA7	NA	MAFW TQL MLL WKNF MYRR QPV QLL VELL WP
6	ABCAA_HUMAN	ATP-binding casse...	ABCA10	NA	MNK M ALAS FM KG RTV IGT PDE ETMDI ELPK KYH
7	ABCB5_HUMAN	ATP-binding casse...	ABCB5	NA	MENSERA EEM QEN YQR NGTAEE QPK LRKE AVGS
8	ABLM1_HUMAN	Actin-binding LIM ...	ABLM1	ABLM KIAA0059 ...	MP AFL GLK CLG KLC SSE KSV TSS ERTS ARGS NRI
9	ABHDA_HUMAN	Mycophenolic acid...	ABHD10	NA	MAVARLA AVAAW VPC RSWG WA AVPFG PHRG LSI
10	ACOC_HUMAN	Cytoplasmic aconi...	ACO1	I REB1	MSNPFAH LAEPL DPV QPG KKFFN LNKL EDS RYGF
11	ACH10_HUMAN	Neuronal acetylch...	CHRNA10	NACHRA10	MGLRSHHLSL GLLL FLLPAECLGAEGRLALKLFR
12	ACO11_HUMAN	Acyl-coenzyme A t...	ACOT11	B FIT KIAA0707 TH...	MIQN VGNHL RRGL ASV FSNRT SRKS ALRAG NDS
13	ACTY_HUMAN	Beta- centactin (A...	ACTR1B	CTR N2	MESYDIIAN QPV VID NGSG VIKAGF AGDQ I PKYCI
14	ACY3_HUMAN	N-acyl-aromatic-L...	ACY3	ASPA2	MCSLP VP REPL RRVA VTGC THGN EMSC VYLARH
15	ACSL3_HUMAN	Long-chain-fatty-...	ACSL3	ACS3 FACL3 LACS3	MNNHVSSKPSTMKLKHTINPILLYFIHFLISLYTILT

Extract or create new objects

You can call a single part of the data frame

```
data$entry_name
```

	entry_name
1	AARD_HUMAN
2	ABHD1_HUMAN
3	AAKG2_HUMAN
4	ABCG8_HUMAN
5	ABCA7_HUMAN
6	ABCAA_HUMAN
7	ABCB5_HUMAN
8	ABLM1_HUMAN
9	ABHDA_HUMAN
10	ACOC_HUMAN

And save it as an object for later use

```
entries <- data$entry_name
```

R
IDE



R

Statistical Programming Language

```
R version 3.5.2 (2018-12-20) -- "Eigenwill Igloo"
Copyright (C) 2018 The R Foundation for Statistical Computing
Platform: x86_64-apple-darwin15.6.0 (64-bit)

R is Free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type "license()" or "licence()" for distribution details.

Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type "contributors()" for more information and
"citation()" on how to cite R or R packages in publications.

Type "demo()" for some demos, "help()" for on-line help, or
"help.start()" for an HTML browser interface to help.
Type "q()" to quit R.

[1] > R (user.out 1.70 (7632) x86_64-apple-darwin15.6.0)
[2] > [Workspace restored from /Users/mattthewhineskey/RData]
[3] > [History restored from /Users/mattthewhineskey/.Rapp.history]
```

RStudio

Integrated Developer Environment

```
Untitled.Rmd
1: ---
2: title: "R Notebook"
3: output: html_notebook
4: ---

6: This is an R Notebook (http://rmarkdown.rstudio.com) Notebook. When you execute code within the notebook, the results appear beneath the code.

8: Try executing this chunk by clicking the "Run" button within the chunk or by placing your cursor inside it and pressing Shift-Enter.
9:
10: ----
11: plot(cars)
12: 

14: Add a new chunk by clicking the "Insert Chunk" button on the toolbar or by pressing "Cmd-Option-I".
15:
16: When you save the notebook, an HTML file containing the code and output will be saved alongside it (click the "Preview" button or press "Cmd-Shift-F12" to preview the HTML file).
17:
18: The preview shows you a rendered HTML copy of the contents of the editor. Consequently, unlike "Knit", "Preview" does not run any R code chunks. Instead, the output of the chunk when it was last run in the editor is displayed.
19:
20: R Notebook 1
21: 
22: 
23: 
24: 
25: 
26: 
27: 
28: 
29: 
30: 
31: 
32: 
33: 
34: 
35: 
36: 
37: 
38: 
39: 
40: 
41: 
42: 
43: 
44: 
45: 
46: 
47: 
48: 
49: 
50: 
51: 
52: 
53: 
54: 
55: 
56: 
57: 
58: 
59: 
60: 
61: 
62: 
63: 
64: 
65: 
66: 
67: 
68: 
69: 
70: 
71: 
72: 
73: 
74: 
75: 
76: 
77: 
78: 
79: 
80: 
81: 
82: 
83: 
84: 
85: 
86: 
87: 
88: 
89: 
90: 
91: 
92: 
93: 
94: 
95: 
96: 
97: 
98: 
99: 
100: 
101: 
102: 
103: 
104: 
105: 
106: 
107: 
108: 
109: 
110: 
111: 
112: 
113: 
114: 
115: 
116: 
117: 
118: 
119: 
120: 
121: 
122: 
123: 
124: 
125: 
126: 
127: 
128: 
129: 
130: 
131: 
132: 
133: 
134: 
135: 
136: 
137: 
138: 
139: 
140: 
141: 
142: 
143: 
144: 
145: 
146: 
147: 
148: 
149: 
150: 
151: 
152: 
153: 
154: 
155: 
156: 
157: 
158: 
159: 
160: 
161: 
162: 
163: 
164: 
165: 
166: 
167: 
168: 
169: 
170: 
171: 
172: 
173: 
174: 
175: 
176: 
177: 
178: 
179: 
180: 
181: 
182: 
183: 
184: 
185: 
186: 
187: 
188: 
189: 
190: 
191: 
192: 
193: 
194: 
195: 
196: 
197: 
198: 
199: 
200: 
201: 
202: 
203: 
204: 
205: 
206: 
207: 
208: 
209: 
210: 
211: 
212: 
213: 
214: 
215: 
216: 
217: 
218: 
219: 
220: 
221: 
222: 
223: 
224: 
225: 
226: 
227: 
228: 
229: 
230: 
231: 
232: 
233: 
234: 
235: 
236: 
237: 
238: 
239: 
240: 
241: 
242: 
243: 
244: 
245: 
246: 
247: 
248: 
249: 
250: 
251: 
252: 
253: 
254: 
255: 
256: 
257: 
258: 
259: 
259: 
260: 
261: 
262: 
263: 
264: 
265: 
266: 
267: 
268: 
269: 
270: 
271: 
272: 
273: 
274: 
275: 
276: 
277: 
278: 
279: 
280: 
281: 
282: 
283: 
284: 
285: 
286: 
287: 
288: 
289: 
289: 
290: 
291: 
292: 
293: 
294: 
295: 
296: 
297: 
298: 
299: 
299: 
300: 
301: 
302: 
303: 
304: 
305: 
306: 
307: 
308: 
309: 
309: 
310: 
311: 
312: 
313: 
314: 
315: 
316: 
317: 
318: 
319: 
319: 
320: 
321: 
322: 
323: 
324: 
325: 
326: 
327: 
328: 
329: 
329: 
330: 
331: 
332: 
333: 
334: 
335: 
336: 
337: 
338: 
339: 
339: 
340: 
341: 
342: 
343: 
344: 
345: 
346: 
347: 
348: 
349: 
349: 
350: 
351: 
352: 
353: 
354: 
355: 
356: 
357: 
358: 
359: 
359: 
360: 
361: 
362: 
363: 
364: 
365: 
366: 
367: 
368: 
369: 
369: 
370: 
371: 
372: 
373: 
374: 
375: 
376: 
377: 
378: 
379: 
379: 
380: 
381: 
382: 
383: 
384: 
385: 
386: 
387: 
388: 
389: 
389: 
390: 
391: 
392: 
393: 
394: 
395: 
396: 
397: 
398: 
399: 
399: 
400: 
401: 
402: 
403: 
404: 
405: 
406: 
407: 
408: 
409: 
409: 
410: 
411: 
412: 
413: 
414: 
415: 
416: 
417: 
418: 
419: 
419: 
420: 
421: 
422: 
423: 
424: 
425: 
426: 
427: 
428: 
429: 
429: 
430: 
431: 
432: 
433: 
434: 
435: 
436: 
437: 
438: 
439: 
439: 
440: 
441: 
442: 
443: 
444: 
445: 
446: 
447: 
448: 
449: 
449: 
450: 
451: 
452: 
453: 
454: 
455: 
456: 
457: 
458: 
459: 
459: 
460: 
461: 
462: 
463: 
464: 
465: 
466: 
467: 
468: 
469: 
469: 
470: 
471: 
472: 
473: 
474: 
475: 
476: 
477: 
478: 
479: 
479: 
480: 
481: 
482: 
483: 
484: 
485: 
486: 
487: 
488: 
489: 
489: 
490: 
491: 
492: 
493: 
494: 
495: 
496: 
497: 
498: 
499: 
499: 
500: 
501: 
502: 
503: 
504: 
505: 
506: 
507: 
508: 
509: 
509: 
510: 
511: 
512: 
513: 
514: 
515: 
516: 
517: 
518: 
519: 
519: 
520: 
521: 
522: 
523: 
524: 
525: 
526: 
527: 
528: 
529: 
529: 
530: 
531: 
532: 
533: 
534: 
535: 
536: 
537: 
538: 
539: 
539: 
540: 
541: 
542: 
543: 
544: 
545: 
546: 
547: 
548: 
549: 
549: 
550: 
551: 
552: 
553: 
554: 
555: 
556: 
557: 
558: 
559: 
559: 
560: 
561: 
562: 
563: 
564: 
565: 
566: 
567: 
568: 
569: 
569: 
570: 
571: 
572: 
573: 
574: 
575: 
576: 
577: 
578: 
579: 
579: 
580: 
581: 
582: 
583: 
584: 
585: 
586: 
587: 
588: 
589: 
589: 
590: 
591: 
592: 
593: 
594: 
595: 
596: 
597: 
598: 
599: 
599: 
600: 
601: 
602: 
603: 
604: 
605: 
606: 
607: 
608: 
609: 
609: 
610: 
611: 
612: 
613: 
614: 
615: 
616: 
617: 
618: 
619: 
619: 
620: 
621: 
622: 
623: 
624: 
625: 
626: 
627: 
628: 
629: 
629: 
630: 
631: 
632: 
633: 
634: 
635: 
636: 
637: 
638: 
639: 
639: 
640: 
641: 
642: 
643: 
644: 
645: 
646: 
647: 
648: 
649: 
649: 
650: 
651: 
652: 
653: 
654: 
655: 
656: 
657: 
658: 
659: 
659: 
660: 
661: 
662: 
663: 
664: 
665: 
666: 
667: 
668: 
669: 
669: 
670: 
671: 
672: 
673: 
674: 
675: 
676: 
677: 
678: 
678: 
679: 
680: 
681: 
682: 
683: 
684: 
685: 
686: 
687: 
688: 
689: 
689: 
690: 
691: 
692: 
693: 
694: 
695: 
696: 
697: 
698: 
699: 
699: 
700: 
701: 
702: 
703: 
704: 
705: 
706: 
707: 
708: 
709: 
709: 
710: 
711: 
712: 
713: 
714: 
715: 
716: 
717: 
718: 
719: 
719: 
720: 
721: 
722: 
723: 
724: 
725: 
726: 
727: 
728: 
729: 
729: 
730: 
731: 
732: 
733: 
734: 
735: 
736: 
737: 
738: 
739: 
739: 
740: 
741: 
742: 
743: 
744: 
745: 
746: 
747: 
748: 
749: 
749: 
750: 
751: 
752: 
753: 
754: 
755: 
756: 
757: 
758: 
759: 
759: 
760: 
761: 
762: 
763: 
764: 
765: 
766: 
767: 
768: 
769: 
769: 
770: 
771: 
772: 
773: 
774: 
775: 
776: 
777: 
778: 
778: 
779: 
780: 
781: 
782: 
783: 
784: 
785: 
786: 
787: 
788: 
788: 
789: 
789: 
790: 
791: 
792: 
793: 
794: 
795: 
796: 
797: 
798: 
799: 
799: 
800: 
801: 
802: 
803: 
804: 
805: 
806: 
807: 
808: 
809: 
809: 
810: 
811: 
812: 
813: 
814: 
815: 
816: 
817: 
818: 
819: 
819: 
820: 
821: 
822: 
823: 
824: 
825: 
826: 
827: 
828: 
829: 
829: 
830: 
831: 
832: 
833: 
834: 
835: 
836: 
837: 
838: 
839: 
839: 
840: 
841: 
842: 
843: 
844: 
845: 
846: 
847: 
848: 
849: 
849: 
850: 
851: 
852: 
853: 
854: 
855: 
856: 
857: 
858: 
858: 
859: 
860: 
861: 
862: 
863: 
864: 
865: 
866: 
867: 
868: 
868: 
869: 
869: 
870: 
871: 
872: 
873: 
874: 
875: 
876: 
877: 
878: 
878: 
879: 
879: 
880: 
881: 
882: 
883: 
884: 
885: 
886: 
887: 
888: 
888: 
889: 
889: 
890: 
891: 
892: 
893: 
894: 
895: 
896: 
897: 
898: 
898: 
899: 
899: 
900: 
901: 
902: 
903: 
904: 
905: 
906: 
907: 
908: 
909: 
909: 
910: 
911: 
912: 
913: 
914: 
915: 
916: 
917: 
918: 
919: 
919: 
920: 
921: 
922: 
923: 
924: 
925: 
926: 
927: 
928: 
929: 
929: 
930: 
931: 
932: 
933: 
934: 
935: 
936: 
937: 
938: 
939: 
939: 
940: 
941: 
942: 
943: 
944: 
945: 
946: 
947: 
948: 
949: 
949: 
950: 
951: 
952: 
953: 
954: 
955: 
956: 
957: 
958: 
959: 
959: 
960: 
961: 
962: 
963: 
964: 
965: 
966: 
967: 
968: 
969: 
969: 
970: 
971: 
972: 
973: 
974: 
975: 
976: 
977: 
978: 
978: 
979: 
979: 
980: 
981: 
982: 
983: 
984: 
985: 
986: 
987: 
988: 
988: 
989: 
989: 
990: 
991: 
992: 
993: 
994: 
995: 
996: 
997: 
998: 
999: 
999: 
1000: 
1001: 
1002: 
1003: 
1004: 
1005: 
1006: 
1007: 
1008: 
1009: 
1009: 
1010: 
1011: 
1012: 
1013: 
1014: 
1015: 
1016: 
1017: 
1018: 
1019: 
1019: 
1020: 
1021: 
1022: 
1023: 
1024: 
1025: 
1026: 
1027: 
1028: 
1029: 
1029: 
1030: 
1031: 
1032: 
1033: 
1034: 
1035: 
1036: 
1037: 
1038: 
1039: 
1039: 
1040: 
1041: 
1042: 
1043: 
1044: 
1045: 
1046: 
1047: 
1048: 
1049: 
1049: 
1050: 
1051: 
1052: 
1053: 
1054: 
1055: 
1056: 
1057: 
1058: 
1059: 
1059: 
1060: 
1061: 
1062: 
1063: 
1064: 
1065: 
1066: 
1067: 
1068: 
1069: 
1069: 
1070: 
1071: 
1072: 
1073: 
1074: 
1075: 
1076: 
1077: 
1078: 
1078: 
1079: 
1079: 
1080: 
1081: 
1082: 
1083: 
1084: 
1085: 
1086: 
1087: 
1088: 
1088: 
1089: 
1089: 
1090: 
1091: 
1092: 
1093: 
1094: 
1095: 
1096: 
1096: 
1097: 
1097: 
1098: 
1099: 
1100: 
1101: 
1102: 
1103: 
1104: 
1105: 
1106: 
1107: 
1108: 
1109: 
1109: 
1110: 
1111: 
1112: 
1113: 
1114: 
1115: 
1116: 
1117: 
1118: 
1119: 
1119: 
1120: 
1121: 
1122: 
1123: 
1124: 
1125: 
1126: 
1127: 
1128: 
1129: 
1129: 
1130: 
1131: 
1132: 
1133: 
1134: 
1135: 
1136: 
1137: 
1138: 
1139: 
1139: 
1140: 
1141: 
1142: 
1143: 
1144: 
1145: 
1146: 
1147: 
1148: 
1148: 
1149: 
1149: 
1150: 
1151: 
1152: 
1153: 
1154: 
1155: 
1156: 
1157: 
1158: 
1158: 
1159: 
1159: 
1160: 
1161: 
1162: 
1163: 
1164: 
1165: 
1166: 
1167: 
1168: 
1168: 
1169: 
1169: 
1170: 
1171: 
1172: 
1173: 
1174: 
1175: 
1176: 
1177: 
1177: 
1178: 
1178: 
1179: 
1179: 
1180: 
1181: 
1182: 
1183: 
1184: 
1185: 
1186: 
1187: 
1188: 
1188: 
1189: 
1189: 
1190: 
1191: 
1192: 
1193: 
1194: 
1195: 
1196: 
1197: 
1198: 
1198: 
1199: 
1199: 
1200: 
1201: 
1202: 
1203: 
1204: 
1205: 
1206: 
1207: 
1208: 
1209: 
1209: 
1210: 
1211: 
1212: 
1213: 
1214: 
1215: 
1216: 
1217: 
1218: 
1218: 
1219: 
1219: 
1220: 
1221: 
1222: 
1223: 
1224: 
1225: 
1226: 
1227: 
1228: 
1228: 
1229: 
1229: 
1230: 
1231: 
1232: 
1233: 
1234: 
1235: 
1236: 
1237: 
1238: 
1238: 
1239: 
1239: 
1240: 
1241: 
1242: 
1243: 
1244: 
1245: 
1246: 
1247: 
1247: 
1248: 
1248: 
1249: 
1249: 
1250: 
1251: 
1252: 
1253: 
1254: 
1255: 
1256: 
1257: 
1257: 
1258: 
1258: 
1259: 
1259: 
1260: 
1261: 
1262: 
1263: 
1264: 
1265: 
1266: 
1267: 
1267: 
1268: 
1268: 
1269: 
1269: 
1270: 
1271: 
1272: 
1273: 
1274: 
1275: 
1276: 
1277: 
1277: 
1278: 
1278: 
1279: 
1279: 
1280: 
1281: 
1282: 
1283: 
1284: 
1285: 
1286: 
1287: 
1287: 
1288: 
1288: 
1289: 
1289: 
1290: 
1291: 
1292: 
1293: 
1294: 
1295: 
1296: 
1297: 
1297: 
1298: 
1298: 
1299: 
1299: 
1300: 
1301: 
1302: 
1303: 
1304: 
1305: 
1306: 
1307: 
1308: 
1309: 
1309: 
1310: 
1311: 
1312: 
1313: 
1314: 
1315: 
1316: 
1317: 
1317: 
1318: 
1318: 
1319: 
1319: 
1320: 
1321: 
1322: 
1323: 
1324: 
1325: 
1326: 
1327: 
1327: 
1328: 
1328: 
1329: 
1329: 
1330: 
1331: 
1332: 
1333: 
1334: 
1335: 
1336: 
1337: 
1337: 
1338: 
1338: 
1339: 
1339: 
1340: 
1341: 
1342: 
1343: 
1344: 
1345: 
1346: 
1347: 
1347: 
1348: 
1348: 
1349: 
1349: 
1350: 
1351: 
1352: 
1353: 
1354: 
1355: 
1356: 
1357: 
1357: 
1358: 
1358: 
1359: 
1359: 
1360: 
13
```

