Class 05: Data Visualization with GGPLOT

Amy Nguyen (PID: A18148284)

Background

There are lot's of ways to make figures in R. These include so-called "base R" graphics (e.g. `plot()`) and tones of add-on packages like **ggplot2**.

For example here we make the same plot with both:

```
head(cars)
```

```
  speed dist
1     4    2
2     4   10
3     7    4
4     7   22
5     8   16
6     9   10
```

```
plot(cars)
```
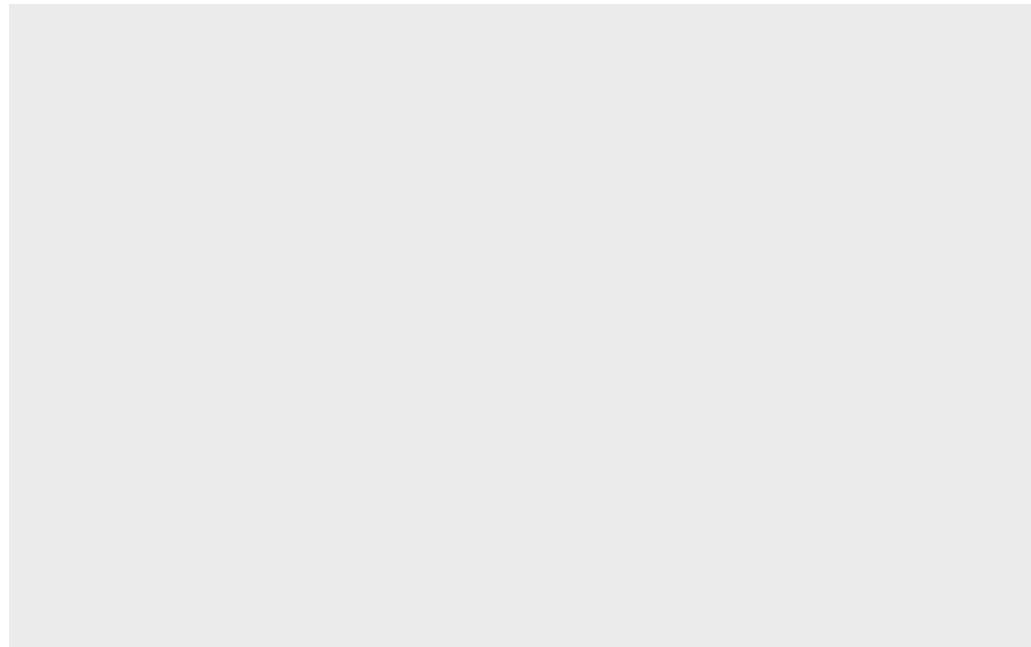
First I need to install the package with the command `install.package()`.

N.B. We never run an install cmd in a quarto code chunk or we will end up re-installing packages many many times - which is not what we want!

Every time we want to use one of these "add-on" packages we need to load it up in R with the `library()` function:

```r
library(ggplot2)
```
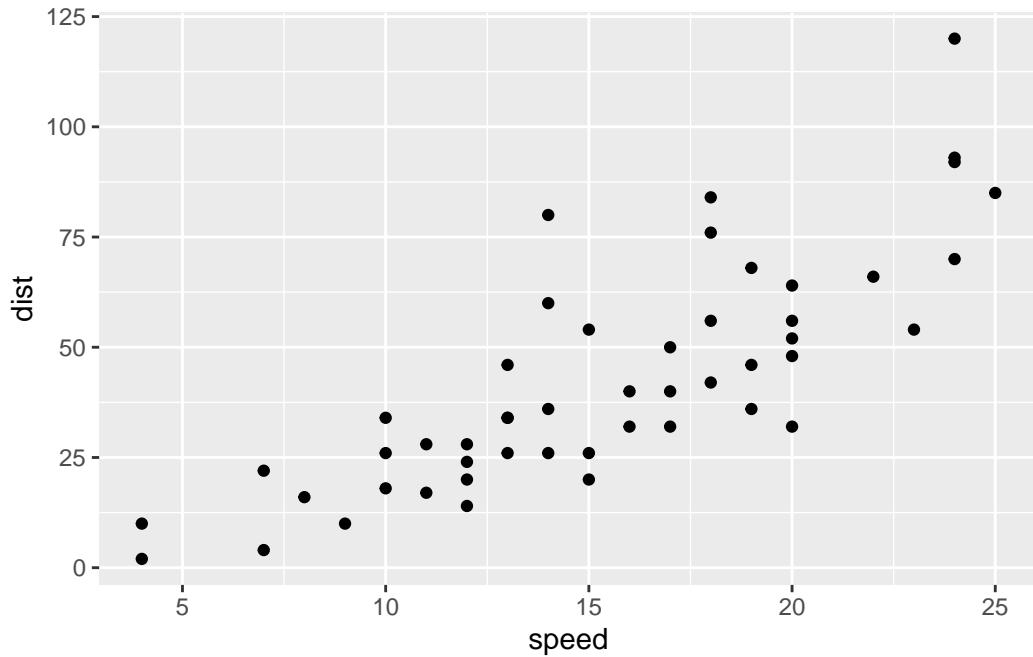
```r
ggplot(cars)
```

Every ggplot needs at least 3 things:

- The **data**, the suff you want plotted
- The **aes**thetics, how the data map to the plot
- The **geom**etry, the type of plot

```
ggplot(cars) +
  aes(x=speed, y=dist) +
  geom_point()
```
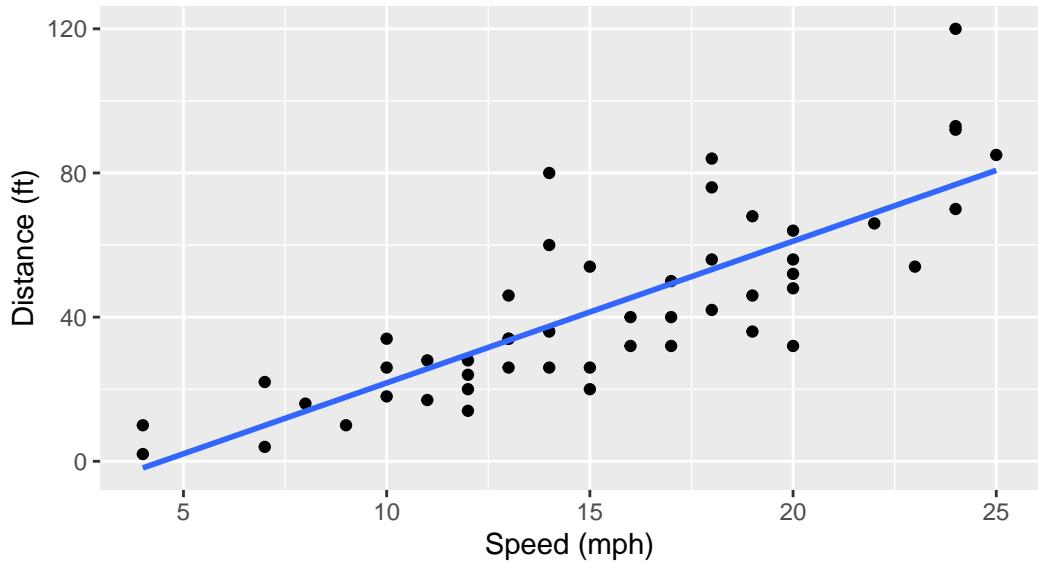
Add a line to better show relationship between speed and dist

```
p <- ggplot(cars) +
  aes(x=speed, y=dist) +
  geom_point() +
  geom_smooth(method="lm", se=FALSE) +
  labs(
    title="Stopping distance of old cars",
      subtitle = "Data from the `cars` object",
      x="Speed (mph)",
      y="Distance (ft)"
  )
p
```

`geom_smooth()` using formula = 'y ~ x'

Stopping distance of old cars
Data from the 'cars' object
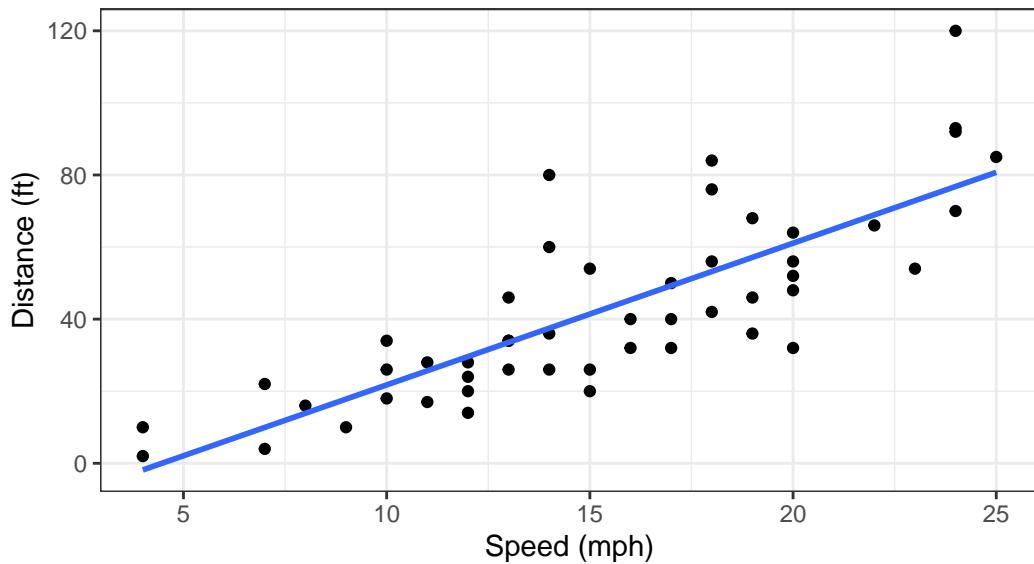
render it out p

```
p + theme_bw()
```