Demo

What am I looking at?

R v. Rstudio

R Markdown

Your Turn

Go to 01_Introduction

Open 01_intro.Rmd

Read through the file and do everything it tells you to do.



R Markdown

An authoring format for Data Science.

The screenshot shows the RStudio interface with an R Markdown file open. The code editor pane contains the following content:

```
1: ---
2: title: "R Notebook"
3: output: html_notebook
4:
5:
6: Text written in **markdown**
7:
8: ```{r}
9: # code written in R
10: (x <- rnorm(7))
11:
12: Text written in _markdown_
13:
14: ```{r}
15: # code written in R
16: hist(x)
17:
18:
19: Text written in __markdown__
20:
21: ```{r}
22: # code written in R
23:
24: 
```

The R console pane shows the output of the R code:

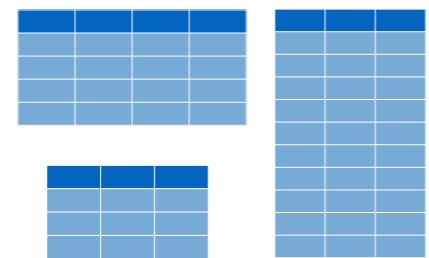
```
[1] -1.2  1.0 -0.5  0.9 -0.6 -1.1 -1.5
```

Three callout boxes point to specific parts of the interface:

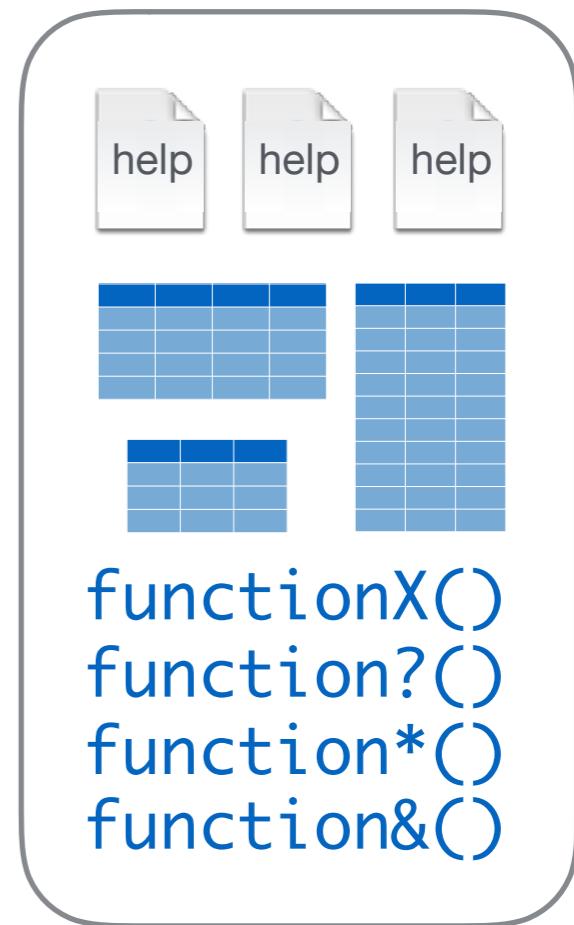
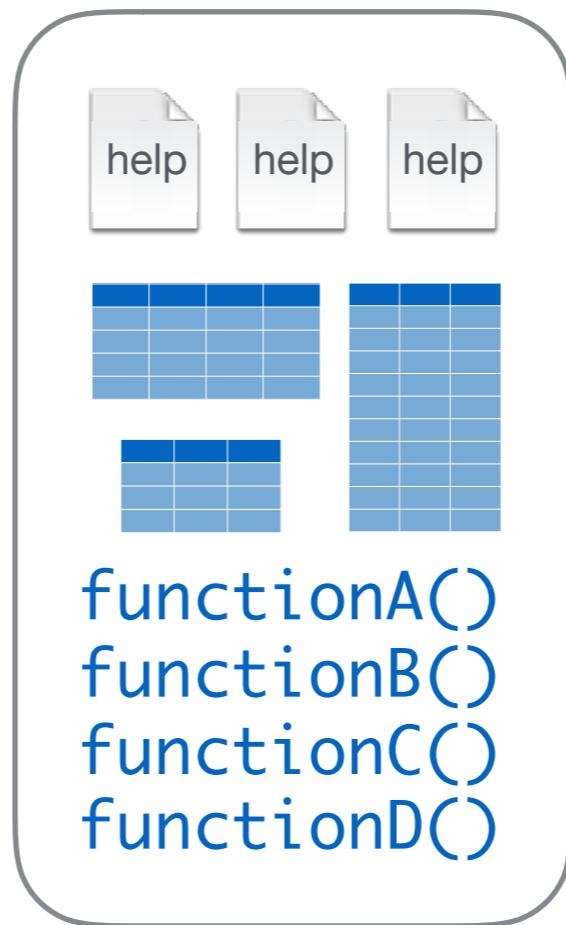
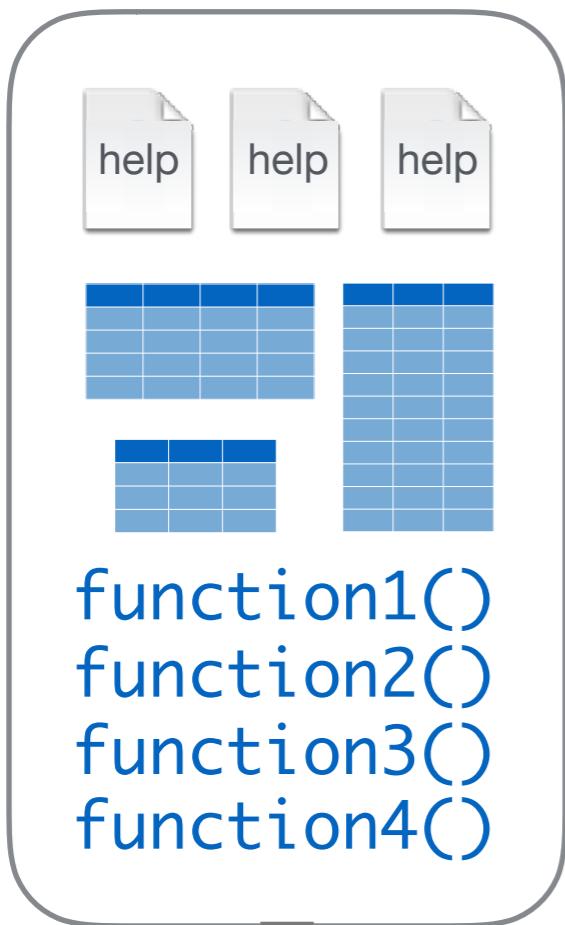
- A grey box points to the code chunk starting at line 8, containing the text "Click to run code in chunk".
- A grey box points to the result of the code execution, showing the numerical output, labeled "Code result".
- A grey box points to the "Preview" tab in the top bar, labeled "Code goes in a chunk".