`geom_smooth()` using formula = 'y ~ x'

Stopping distance of old cars
Data from the 'cars' object

Gene expression plot

We can read the input data from the class website

```
url <- "https://bioboot.github.io/bimm143_S20/class-material/up_down_expression.txt"
genes <- read.delim(url)
head(genes)
```
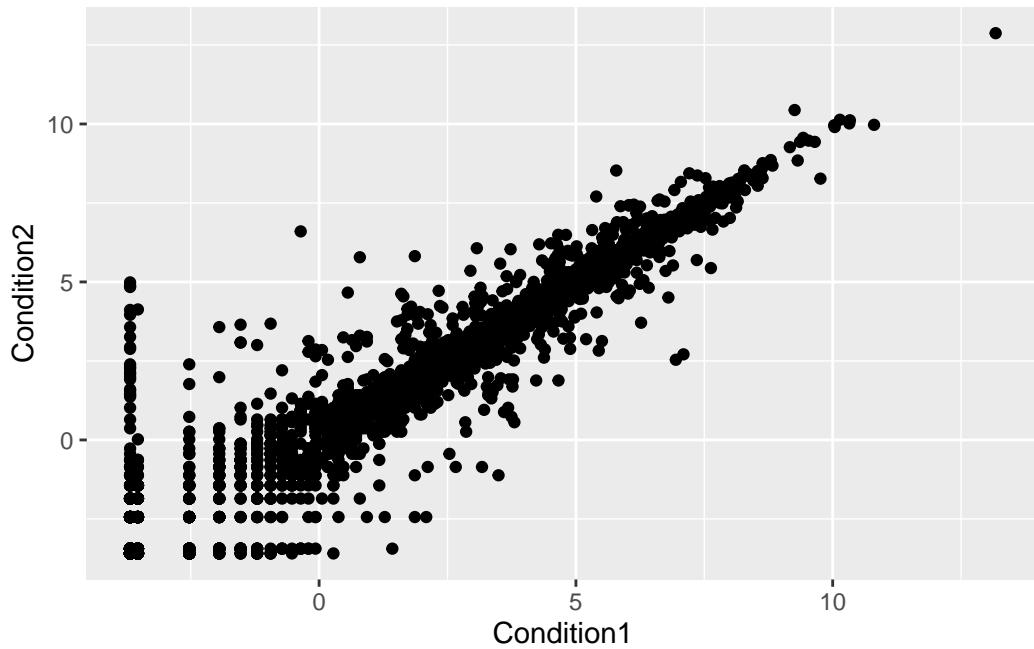
```
       Gene Condition1 Condition2      State
1      A4GNT -3.6808610 -3.4401355 unchanging
2       AAAS  4.5479580  4.3864126 unchanging
3      AASDH  3.7190695  3.4787276 unchanging
4       AATF  5.0784720  5.0151916 unchanging
5       AATK  0.4711421  0.5598642 unchanging
6 AB015752.4 -3.6808610 -3.5921390 unchanging
```

```
table( genes$State )
```

```
      down unchanging         up
        72       4997        127
```

A first version plot

```
ggplot(genes) +
  aes(Condition1, Condition2)+
  geom_point()
```



```
genes$State
```