R Packages

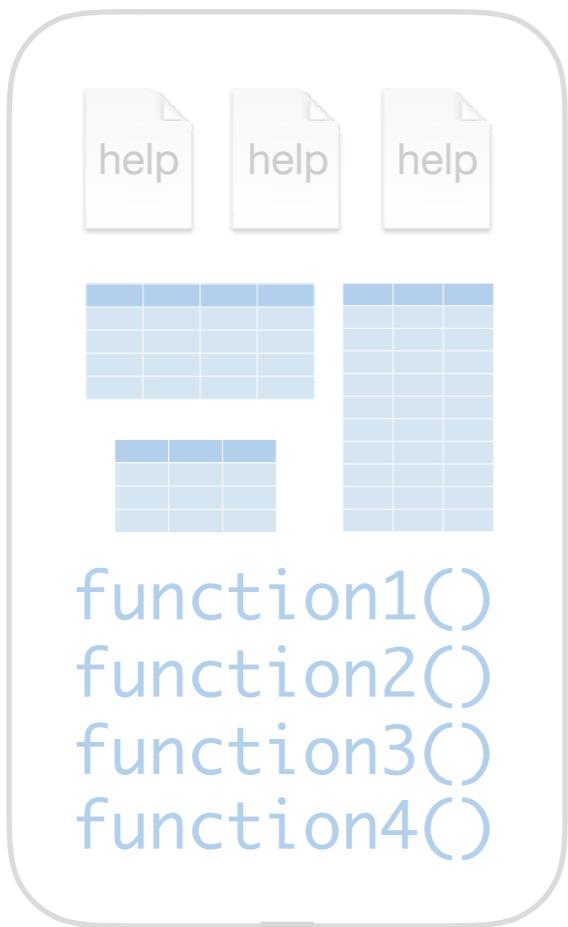




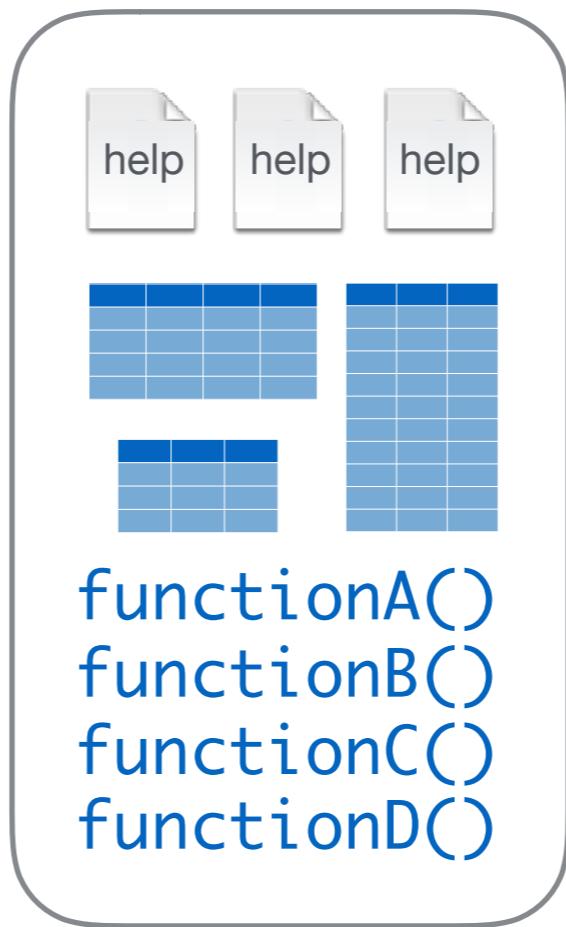
function1()
function2()
function3()
function4()



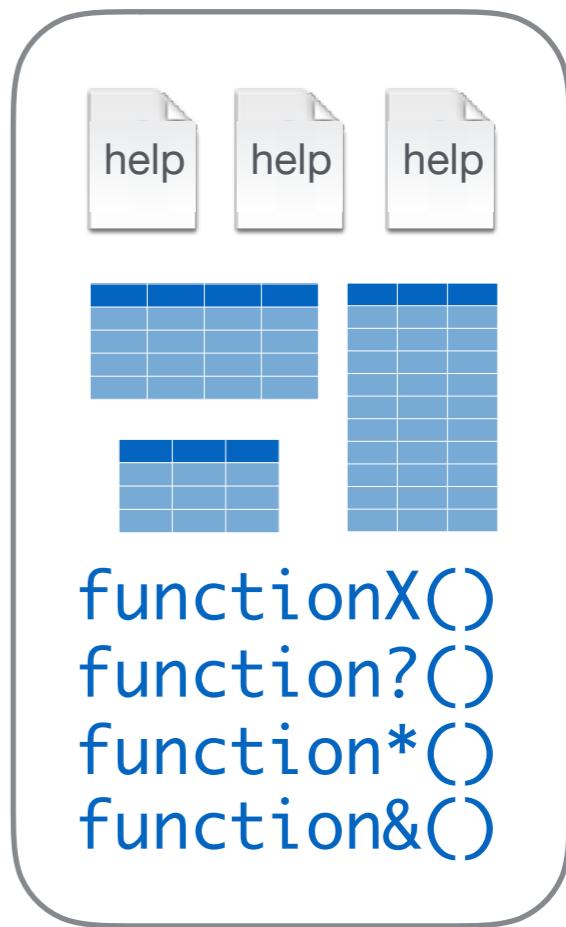
Base R



Base R



R Packages



“Verbs” (i.e. functions) act on data

These “verbs” act on data

```
do_this(to_that)  
do_this(to_that, using_these)
```

Packages contain functions, documentation, data

Package





dplyr part of the [tidyverse](#)
0.8.3

Overview

dplyr is a grammar of data manipulation, providing a consistent set of verbs that help you solve the most common data manipulation challenges:

- `mutate()` adds new variables that are functions of existing variables
- `select()` picks variables based on their names.
- `filter()` picks cases based on their values.
- `summarise()` reduces multiple values down to a single summary.
- `arrange()` changes the ordering of the rows.

The Comprehensive R Archive Garrett

Secure | https://cran.r-project.org



[CRAN
Mirrors](#)
[What's new?](#)
[Task Views](#)
[Search](#)

[About R](#)
[R Homepage](#)
[The R Journal](#)

[Software](#)
[R Sources](#)
[R Binaries](#)
[Packages](#)
[Other](#)

[Documentation](#)
[Manuals](#)
[FAQs](#)
[Contributed](#)

[A3](#)
[abyyR](#)
[abc](#)
[ABCAnalysis](#)
[abc.data](#)
[abcdeFBA](#)

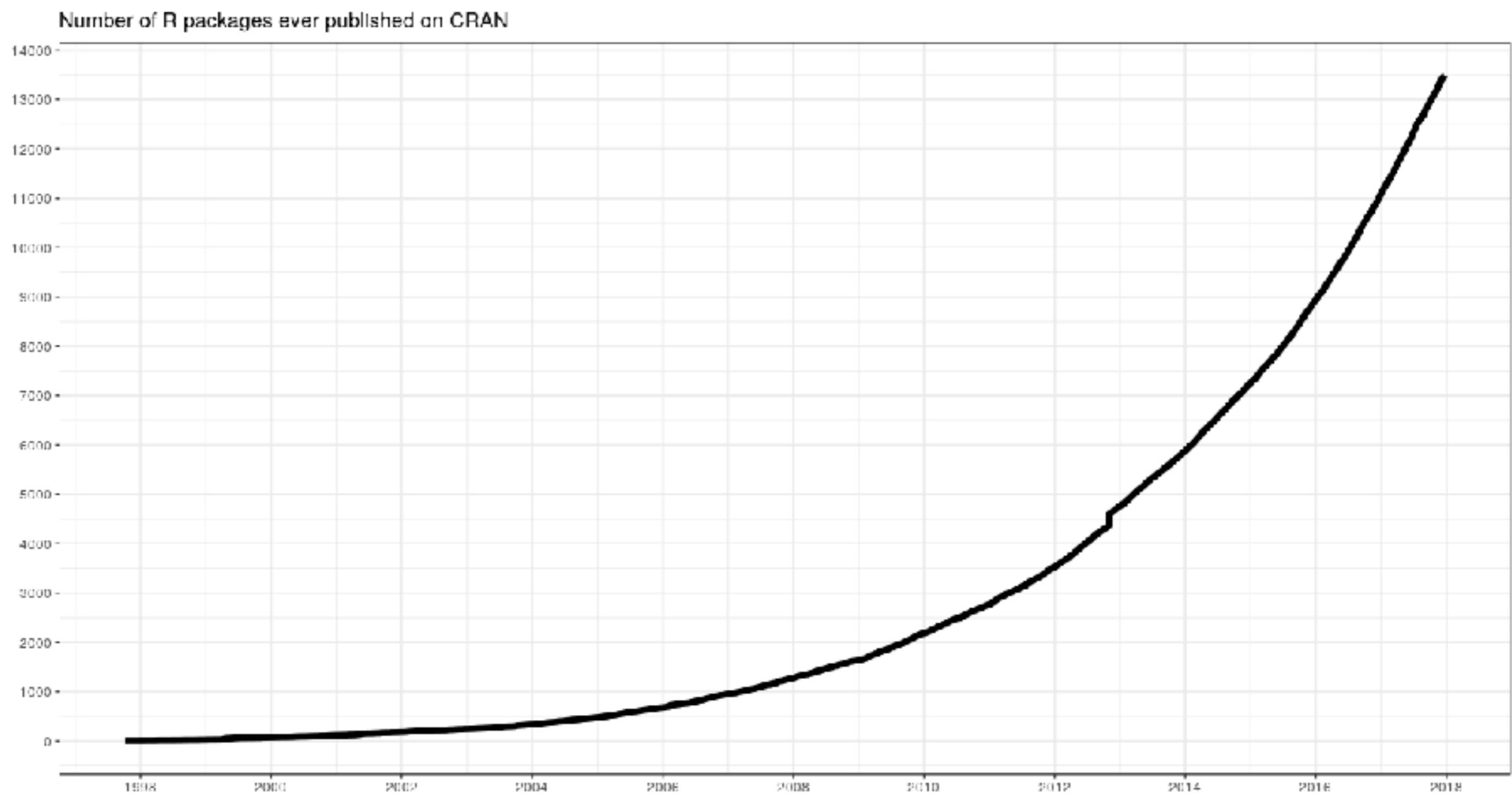
[ABCOptim](#)
[ABCp2](#)
[ABC.RAP](#)
[abcrf](#)
[abctools](#)
[ahd](#)
[abf2](#)
[ABHgenotypeR](#)
[abind](#)
[abjutils](#)
[ahn](#)
[abodOutlier](#)
[AbsFilterGSEA](#)
[AbSim](#)
[abundant](#)
[ACA](#)
[acc](#)
[accelrometry](#)
[accelmissing](#)
[AcceptanceSampling](#)