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  [1] "unchanging" "unchanging" "unchanging" "unchanging" "unchanging"
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[4796] "unchanging" "unchanging" "unchanging" "unchanging" "unchanging"
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[5016] "unchanging" "unchanging" "unchanging" "unchanging" "unchanging"
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[5191] "unchanging" "unchanging" "unchanging" "unchanging" "unchanging"
[5196] "unchanging"
```

Version 2 let's color by `State` so we can see the "up" and "down" genes compared to all the "unchanging" genes
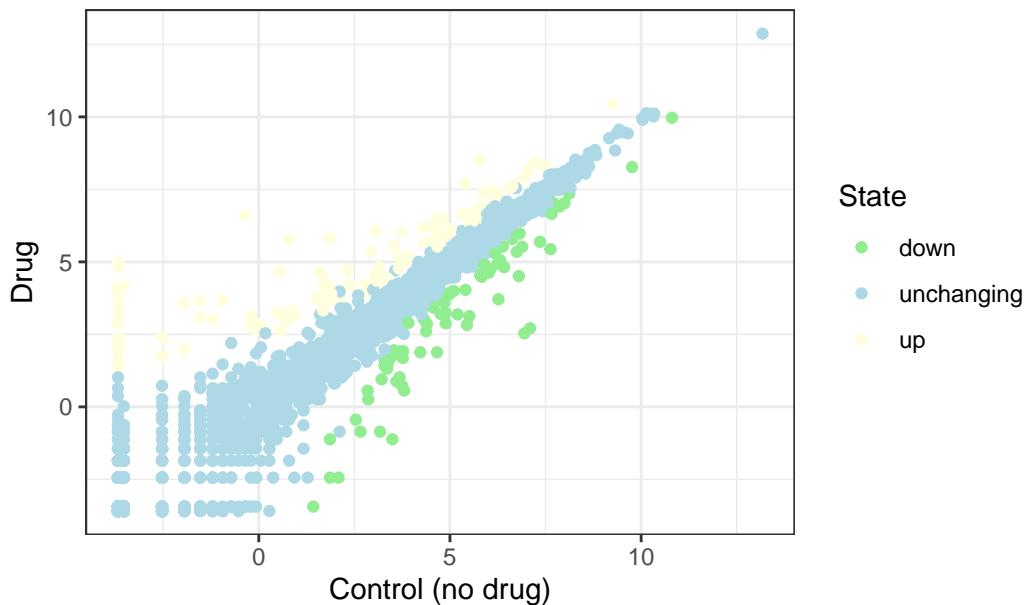
```
ggplot(genes) +
  aes(Condition1, Condition2, col=State) +
  geom_point()
```


Version 3 plot, let's modify the default colors to something we like

```
ggplot(genes) +
  aes(Condition1, Condition2, col=State) +
  geom_point() +
  scale_color_manual( values=c("lightgreen",
                               "lightblue",
                               "lightyellow")) +
labs(
  x="Control (no drug)",
     y="Drug",
     title="Gene Expression Changes upon GLP-1 drug"
  ) +
  theme_bw()
```

Gene Expression Changes upon GLP−1 drug


```r
nrow(genes)
```

```
[1] 5196
```
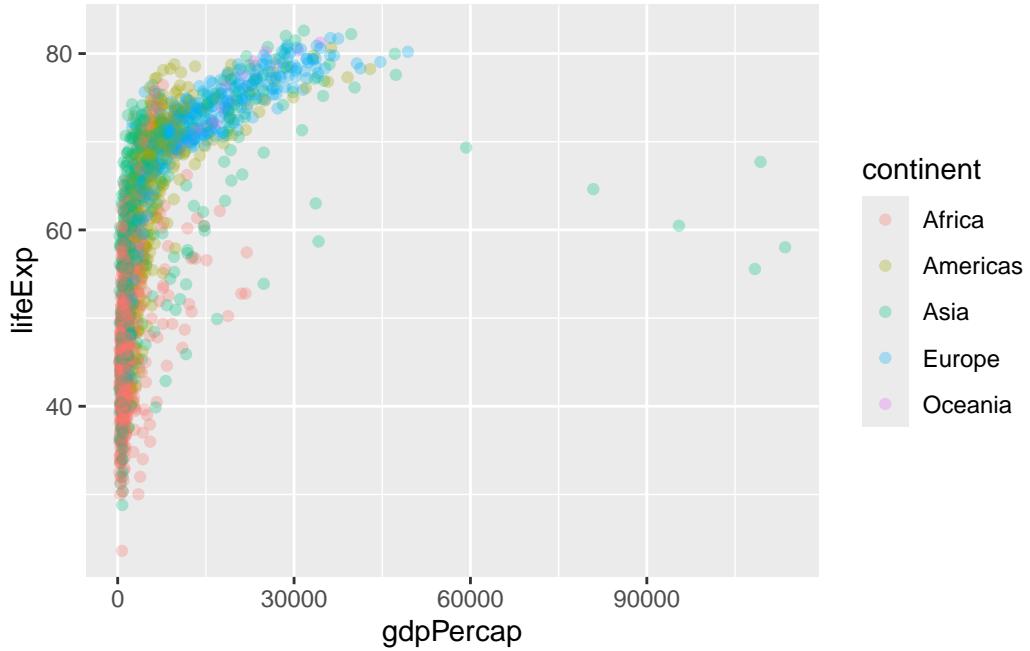
##Going Further Lets have a look at the famous **gapminder** dataset