Available CRAN Packages By Name

[A](#) [B](#) [C](#) [D](#) [E](#) [F](#) [G](#) [H](#) [I](#) [J](#) [K](#) [L](#) [M](#) [N](#) [O](#) [P](#) [Q](#) [R](#) [S](#) [T](#) [U](#) [V](#) [W](#) [X](#) [Y](#) [Z](#)

Accurate, Adaptable, and Accessible Error Metrics for Predictive Models
Access to Abbyy Optical Character Recognition (OCR) API
Tools for Approximate Bayesian Computation (ABC)
Computed ABC Analysis
Data Only: Tools for Approximate Bayesian Computation (ABC)
ABCDE_FBA: A-Biologist-Can-Do-Everything of Flux Balance Analysis with this package
Implementation of Artificial Bee Colony (ABC) Optimization
Approximate Bayesian Computational Model for Estimating P2
Array Based CpG Region Analysis Pipeline
Approximate Bayesian Computation via Random Forests
Tools for ABC Analyses
The Analysis of Biological Data
Load Gap-Free Axon ABF2 Files
Easy Visualization of ABH Genotypes
Combine Multidimensional Arrays
Useful Tools for Jurimetrical Analysis Used by the Brazilian Jurimetrics Association
Modelling Multivariate Data with Additive Bayesian Networks
Angle-Based Outlier Detection
Improved False Positive Control of Gene-Permuting GSEA with Absolute Filtering
Time Resolved Simulations of Antibody Repertoires
High-Dimensional Principal Fitted Components and Abundant Regression
Abrupt Change-Point or Aberration Detection in Point Series
Exploring Accelerometer Data
Functions for Processing Minute-to-Minute Accelerometer Data
Missing Value Imputation for Accelerometer Data
Creation and Evaluation of Acceptance Sampling Plans

14108
packages
as of 5/2019



Using packages

Step 1

```
install.packages("tidybiology")
```

Downloads files to computer

1 x per
computer



R packages for data science

The tidyverse is an opinionated collection of R packages designed for data science. All packages share an underlying design philosophy, grammar, and data structures.

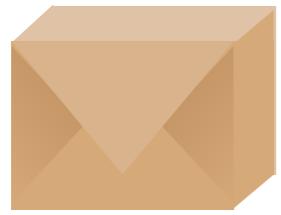
Pop Quiz!

The tidyverse contains the following packages. How would you install them?

ggplot2	tibble	DBI	
dplyr	hms	haven	rvest
tidyr	stringr	httr	xml2
readr	lubridate	jsonlite	modelr
purrr	forcats	readxl	tidyverse

```
install.packages("ggplot2")
install.packages("dplyr")
install.packages("tidyr")
install.packages("readr")
install.packages("purrr")
install.packages("tibble")
install.packages("hms")
install.packages("stringr")
install.packages("lubridate")
install.packages("forcats")
install.packages("DBI")
install.packages("haven")
install.packages("httr")
install.packages("jsonlite")
install.packages("readxl")
install.packages("rvest")
install.packages("xml2")
install.packages("modelr")
install.packages("broom")
```

tidyverse



An R package that serves as a short cut for installing and loading the components of the tidyverse.

```
install.packages("tidyverse")
```

```
install.packages("tidyverse")
```

does the equivalent of

```
install.packages("ggplot2")
install.packages("dplyr")
install.packages("tidyr")
install.packages("readr")
install.packages("purrr")
install.packages("tibble")
install.packages("hms")
install.packages("stringr")
install.packages("lubridate")
install.packages("forcats")
install.packages("DBI")
install.packages("haven")
install.packages("httr")
install.packages("jsonlite")
install.packages("readxl")
install.packages("rvest")
install.packages("xml2")
install.packages("modelr")
install.packages("broom")
```

I've already installed all of
the packages you need

Using packages

Step1

```
install.packages("tidybiology")
```

Downloads files to computer

1 x per computer

Step2

```
library("tidybiology")
```

Loads package

1 x per R Session

```
install.packages("tidyverse")
```

does the equivalent of

```
install.packages("ggplot2")
install.packages("dplyr")
install.packages("tidyr")
install.packages("readr")
install.packages("purrr")
install.packages("tibble")
install.packages("stringr")
install.packages("forcats")
install.packages("lubridate")
install.packages("hms")
install.packages("DBI")
install.packages("haven")
install.packages("httr")
install.packages("jsonlite")
install.packages("readxl")
install.packages("rvest")
install.packages("xml2")
install.packages("modelr")
install.packages("broom")
```

```
library("tidyverse")
```

does the equivalent of

```
library("ggplot2")
library("dplyr")
library("tidyr")
library("readr")
library("purrr")
library("tibble")
library("stringr")
library("forcats")
```

Setup

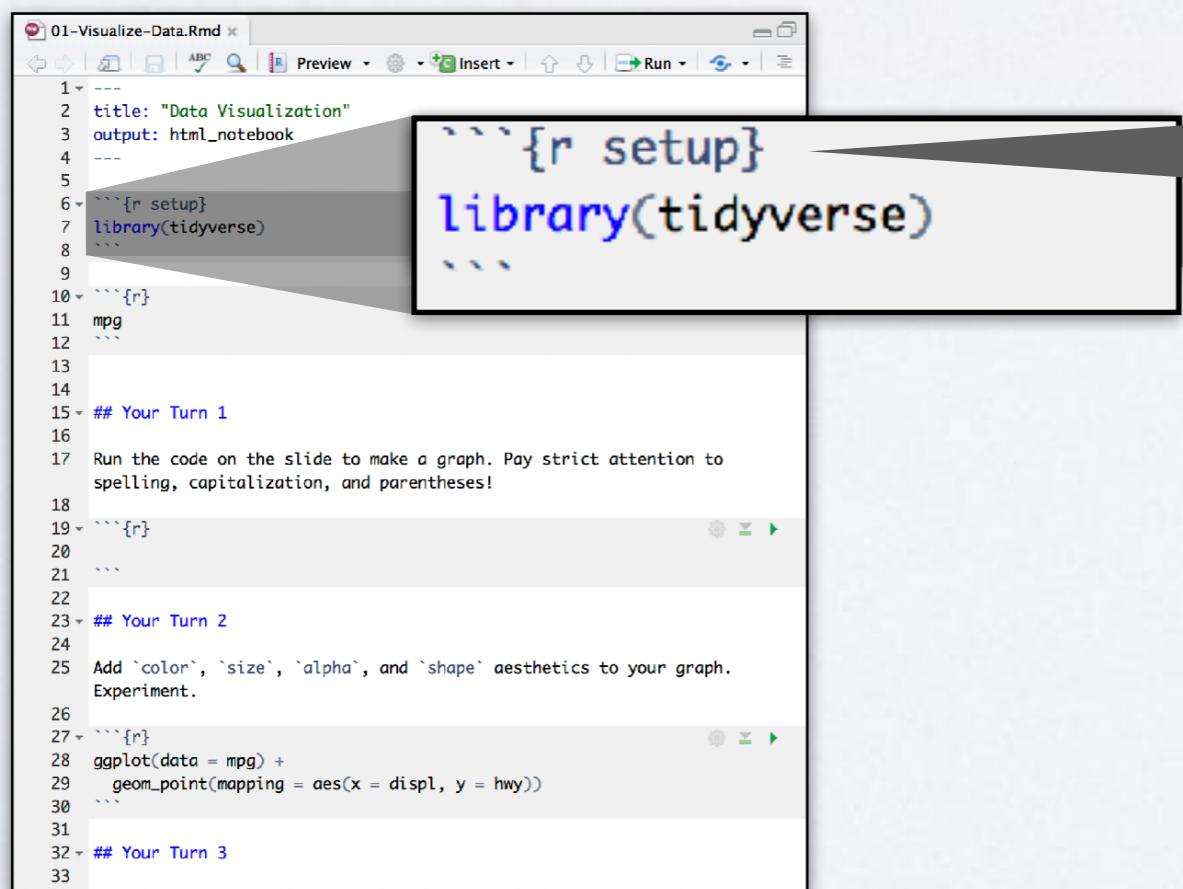
The setup chunk is always run once before anything else

```
1 ---  
2 title: "Data Visualization"  
3 output: html_notebook  
4 ---  
5  
6 ```{r setup}  
7 library(tidyverse)  
8 ...  
9  
10 ```{r}  
11 mpg  
12 ...  
13  
14  
15 ## Your Turn 1  
16  
17 Run the code on the slide to make a graph. Pay strict attention to  
spelling, capitalization, and parentheses!  
18  
19 ```{r}  
20  
21 ...  
22  
23 ## Your Turn 2  
24  
25 Add `color`, `size`, `alpha`, and `shape` aesthetics to your graph.  
Experiment.  
26  
27 ```{r}  
28 ggplot(data = mpg) +  
29   geom_point(mapping = aes(x = displ, y = hwy))  
30 ...  
31  
32 ## Your Turn 3  
33  
34 Replace this scatterplot with one that draws boxplots. Use the cheatsheet.  
Try your best guess.  
35  
36 ```{r}  
37 ggplot(mpg) + geom_point(aes(class, hwy))  
38 ...  
39
```

chunk labels are optional, the setup label is special

Exercise

Add a setup chunk (as shown below) to the top of 01_intro.Rmd.
Use it to load the tidyverse package (*remember to run this chunk)
Then uncomment and run the final code chunk at the bottom of
your file.



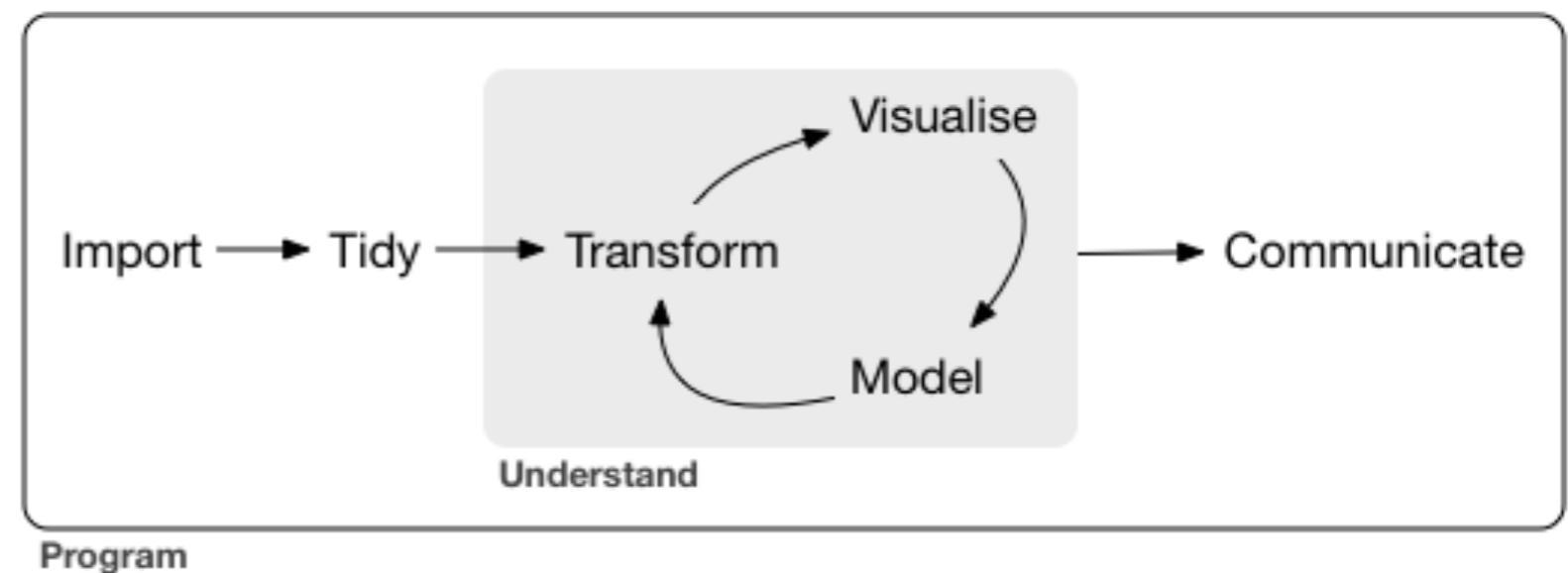
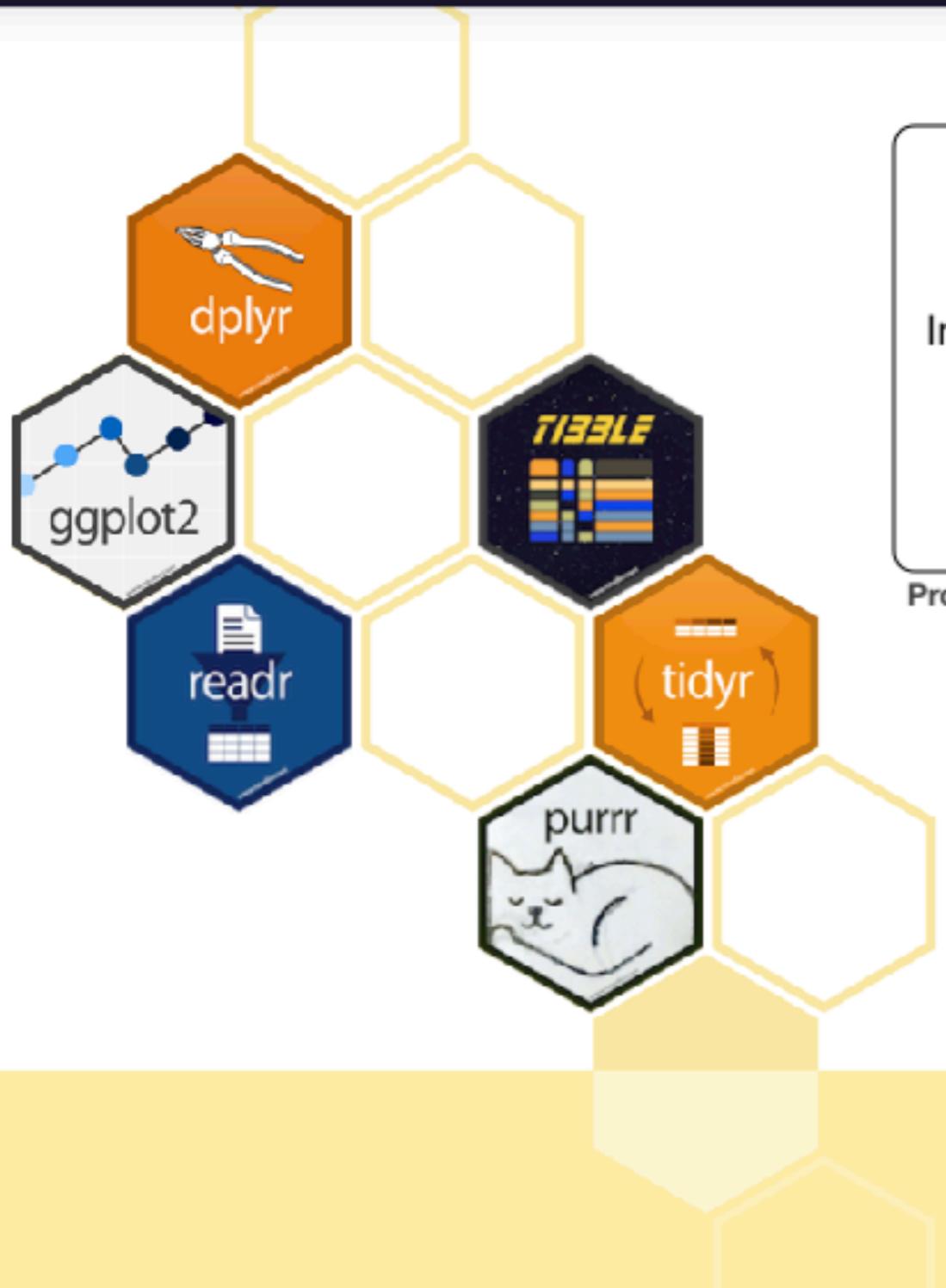
```
1 ---  
2 title: "Data Visualization"  
3 output: html_notebook  
4 ---  
5  
6 ```{r setup}  
7 library(tidyverse)  
8 ```  
9  
10 ```{r}  
11 mpg  
12  
13  
14  
15 ## Your Turn 1  
16  
17 Run the code on the slide to make a graph. Pay strict attention to  
spelling, capitalization, and parentheses!  
18  
19 ```{r}  
20  
21 ...  
22  
23 ## Your Turn 2  
24  
25 Add `color`, `size`, `alpha`, and `shape` aesthetics to your graph.  
Experiment.  
26  
27 ```{r}  
28 ggplot(data = mpg) +  
29   geom_point(mapping = aes(x = displ, y = hwy))  
30 ...  
31  
32 ## Your Turn 3
```

chunk labels are
optional, the
setup label is
special

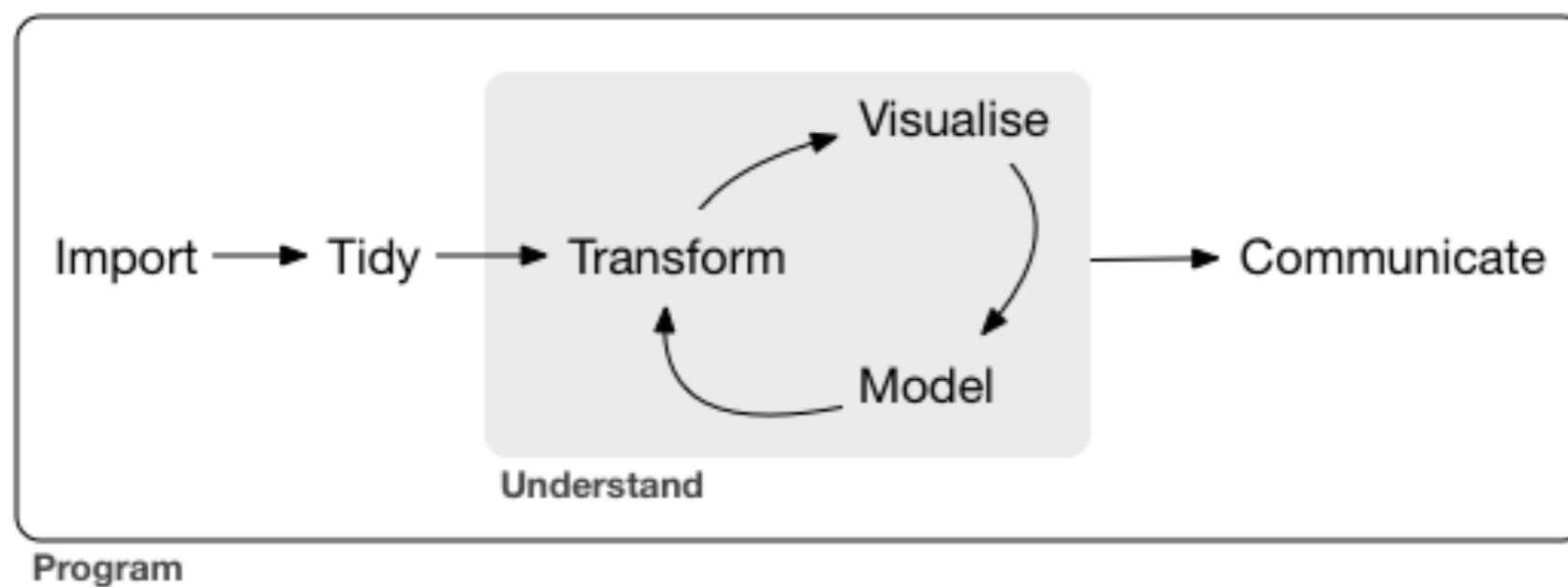


Tidyverse

Packages Articles Learn Help Contribute



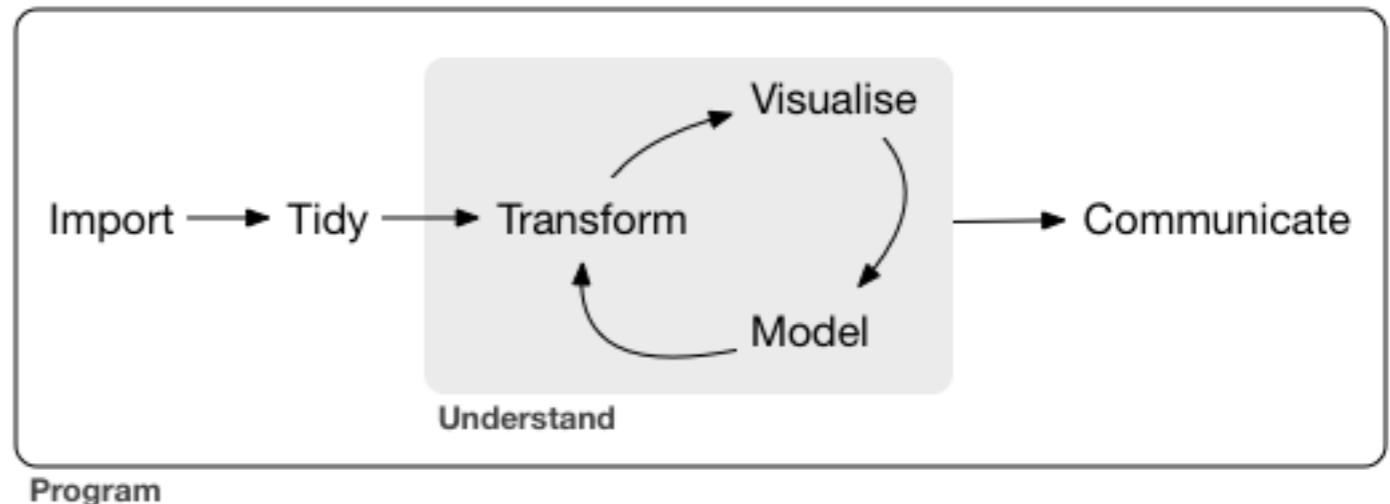
Exploratory Data Analysis (EDA)



Basic Tidyverse Principles

IMPORT(readr):

- » `read_csv()`
- » `read_tsv()`
- » `read_delim()`



TIDY & TRANSFORM(dplyr):

- » `mutate()` adds new variables that are functions of existing variables
- » `select()` picks variables based on their names.
- » `filter()` picks cases based on their values.
- » `summarise()` reduces multiple values down to a single summary.
- » `arrange()` changes the ordering of the rows.

VISUALISE(ggplot): creating graphics, based on 'The Grammar of Graphics'

- » `aes()`
- » `geom_x() + layers`

MODEL(broom):

- » `tidy()`, `glance()`, `augment()`
- » `lm(~)`



Ceci n'est pas une pipe.