```r
url <- "https://raw.githubusercontent.com/jennybc/gapminder/master/inst/extdata/gapminder.tsv"

gapminder <- read.delim(url)

head(gapminder, 3)
```
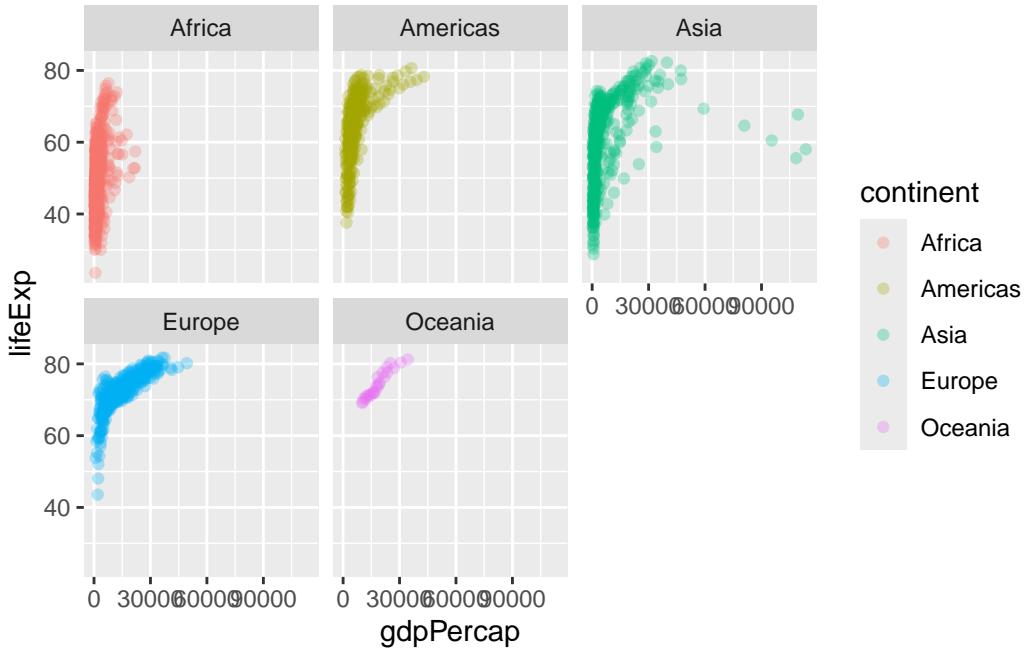
```
      country continent year lifeExp      pop gdpPercap
1 Afghanistan      Asia 1952  28.801  8425333  779.4453
2 Afghanistan      Asia 1957  30.332  9240934  820.8530
3 Afghanistan      Asia 1962  31.997 10267083  853.1007
```

```r
ggplot(gapminder) +
  aes(x=gdpPercap, y=lifeExp, col=continent) +
  geom_point(alpha=0.3)
```

Let's "facet" (i.e. make a separate plot) by continent rather than the big hot mess above.

```
ggplot(gapminder) +
  aes(x=gdpPercap, y=lifeExp, col=continent) +
  geom_point(alpha=0.3) +
  facet_wrap(~continent)
```

Custom plots

How big is this gapminder dataset?

```r
nrow(gapminder)
```

```
[1] 1704
```

I want to "filter" down to a subset of this data. I will use the **dplyr** package to help me.

First I need to install it and then load it up… `install.packages("dplyr")` and then `library(dplyr)`

```r
library(dplyr)
```

```
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag
```

```
The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

```
gapminder_2007 <- filter(gapminder, year==2007)
head(gapminder_2007)
```

```
      country continent year lifeExp      pop gdpPercap
1 Afghanistan      Asia 2007  43.828 31889923  974.5803
2     Albania    Europe 2007  76.423  3600523 5937.0295
3     Algeria    Africa 2007  72.301 33333216 6223.3675
4      Angola    Africa 2007  42.731 12420476 4797.2313
5   Argentina  Americas 2007  75.320 40301927 12779.3796
6   Australia   Oceania 2007  81.235 20434176 34435.3674
```

```
filter(gapminder, year==2007, country=="Ireland")
```

```
  country continent year lifeExp     pop gdpPercap
1 Ireland    Europe 2007  78.885 4109086     40676
```

```
filter(gapminder, year==2007, country=="United States")
```

```
        country continent year lifeExp       pop gdpPercap
1 United States  Americas 2007  78.242 301139947  42951.65
```

Q. Make a plot comparing 1977 and 2007 for all countries

```
filter(gapminder, year %in% c(1977,2007))
```

```
              country continent year  lifeExp      pop  gdpPercap
1         Afghanistan      Asia 1977 38.43800 14880372   786.1134
2         Afghanistan      Asia 2007 43.82800 31889923   974.5803
3             Albania    Europe 1977 68.93000  2509048  3533.0039
4             Albania    Europe 2007 76.42300  3600523  5937.0295
5             Algeria    Africa 1977 58.01400 17152804  4910.4168
6             Algeria    Africa 2007 72.30100 33333216  6223.3675
7              Angola    Africa 1977 39.48300  6162675  3008.6474
8              Angola    Africa 2007 42.73100 12420476  4797.2313
9           Argentina  Americas 1977 68.48100 26983828 10079.0267
```