%>%
magrittr

Ceci n'est pas un pipe.

magrittr package by Stefan Milton Bache developed the concept of the pipe, which is used heavily in the tidyverse

“and then”

The “pipe” is a sequence of functions, that are sequentially applied to an object

```
wakeup(self) %>%  
  put_on("clothes") %>%  
  eat("breakfast") %>%  
  go(to = "work")
```

Alternative nested code

```
go(eat(put_on(wakeup(self), "clothes"), "brekfast"), to = "work")
```

What does this code do?

```
wakeup(self) %>%  
  put_on("clothes") %>%  
  eat("breakfast") %>%  
  fmk() %>%  
  go(to = "work")
```

```
morning_routine <- wakeup(self) %>%  
  put_on("clothes") %>%  
  eat("breakfast") %>%  
  fmk() %>%  
  go(to = "work")
```

The “pipe” is a sequence of functions, that are sequentially applied to an object

What does this code do?

```
data %>%
  select("gene", "expression_level_control", "expression_level_experimental") %>%
  mutate(differential_expression_level = expression_level_experimental - expression_level_control) %>%
  arrange(desc(differential_expression_level))
```

```
ranked_dge <- data %>%
  select("gene", "expression_level_control", "expression_level_experimental") %>%
  mutate(differential_expression_level = expression_level_experimental - expression_level_control) %>%
  arrange(desc(differential_expression_level))
```

Project

Go to 01_Introduction

Open 01_project.Rmd

Read through the file and the code, to do everything it tells you to do.

Writing code is NOT like drawing an owl

How to draw an owl

1.



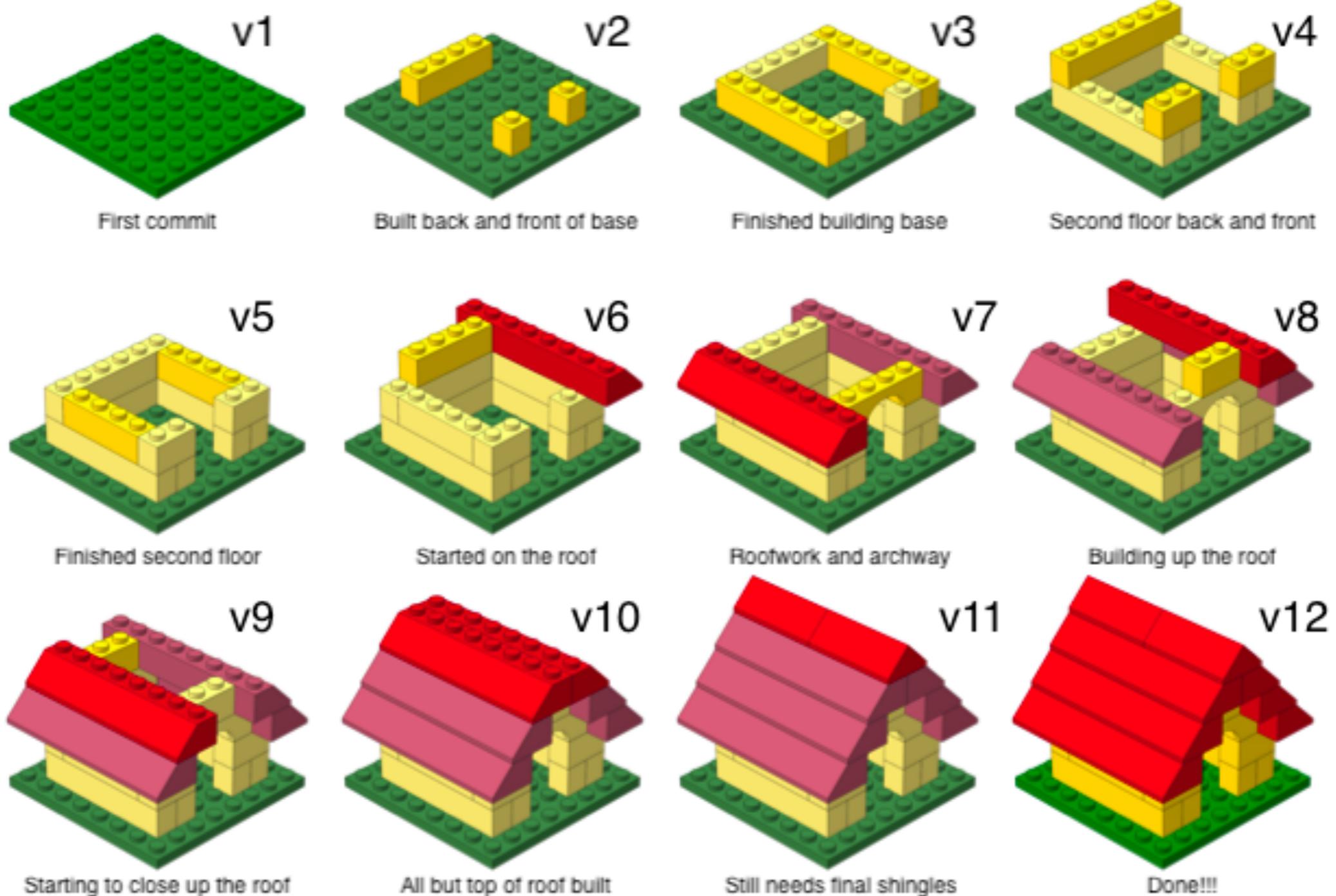
2.



1. Draw some circles

2. Draw the rest of the fucking owl

Writing code is a step-wise process



Resources: Cheat Sheets

Cheat sheets make it easy to learn about and quickly refer to function in some of the common packages.

Data Import :: CHEAT SHEET

R's tidyverse is built around `tidy` stored in `tibbles`, which are enhanced data frames.

The front side of this sheet shows how to read text files into R with `readr`.

The reverse side shows how to create tibbles with `tibble` and to layout tidy data with `tidyR`.

OTHER TYPES OF DATA

Try one of the following packages to import other types of files

- `haven` - SPSS, Stata, and SAS files
- `readxl` - excel files (.xls and .xlsx)
- `DBI` - databases
- `jsonlite`
- `xml2` - XML
- `httr` - Web APIs
- `rvest` - HTML (Web Scraping)

Save Data

Save `x`, an object, to `path`, a file path, as:

Comma delimited file
`write_csv(x, path, na = "NA", append = FALSE, col_names = lapply)`

File with a single delimiter
`write_delim(x, file, delim = " ", na = "NA", append = FALSE, col.names = lapply)`

CSV for excel
`write_excel(x, path, na = "NA", append = FALSE, col.names = lapply)`

String for excel
`write_xlsx(x, path, append = FALSE)`

String vector to file, one element per line
`write_lines(path, na = "NA", append = FALSE)`

String to file
`write_file(path, text, append = FALSE)`

String vector to file, path compression = c("none", "gz", "bz2", "xz", ...)
`write_rds(x, path, compress = c("none", "gz", "bz2", "xz", ...))`

Tab delimited files
`write_tsv(path, na = "NA", append = FALSE, col.names = lapply)`

Read Tabular Data

- These functions share the common arguments:

`read_*`(file, col_names = TRUE, col_types = NULL, locale = `default_locale()`, na = c("", "NA"), quoted = TRUE, comment = "#", trim_ws = TRUE, skip = 0, n_max = Inf, guess_max = min(1000, n_max), progress = interactive())

Common Delimited Files

```
read_csv(file.csv)
# To make file.csv from
write_file("file.csv", file = "a,b,c\n1,2,3\n4,5,NA")
```

Semi-colon Delimited Files

```
read_csv2(file2.csv)
# write_file("file2.csv", file = "a,b,c\n1,2,3\n4,5,NA", path = "file.csv")
```

Files with Any Delimiter

```
read_delim("file.txt", delim = "|")
# write_file("file.txt", file = "a|b|c\n1|2|3\n4|5|NA")
```

Fixed Width Files

```
read_fwf(file.fwf, col_positions = c(1, 3, 5))
# write_file("file.fwf", file = "a   b   c\n1   2   3\n4   5   NA")
```

Tab Delimited Files

```
read_tsv(file.tsv) # Also read_table(), read_table2()
# write_file("file.tsv", file = "a\tb\tc\n1\t2\t3\n4\t5\tNA")
```

USEFUL ARGUMENTS

Example file	1	2	3	4	5	NA	skip lines
write_file("file1,n1,n2,n3,n4,n5,NA","file.csv") f <- "file.csv"	1	2	3	4	5	NA	read_csv(f, skip = 1)
No header	A	B	C	D	E	F	
read_csv(f, col.names = FALSE)	1	2	3	4	5	NA	
Provide header	A	B	C	D	E	F	
read_csv(f, col.names = c("x", "y", "z"))	1	2	3	4	5	NA	

1	2	3	4	5	NA	skip lines	
A	B	C	D	E	F	read_csv(f, skip = 1)	
1	2	3	4	5	NA		
Read in a subset	1	2	3	4	5	NA	read_csv(f, n_max = 1)
A	B	C	D	E	F		
Provide header	A	B	C	D	E	F	
read_csv(f, col.names = c("x", "y", "z"))	1	2	3	4	5	NA	
Missing Values	A	B	C	D	E	F	
read_csv(f, na = c("1", ""))	1	2	3	4	5	NA	read_csv(f, na = c("1", ""))

Read Non-Tabular Data

Read a file into a single string
`read_file(file, locale = default_locale())`

Read each line into its own string
`read_lines(file, skip = 0, n_max = -1, na = character(), locale = default_locale(), progress = interactive())`

Read Apache style log file
`read_log_file(file, col_names = FALSE, col_types = NULL, skip = 0, n_max = -1, progress = interactive())`

Read a file into a raw vector
`read_file(file)`

Read each line into a raw vector
`read_lines_raw(file, skip = 0, n_max = -1, na = character(), locale = default_locale(), progress = interactive())`

Data Visualization with ggplot2 :: CHEAT SHEET

Basics

ggplot2 is based on the **grammar of graphics**, the idea that you can build every graph from the same components: **data**, **geom**, **stat**, **coordinate system**, and **geoms**—marks that represent data points.

The diagram illustrates the grammar of graphics as a sum: **data** + **geom** + **coordinate system** = **plot**.

To display values, map variables in the data to visual properties of the geom (**aesthetics**) like size, color, and x + y locations.

The diagram illustrates the grammar of graphics as a sum: **data** + **geom** + **mapping** + **coordinate system** = **plot**.

Complete the template below to build a graph.

graph: data = **DATA**

+ **geom_**(**FUNCTION**) **mapping** = **aest**(**MAPPINGS**)

+ **stat_**(**STAT**) **position** = **POSITION**

+ **COORDINATE_**(**FUNCTION**)

+ **SCALE_**(**FUNCTION**)

+ **THEME_**(**FUNCTION**)

Required

Not required,
use defaults

Mapping
supplied

ggplot(data = mpg, aes(x = cyl, y = hwy)) +
 geom_point(mapping = aes(x = cyl, y = hwy))

Begins a plot that you finish by adding layers to it. Add one geom at a time.

geom_point(mapping = aes(x = cyl, y = hwy))
 + geom_point(mapping = aes(x = cyl, y = hwy))

Creates a plot with two points. If you add more data, geom, and mappings. Supplies many useful defaults.

last_plot() Returns the last plot

ggplot2::plot_ggplot(mpg, width = 5, height = 5) Saves last plot as a file named `mpg.pdf` in working directory.

Matches file type to file extension.
File types to file extensions:

ggplot2::plot_ggplot(mpg, width = 5, height = 5) Saves last plot as a file named `mpg.pdf` in working directory.

ggplot2::plot_ggplot(mpg, width = 5, height = 5) Saves last plot as a file named `mpg.pdf` in working directory.

ggplot2::plot_ggplot(mpg, width = 5, height = 5) Saves last plot as a file named `mpg.pdf` in working directory.

RStudio® is a trademark of RStudio, Inc. • CC BY SA RStudio - info@rstudio.com • 844-448-1212 | rstudio.com • Learn more at <http://ggplot2.tidyverse.org> | ggplot2 3.1.0 • Updated: 2018-12

Geoms

Use a geom function to represent data points, use the geom's aesthetic properties to represent variables. Each function returns a layer.

GRAPHICAL PRIMITIVES

- b = `geom_point(mapping = aes(x = x, y = y))`
- b = `geom_rect(mapping = aes(x = x, y = y, xend = xend, yend = yend))`
- + `geom_rect(mapping = aes(x = x, y = y, xend = xend, yend = yend), fill = "blue")` (Useful for expanding limits)
- b = `geom_curve(mapping = aes(x = x, y = y, xend = xend, yend = yend))`
- + `geom_path(mapping = aes(x = x, y = y, group = group), linejoin = "round")`
- b = `geom_pointray(mapping = aes(x = x, y = y, alpha = alpha, color = color, fill = fill, shape = shape))`
- b = `geom_rect(mapping = aes(x = x, y = y, min = min, max = max, long = 1, ymin = 1, ymax = 1))` (max, min, ymin, alpha, color, fill, linejoin, size)
- a = `geom_ribbon(mapping = aes(x = x, y = y, min = min, max = max, fill = fill, linejoin = linejoin, size = size))` (min, max, fill, linejoin, size, weight)

LINE GEOMS

- common aesthetics: x, y, alpha, color, linejoin, size
- b = `geom_abline(mapping = aes(intercept = intercept, slope = slope))`
- b = `geom_hline(mapping = aes(yintercept = yintercept))`
- b = `geom_segment(mapping = aes(x = x1, y = y1, xend = x2, yend = y2))`
- b = `geom_spoke(mapping = aes(x = x, y = y, radius = radius))`

ONE VARIABLE

- continuous y
- c = `geom_qq(mapping = aes(ylab = "qq"))`
- b = `geom_bar(mapping = aes(x = x, fill = fill))`
- c = `geom_bar(mapping = aes(x = x, stat = "bin"))`
- c = `geom_bar(mapping = aes(x = x, stat = "count"))`
- c = `geom_bar(mapping = aes(x = x, stat = "percent"))`
- c = `geom_bar(mapping = aes(x = x, stat = "sum"))`
- c = `geom_dotplot(mapping = aes(x = x, fill = fill))`
- c = `geom_freqpoly(mapping = aes(x = x, alpha = alpha, color = color, fill = fill))`
- c = `geom_hex(mapping = aes(x = x, y = y, fill = fill, size = size))`
- c = `geom_histogram(mapping = aes(x = x, fill = fill, size = size))`
- c = `geom_linerange(mapping = aes(x = x, y = y, alpha = alpha, color = color, fill = fill, size = size))`
- c = `geom_parallel(mapping = aes(x = x, alpha = alpha, color = color, fill = fill, size = size))`
- c = `geom_point(mapping = aes(x = x, y = y, alpha = alpha, color = color, fill = fill, size = size))`
- c = `geom_rect(mapping = aes(x = x, y = y, xend = xend, yend = yend, fill = fill, size = size))`
- c = `geom_rug(mapping = aes(x = x, y = y, alpha = alpha, color = color, fill = fill, size = size))`
- c = `geom_violin(mapping = aes(x = x, alpha = alpha, color = color, fill = fill, size = size))`

DISCRETE X

- continuous y
- f = `geom_bar(mapping = aes(fill = fill))`
- f = `geom_bar(mapping = aes(fill = fill, stat = "bin"))`
- f = `geom_bar(mapping = aes(fill = fill, stat = "count"))`
- f = `geom_bar(mapping = aes(fill = fill, stat = "percent"))`
- f = `geom_bar(mapping = aes(fill = fill, stat = "sum"))`
- f = `geom_dotplot(mapping = aes(fill = fill))`
- f = `geom_hex(mapping = aes(fill = fill, size = size))`
- f = `geom_linerange(mapping = aes(fill = fill))`
- f = `geom_parallel(mapping = aes(fill = fill))`
- f = `geom_point(mapping = aes(fill = fill))`
- f = `geom_rect(mapping = aes(fill = fill))`
- f = `geom_rug(mapping = aes(fill = fill))`
- f = `geom_violin(mapping = aes(fill = fill))`

DISCRETE X, DISCRETE Y

- f = `geom_bar(mapping = aes(x = x, fill = fill))`
- f = `geom_bar(mapping = aes(x = x, fill = fill, color = color))`
- f = `geom_bar(mapping = aes(x = x, fill = fill, size = size))`
- f = `geom_bar(mapping = aes(x = x, fill = fill, stroke = stroke))`

DISCRETE X, CONTINUOUS Y

- f = `geom_bar(mapping = aes(x = x, fill = fill, stat = "bin"))`
- f = `geom_bar(mapping = aes(x = x, fill = fill, stat = "count"))`
- f = `geom_bar(mapping = aes(x = x, fill = fill, stat = "percent"))`
- f = `geom_bar(mapping = aes(x = x, fill = fill, stat = "sum"))`
- f = `geom_hex(mapping = aes(x = x, fill = fill, size = size))`
- f = `geom_linerange(mapping = aes(x = x, fill = fill))`
- f = `geom_parallel(mapping = aes(x = x, fill = fill))`
- f = `geom_point(mapping = aes(x = x, fill = fill))`
- f = `geom_rect(mapping = aes(x = x, fill = fill))`
- f = `geom_rug(mapping = aes(x = x, fill = fill))`
- f = `geom_violin(mapping = aes(x = x, fill = fill))`

THREE VARIABLES

- f = `geom_point(mapping = aes(x = x, y = y, z = z))`
- f = `geom_contour(mapping = aes(x = x, y = y, z = z))`
- f = `geom_hex(mapping = aes(x = x, y = y, z = z))`

TWO VARIABLES

CONTINUOUS X, CONTINUOUS Y

- f = `geom_abline(mapping = aes(intercept = intercept, slope = slope))`
- b = `geom_label(mapping = aes(x = x, y = y, label = label))`
- + `geom_label(mapping = aes(x = x, y = y, label = label), nudge_x = 1, nudge_y = 1, check_overlap = TRUE, x_jitter = 1, y_jitter = 1, fontface = "italic", fontweight = "bold")`
- b = `geom_linerange(mapping = aes(x = x, y = y, yend = yend), linejoin = "round")`
- b = `geom_rect(mapping = aes(x = x, y = y, xend = xend, yend = yend), fill = "blue")`
- b = `geom_text(mapping = aes(x = x, y = y, label = label), size = size)`
- e = `geom_quantile(mapping = aes(x = x, y = y, alpha = alpha, color = color, group = group), size = size, weight = weight)`
- e = `geom_ridgeline(mapping = aes(x = x, y = y, alpha = alpha, color = color, group = group), size = size)`
- e = `geom_rect(mapping = aes(x = x, y = y, xend = xend, yend = yend), fill = "red")`
- e = `geom_text(mapping = aes(x = x, y = y, label = label), size = size, weight = weight)`

DISCRETE X, CONTINUOUS Y

- f = `geom_bar(mapping = aes(fill = fill, stat = "bin"))`
- f = `geom_bar(mapping = aes(fill = fill, stat = "count"))`
- f = `geom_bar(mapping = aes(fill = fill, stat = "percent"))`
- f = `geom_bar(mapping = aes(fill = fill, stat = "sum"))`
- f = `geom_hex(mapping = aes(fill = fill, size = size))`
- f = `geom_linerange(mapping = aes(fill = fill))`
- f = `geom_parallel(mapping = aes(fill = fill))`
- f = `geom_point(mapping = aes(fill = fill))`
- f = `geom_rect(mapping = aes(fill = fill))`
- f = `geom_rug(mapping = aes(fill = fill))`
- f = `geom_violin(mapping = aes(fill = fill))`

DISCRETE X, DISCRETE Y

- f = `geom_bar(mapping = aes(x = x, fill = fill, color = color))`
- f = `geom_bar(mapping = aes(x = x, fill = fill, size = size))`
- f = `geom_bar(mapping = aes(x = x, fill = fill, stroke = stroke))`

DISCRETE X, CONTINUOUS Y, CONTINUOUS Z

- f = `geom_hex(mapping = aes(x = x, y = y, z = z))`
- f = `geom_linerange(mapping = aes(x = x, y = y, z = z))`
- f = `geom_parallel(mapping = aes(x = x, y = y, z = z))`
- f = `geom_point(mapping = aes(x = x, y = y, z = z))`
- f = `geom_rect(mapping = aes(x = x, y = y, z = z))`
- f = `geom_rug(mapping = aes(x = x, y = y, z = z))`
- f = `geom_violin(mapping = aes(x = x, y = y, z = z))`

CONTINUOUS X, CONTINUOUS Y, CONTINUOUS Z

- f = `geom_hex(mapping = aes(x = x, y = y, z = z))`
- f = `geom_linerange(mapping = aes(x = x, y = y, z = z))`
- f = `geom_parallel(mapping = aes(x = x, y = y, z = z))`
- f = `geom_point(mapping = aes(x = x, y = y, z = z))`
- f = `geom_rect(mapping = aes(x = x, y = y, z = z))`
- f = `geom_rug(mapping = aes(x = x, y = y, z = z))`
- f = `geom_violin(mapping = aes(x = x, y = y, z = z))`

THREE VARIABLES

- f = `geom_hex(mapping = aes(x = x, y = y, z = z))`
- f = `geom_linerange(mapping = aes(x = x, y = y, z = z))`
- f = `geom_parallel(mapping = aes(x = x, y = y, z = z))`
- f = `geom_point(mapping = aes(x = x, y = y, z = z))`
- f = `geom_rect(mapping = aes(x = x, y = y, z = z))`
- f = `geom_rug(mapping = aes(x = x, y = y, z = z))`
- f = `geom_violin(mapping = aes(x = x, y = y, z = z))`

CONTINUOUS BIVARIATE DISTRIBUTION

- b = `geom_diamond(mapping = aes(x = x, y = y))`
- b = `geom_hex(mapping = aes(x = x, y = y))`
- b = `geom_hex(mapping = aes(x = x, y = y, fill = fill))`
- b = `geom_hex(mapping = aes(x = x, y = y, fill = fill, alpha = alpha))`
- b = `geom_hex(mapping = aes(x = x, y = y, fill = fill, alpha = alpha, color = color))`
- b = `geom_hex(mapping = aes(x = x, y = y, fill = fill, alpha = alpha, color = color, size = size))`
- b = `geom_hex(mapping = aes(x = x, y = y, fill = fill, alpha = alpha, color = color, size = size, weight = weight))`

CONTINUOUS FUNCTION

- i = `geom_area(mapping = aes(x = x, y = y))`
- i = `geom_area(mapping = aes(x = x, y = y, fill = fill))`
- i = `geom_area(mapping = aes(x = x, y = y, fill = fill, alpha = alpha))`
- i = `geom_area(mapping = aes(x = x, y = y, fill = fill, alpha = alpha, color = color))`
- i = `geom_area(mapping = aes(x = x, y = y, fill = fill, alpha = alpha, color = color, size = size))`
- i = `geom_area(mapping = aes(x = x, y = y, fill = fill, alpha = alpha, color = color, size = size, weight = weight))`

VISUALIZING ERROR

- j = `geom_crossbar(mapping = aes(x = x, y = y, ymin = ymin, ymax = ymax))`
- j = `geom_crossbar(mapping = aes(x = x, y = y, ymin = ymin, ymax = ymax, fill = fill))`
- j = `geom_errorbar(mapping = aes(x = x, y = y, ymin = ymin, ymax = ymax))`
- j = `geom_errorbar(mapping = aes(x = x, y = y, ymin = ymin, ymax = ymax, width = width))`
- j = `geom_linerange(mapping = aes(x = x, y = y, ymin = ymin, ymax = ymax))`
- j = `geom_parallel(mapping = aes(x = x, y = y, ymin = ymin, ymax = ymax))`
- j = `geom_pointrange(mapping = aes(x = x, y = y, ymin = ymin, ymax = ymax))`

MAPS

- d = `data = data.frame(matrix(runif(10000), nrow = 100, ncol = 100))`
- d = `map = ggplot2::map("USArrests", resolution = 1)`
- d = `map = map_data("state", map = map)`
- d = `map = ggplot2::map("state", map = map)`
- d = `map = expand_limits(x = map$x, y = map$y)`
- d = `map = expand_limits(x = map$x, y = map$y, size = size)`
- d = `map = geom_hex(mapping = aes(x = map$x, y = map$y, size = size, weight = weight))`
- d = `map = geom_hex(mapping = aes(x = map$x, y = map$y, fill = fill, color = color, size = size, weight = weight))`

R Markdown Cheat Sheet

learn more at rmarkdown.rstudio.com

 R Studio

1. Workflow R Markdown is a format for writing reproducible, dynamic reports with R. Use it to embed R code and results into slideshows, pdfs, html documents, Word files and more. To make a report:

- i. Open - Open a file that uses the .Rmd extension.
- ii. Write - Write content with the easy to use R Markdown syntax
- iii. Embed - Embed R code that creates output to include in the report
- iv. Render - Replace R code with its output and transform the report into a slideshow, pdf, html or ms Word file.