10	Argentina	Americas	2007	75.32000	40301927	12779.3796
11	Australia	Oceania	1977	73.49000	14074100	18334.1975
12	Australia	Oceania	2007	81.23500	20434176	34435.3674
13	Austria	Europe	1977	72.17000	7568430	19749.4223
14	Austria	Europe	2007	79.82900	8199783	36126.4927
15	Bahrain	Asia	1977	65.59300	297410	19340.1020
16	Bahrain	Asia	2007	75.63500	708573	29796.0483
17	Bangladesh	Asia	1977	46.92300	80428306	659.8772
18	Bangladesh	Asia	2007	64.06200	150448339	1391.2538
19	Belgium	Europe	1977	72.80000	9821800	19117.9745
20	Belgium	Europe	2007	79.44100	10392226	33692.6051
21	Benin	Africa	1977	49.19000	3168267	1029.1613
22	Benin	Africa	2007	56.72800	8078314	1441.2849
23	Bolivia	Americas	1977	50.02300	5079716	3548.0978
24	Bolivia	Americas	2007	65.55400	9119152	3822.1371
25	Bosnia and Herzegovina	Europe	1977	69.86000	4086000	3528.4813
26	Bosnia and Herzegovina	Europe	2007	74.85200	4552198	7446.2988
27	Botswana	Africa	1977	59.31900	781472	3214.8578
28	Botswana	Africa	2007	50.72800	1639131	12569.8518
29	Brazil	Americas	1977	61.48900	114313951	6660.1187
30	Brazil	Americas	2007	72.39000	190010647	9065.8008
31	Bulgaria	Europe	1977	70.81000	8797022	7612.2404
32	Bulgaria	Europe	2007	73.00500	7322858	10680.7928
33	Burkina Faso	Africa	1977	46.13700	5889574	743.3870
34	Burkina Faso	Africa	2007	52.29500	14326203	1217.0330
35	Burundi	Africa	1977	45.91000	3834415	556.1033
36	Burundi	Africa	2007	49.58000	8390505	430.0707
37	Cambodia	Asia	1977	31.22000	6978607	524.9722
38	Cambodia	Asia	2007	59.72300	14131858	1713.7787
39	Cameroon	Africa	1977	49.35500	7959865	1783.4329
40	Cameroon	Africa	2007	50.43000	17696293	2042.0952
41	Canada	Americas	1977	74.21000	23796400	22090.8831
42	Canada	Americas	2007	80.65300	33390141	36319.2350
43	Central African Republic	Africa	1977	46.77500	2167533	1109.3743
44	Central African Republic	Africa	2007	44.74100	4369038	706.0165
45	Chad	Africa	1977	47.38300	4388260	1133.9850
46	Chad	Africa	2007	50.65100	10238807	1704.0637
47	Chile	Americas	1977	67.05200	10599793	4756.7638
48	Chile	Americas	2007	78.55300	16284741	13171.6388
49	China	Asia	1977	63.96736	943455000	741.2375
50	China	Asia	2007	72.96100	1318683096	4959.1149
51	Colombia	Americas	1977	63.83700	25094412	3815.8079
52	Colombia	Americas	2007	72.88900	44227550	7006.5804

53	Comoros	Africa	1977	50.93900	304739	1172.6030
54	Comoros	Africa	2007	65.15200	710960	986.1479
55	Congo, Dem. Rep.	Africa	1977	47.80400	26480870	795.7573
56	Congo, Dem. Rep.	Africa	2007	46.46200	64606759	277.5519
57	Congo, Rep.	Africa	1977	55.62500	1536769	3259.1790
58	Congo, Rep.	Africa	2007	55.32200	3800610	3632.5578
59	Costa Rica	Americas	1977	70.75000	2108457	5926.8770
60	Costa Rica	Americas	2007	78.78200	4133884	9645.0614
61	Cote d'Ivoire	Africa	1977	52.37400	7459574	2517.7365
62	Cote d'Ivoire	Africa	2007	48.32800	18013409	1544.7501
63	Croatia	Europe	1977	70.64000	4318673	11305.3852
64	Croatia	Europe	2007	75.74800	4493312	14619.2227
65	Cuba	Americas	1977	72.64900	9537988	6380.4950
66	Cuba	Americas	2007	78.27300	11416987	8948.1029
67	Czech Republic	Europe	1977	70.71000	10161915	14800.1606
68	Czech Republic	Europe	2007	76.48600	10228744	22833.3085
69	Denmark	Europe	1977	74.69000	5088419	20422.9015
70	Denmark	Europe	2007	78.33200	5468120	35278.4187
71	Djibouti	Africa	1977	46.51900	228694	3081.7610
72	Djibouti	Africa	2007	54.79100	496374	2082.4816
73	Dominican Republic	Americas	1977	61.78800	5302800	2681.9889
74	Dominican Republic	Americas	2007	72.23500	9319622	6025.3748
75	Ecuador	Americas	1977	61.31000	7278866	6679.6233
76	Ecuador	Americas	2007	74.99400	13755680	6873.2623
77	Egypt	Africa	1977	53.31900	38783863	2785.4936
78	Egypt	Africa	2007	71.33800	80264543	5581.1810
79	El Salvador	Americas	1977	56.69600	4282586	5138.9224
80	El Salvador	Americas	2007	71.87800	6939688	5728.3535
81	Equatorial Guinea	Africa	1977	42.02400	192675	958.5668
82	Equatorial Guinea	Africa	2007	51.57900	551201	12154.0897
83	Eritrea	Africa	1977	44.53500	2512642	505.7538
84	Eritrea	Africa	2007	58.04000	4906585	641.3695
85	Ethiopia	Africa	1977	44.51000	34617799	556.8084
86	Ethiopia	Africa	2007	52.94700	76511887	690.8056
87	Finland	Europe	1977	72.52000	4738902	15605.4228
88	Finland	Europe	2007	79.31300	5238460	33207.0844
89	France	Europe	1977	73.83000	53165019	18292.6351
90	France	Europe	2007	80.65700	61083916	30470.0167
91	Gabon	Africa	1977	52.79000	706367	21745.5733
92	Gabon	Africa	2007	56.73500	1454867	13206.4845
93	Gambia	Africa	1977	41.84200	608274	884.7553
94	Gambia	Africa	2007	59.44800	1688359	752.7497
95	Germany	Europe	1977	72.50000	78160773	20512.9212