2. Open File Start by saving a text file with the extension .Rmd, or open an RStudio Rmd template

In the menu bar, click **File > New File > R Markdown...**. A window will open. Select the class of output you would like to make with your .Rmd file.

Select the specific type of output to make with the radio buttons (you can change this later)

Click OK.

3. Markdown Next, write your report in plain text. Use markdown syntax to describe how to format text in the final report.

syntax

```
Plain text
End a line with two spaces to start a new paragraph.
**italic** and _italic_
**bold** and __bold__
superscript + strikethrough
[[link]](www.rstudio.com)

# Header 1
## Header 2
### Header 3
#### Header 4
##### Header 5
##### Header 6

endash: ---
endash: ---
ellipsize: ...
image: ...
image-relation: EA = lgp+r^235
image: [[path/to/smallor*.png]]

horizontal rule (or slide break):
***
```

becomes

```
Pain text
End a line with two spaces to start a new paragraph.
italics and italics
bolds and bolds
superscript and strikethrough
link: www.rstudio.com

Header 1
Header 2
Header 3
```

Header 4

Header 5

Header 6

endash: ---

endash: ---

ellipsize: ...

image: ...

image-relation: EA = $lgp + r^{235}$

image: [[path/to/smallor*.png]]

horizontal rule (or slide break):

block quote

unordered list

- * item 2
 - + sub-item 1
 - + sub-item 2

1. ordered list

1. item 2
 1. sub-item 1
 1. sub-item 2

Table Header | **Second Header**

Table Cell	Second Header
Cell 1	Cell 2
Cell 3	Cell 4

Table Header | **Second Header**

Table Cell	Second Header
Cell 1	Cell 2
Cell 3	Cell 4

4. Choose Output Write a YAML header that explains what type of document to build from your R Markdown file.

The RStudio template writes the YAML header for you

A YAML header is a set of key: value pairs at the start of your file. Begin and end the header with a line of three dashes (---)

The output value determines which type of file R will build from your .Rmd file (in Step 6)

output: html_document	html file (web page)
output: pdf_document	pdf document
output: word_document	Microsoft Word .docx
output: beamer_presentation	beamer slideshow (pdf)
output: ioslides_presentation	ioslides slideshow (html)

RStudio is a trademark of RStudio, Inc. | www.RStudio.com | 844-448-3212 | support@rstudio.com

Resources: Stackoverflow

stack overflow Products Customers Use cases Log in Sign up

Home PUBLIC Stack Overflow Tags Users Jobs TEAMS What's this? Join Private Q&A

Search Results

Results for removing legend title ggplot

removing legend title ggplot

20 results

Q: remove legend title in ggplot
99 votes 3 answers
I'm trying to **remove the title of a legend** in ggplot2: `df <- data frame(g = rep(letters[1:2], 5), x = rnorm(10), y = rnorm(10)) library(ggplot2) ggplot(df, aes(x, y, colour=g ...`
asked Feb 8 '13 by [smiling](#)

Q: How to change the position of plotly figures using ggplotly
0 votes 1 answer
I am trying to **remove the legend title** using ggplotly without success. I'm sure there is an easy fix, but I cannot find the documentation for it - and **removing the legend title** (or changing the ...) + `geom_boxplot() + theme(legend.title=element_blank())` a # No Legend Title # plotly puts back the **legend title** ggplotly(a) Any ideas how to change / **remove the title** of the graph? Should it be done using ggplotly or ggplot? ...
asked Dec 26 '15 by [Nick](#)

Q: Remove legend in ggplot in Python
1 vote 0 answers
The **title** says it all: Is there any way to **remove the legend** in ggplot in Python? I tried to google but could only find the solution for R ...
asked Jul 25 '15 by [Giang Do](#)

Q: ggplot legend / label change with various guides
0 votes
already used to **remove** the titles and also **remove legend** for a 3rd aes, but I do not manage to do it. Do you have a solution? Here is my code : `p <- ggplot(data, aes(x = Nb)) p + geom_ribbon(aes(ymin ...` I am trying to

Siemens Siemens AG 9 Singapore Electronics Public 10k+ people
Senior Data Scientist machine-learning sql
HTML5 Code King html5 css3
Business Architect enterprise

[View all 14 job openings!](#)

Hot Network Questions

Resources

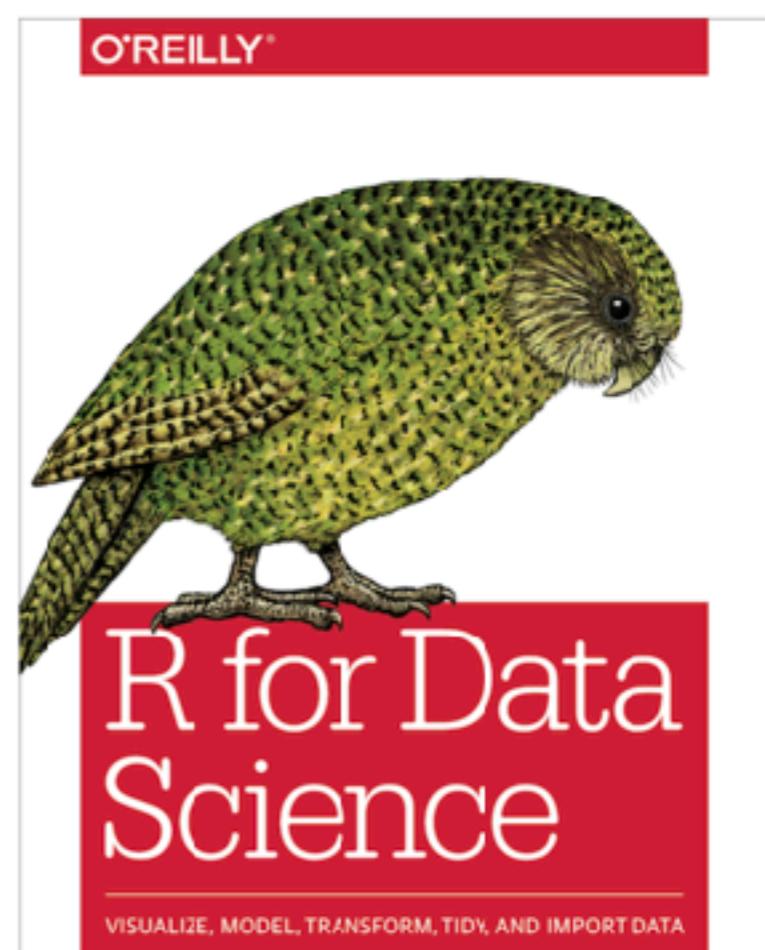
R for Data Science

Garrett Grolemund

Hadley Wickham

Welcome

This is the website for “**R for Data Science**”. This book will teach you how to do data science with R: You’ll learn how to get your data into R, get it into the most useful structure, transform it, visualise it and model it. In this book, you will find a practicum of skills for data science. Just as a chemist learns how to clean test tubes and stock a lab, you’ll learn how to clean data and draw plots – and many other things besides. These are the skills that allow data science to happen, and here you will find the best practices for doing each of these things with R. You’ll learn how to use the grammar of graphics, literate programming, and reproducible research to save time. You’ll also learn how to manage cognitive resources to facilitate discoveries when wrangling, visualising, and exploring data.



Resources: Stackoverflow

stack overflow Products Customers Use cases Log in Sign up

Home PUBLIC Stack Overflow Tags Users Jobs TEAMS What's this? Join Private Q&A

Search Results

Results for removing legend title ggplot

removing legend title ggplot

20 results

Q: remove legend title in ggplot
99 votes 3 answers
I'm trying to **remove the title of a legend** in ggplot2: `df <- data frame(g = rep(letters[1:2], 5), x = rnorm(10), y = rnorm(10)) library(ggplot2) ggplot(df, aes(x, y, colour=g ...`
asked Feb 8 '13 by [smiling](#)

Q: How to change the position of plotly figures using ggplotly
0 votes 1 answer
I am trying to **remove the legend title** using ggplotly without success. I'm sure there is an easy fix, but I cannot find the documentation for it - and **removing the legend title** (or changing the ...) + `geom_boxplot() + theme(legend.title=element_blank())` a # No Legend Title # plotly puts back the **legend title** ggplotly(a) Any ideas how to change / **remove the title** of the graph? Should it be done using ggplotly or ggplot? ...
asked Dec 26 '15 by [Nick](#)

Q: Remove legend in ggplot in Python
1 vote 0 answers
The **title** says it all: Is there any way to **remove the legend** in ggplot in Python? I tried to google but could only find the solution for R ...
asked Jul 25 '15 by [Giang Do](#)

Q: ggplot legend / label change with various guides
0 votes
already used to **remove** the titles and also **remove legend** for a 3rd aes, but I do not manage to do it. Do you have a solution? Here is my code : `p <- ggplot(data, aes(x = Nb)) p + geom_ribbon(aes(ymin ...` I am trying to

Siemens Siemens AG 9 Singapore Electronics Public 10k+ people Senior Data Scientist machine-learning sql **HTML5 Code King** html5 css3 **Business Architect** enterprise

Hot Network Questions

Resources: Help file documentation

```
>  
>  
> ?mean  
> |
```

mean {base}

R Documentation

Arithmetic Mean

Description

Generic function for the (trimmed) arithmetic mean.

Usage

```
mean(x, ...)  
  
## Default S3 method:  
mean(x, trim = 0, na.rm = FALSE, ...)
```

Arguments

- x An R object. Currently there are methods for numeric/logical vectors and [date](#), [date-time](#) and [time interval](#) objects. Complex vectors are allowed for trim = 0,

Resources: Help file documentation

The name of the function, and the library it is in.

mean [base]

R Documentation

Arithmetic Mean

What it does.

Generic function for the (trimmed) arithmetic mean.

Usage

```
mean(x, ...)  
## Default S3 method:  
mean(x, trim = 0, na.rm = FALSE, ...)
```

Arguments

- > An R object. Currently there are methods for numeric/logical vectors and [date](#), [date-time](#) and [time interval](#) objects. Complex vectors are allowed for `trim = 0`, only.
- `trim` the fraction (0 to 0.5) of observations to be trimmed from each end of `x` before the mean is computed. Values of `trim` outside that range are taken as the nearest endpoint.
- `na.rm` a logical value indicating whether `NA` values should be stripped before the computation proceeds.
- ... further arguments passed to or from other methods.

The function's name, and in the parentheses the named arguments it expects, in the order it expects them. If an argument has a default value, it is shown. Arguments without default values (e.g. `x`) must be provided by you.

More details on each named argument. This will tell you what class of thing each argument has to be—an object, a number, a data frame, a logical value, etc.

What the function returns—i.e., the result of whatever operation or calculation it performs. This can be a single number, as here, or a multi-part object such as a list, a data frame, a plot, or a model.

Value

If `trim` is zero (the default), the arithmetic mean of the values in `x` is computed, as a numeric or complex vector of length one. If `x` is not logical (coerced to numeric), numeric (including `integer`) or complex, `NA_real_` is returned, with a warning.
If `trim` is non-zero, a symmetrically trimmed mean is computed with a fraction of `trim` observations deleted from each end before the mean is computed.

References

Becker, R. A., Chambers, J. M. and Wilks, A. R. (1988) *The New S Language*. Wadsworth & Brooks/Cole.

See Also

[weighted.mean](#), [mean](#), [POSIXct](#), [colMeans](#) for row and column means

Examples

```
x <- c(0:10, 50)  
xm <- mean(x)  
c(xm, mean(x, trim = 0.10))
```

The ellipsis allows other arguments to be passed to and from the function.

Other related functions

Self-contained examples that you can run at the console. These may use built-in datasets or other R functions.

[Package base version 3.4.3 [Index](#)]

Visit the package's Index page to look for Demos and Vignettes detailing how it works.

Help files

Go to helpfile_project

View code for: pivot_longer.Rmd,

View helpfile_template.Rmd

Each student will work to generate a 'help file' as part of the final project.