96	Germany	Europe	2007	79.40600	82400996	32170.3744
97	Ghana	Africa	1977	51.75600	10538093	993.2240
98	Ghana	Africa	2007	60.02200	22873338	1327.6089
99	Greece	Europe	1977	73.68000	9308479	14195.5243
100	Greece	Europe	2007	79.48300	10706290	27538.4119
101	Guatemala	Americas	1977	56.02900	5703430	4879.9927
102	Guatemala	Americas	2007	70.25900	12572928	5186.0500
103	Guinea	Africa	1977	40.76200	4227026	874.6859
104	Guinea	Africa	2007	56.00700	9947814	942.6542
105	Guinea-Bissau	Africa	1977	37.46500	745228	764.7260
106	Guinea-Bissau	Africa	2007	46.38800	1472041	579.2317
107	Haiti	Americas	1977	49.92300	4908554	1874.2989
108	Haiti	Americas	2007	60.91600	8502814	1201.6372
109	Honduras	Americas	1977	57.40200	3055235	3203.2081
110	Honduras	Americas	2007	70.19800	7483763	3548.3308
111	Hong Kong, China	Asia	1977	73.60000	4583700	11186.1413
112	Hong Kong, China	Asia	2007	82.20800	6980412	39724.9787
113	Hungary	Europe	1977	69.95000	10637171	11674.8374
114	Hungary	Europe	2007	73.33800	9956108	18008.9444
115	Iceland	Europe	1977	76.11000	221823	19654.9625
116	Iceland	Europe	2007	81.75700	301931	36180.7892
117	India	Asia	1977	54.20800	634000000	813.3373
118	India	Asia	2007	64.69800	1110396331	2452.2104
119	Indonesia	Asia	1977	52.70200	136725000	1382.7021
120	Indonesia	Asia	2007	70.65000	223547000	3540.6516
121	Iran	Asia	1977	57.70200	35480679	11888.5951
122	Iran	Asia	2007	70.96400	69453570	11605.7145
123	Iraq	Asia	1977	60.41300	11882916	14688.2351
124	Iraq	Asia	2007	59.54500	27499638	4471.0619
125	Ireland	Europe	1977	72.03000	3271900	11150.9811
126	Ireland	Europe	2007	78.88500	4109086	40675.9964
127	Israel	Asia	1977	73.06000	3495918	13306.6192
128	Israel	Asia	2007	80.74500	6426679	25523.2771
129	Italy	Europe	1977	73.48000	56059245	14255.9847
130	Italy	Europe	2007	80.54600	58147733	28569.7197
131	Jamaica	Americas	1977	70.11000	2156814	6650.1956
132	Jamaica	Americas	2007	72.56700	2780132	7320.8803
133	Japan	Asia	1977	75.38000	113872473	16610.3770
134	Japan	Asia	2007	82.60300	127467972	31656.0681
135	Jordan	Asia	1977	61.13400	1937652	2852.3516
136	Jordan	Asia	2007	72.53500	6053193	4519.4612
137	Kenya	Africa	1977	56.15500	14500404	1267.6132
138	Kenya	Africa	2007	54.11000	35610177	1463.2493

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139         Korea, Dem. Rep.     Asia 1977 67.15900   16325320  4106.3012
140         Korea, Dem. Rep.     Asia 2007 67.29700   23301725  1593.0655
141            Korea, Rep.       Asia 1977 64.76600   36436000  4657.2210
142            Korea, Rep.       Asia 2007 78.62300   49044790 23348.1397
143                 Kuwait       Asia 1977 69.34300    1140357 59265.4771
144                 Kuwait       Asia 2007 77.58800    2505559 47306.9898
145                Lebanon       Asia 1977 66.09900    3115787  8659.6968
146                Lebanon       Asia 2007 71.99300    3921278 10461.0587
147                Lesotho     Africa 1977 52.20800    1251524   745.3695
148                Lesotho     Africa 2007 42.59200    2012649  1569.3314
149                Liberia     Africa 1977 43.76400    1703617   640.3224
150                Liberia     Africa 2007 45.67800    3193942   414.5073
151                  Libya     Africa 1977 57.44200    2721783 21951.2118
152                  Libya     Africa 2007 73.95200    6036914 12057.4993
153             Madagascar     Africa 1977 46.88100    8007166  1544.2286
154             Madagascar     Africa 2007 59.44300   19167654  1044.7701
155                 Malawi     Africa 1977 43.76700    5637246   663.2237
156                 Malawi     Africa 2007 48.30300   13327079   759.3499
157               Malaysia       Asia 1977 65.25600   12845381  3827.9216
158               Malaysia       Asia 2007 74.24100   24821286 12451.6558
159                   Mali     Africa 1977 41.71400    6491649   686.3953
160                   Mali     Africa 2007 54.46700   12031795  1042.5816
161             Mauritania     Africa 1977 50.85200    1456688  1497.4922
162             Mauritania     Africa 2007 64.16400    3270065  1803.1515
163              Mauritius     Africa 1977 64.93000     913025  3710.9830
164              Mauritius     Africa 2007 72.80100    1250882 10956.9911
165                 Mexico   Americas 1977 65.03200   63759976  7674.9291
166                 Mexico   Americas 2007 76.19500  108700891 11977.5750
167               Mongolia       Asia 1977 55.49100    1528000  1647.5117
168               Mongolia       Asia 2007 66.80300    2874127  3095.7723
169             Montenegro     Europe 1977 73.06600     560073  9595.9299
170             Montenegro     Europe 2007 74.54300     684736  9253.8961
171                Morocco     Africa 1977 55.73000   18396941  2370.6200
172                Morocco     Africa 2007 71.16400   33757175  3820.1752
173             Mozambique     Africa 1977 42.49500   11127868   502.3197
174             Mozambique     Africa 2007 42.08200   19951656   823.6856
175                Myanmar       Asia 1977 56.05900   31528087   371.0000
176                Myanmar       Asia 2007 62.06900   47761980   944.0000
177                Namibia     Africa 1977 56.43700     977026  3876.4860
178                Namibia     Africa 2007 52.90600    2055080  4811.0604
179                  Nepal       Asia 1977 46.74800   13933198   694.1124
180                  Nepal       Asia 2007 63.78500   28901790  1091.3598
181            Netherlands     Europe 1977 75.24000   13852989 21209.0592
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182	Netherlands	Europe	2007	79.76200	16570613	36797.9333
183	New Zealand	Oceania	1977	72.22000	3164900	16233.7177
184	New Zealand	Oceania	2007	80.20400	4115771	25185.0091
185	Nicaragua	Americas	1977	57.47000	2554598	5486.3711
186	Nicaragua	Americas	2007	72.89900	5675356	2749.3210
187	Niger	Africa	1977	41.29100	5682086	808.8971
188	Niger	Africa	2007	56.86700	12894865	619.6769
189	Nigeria	Africa	1977	44.51400	62209173	1981.9518
190	Nigeria	Africa	2007	46.85900	135031164	2013.9773
191	Norway	Europe	1977	75.37000	4043205	23311.3494
192	Norway	Europe	2007	80.19600	4627926	49357.1902
193	Oman	Asia	1977	57.36700	1004533	11848.3439
194	Oman	Asia	2007	75.64000	3204897	22316.1929
195	Pakistan	Asia	1977	54.04300	78152686	1175.9212
196	Pakistan	Asia	2007	65.48300	169270617	2605.9476
197	Panama	Americas	1977	68.68100	1839782	5351.9121
198	Panama	Americas	2007	75.53700	3242173	9809.1856
199	Paraguay	Americas	1977	66.35300	2984494	3248.3733
200	Paraguay	Americas	2007	71.75200	6667147	4172.8385
201	Peru	Americas	1977	58.44700	15990099	6281.2909
202	Peru	Americas	2007	71.42100	28674757	7408.9056
203	Philippines	Asia	1977	60.06000	46850962	2373.2043
204	Philippines	Asia	2007	71.68800	91077287	3190.4810
205	Poland	Europe	1977	70.67000	34621254	9508.1415
206	Poland	Europe	2007	75.56300	38518241	15389.9247
207	Portugal	Europe	1977	70.41000	9662600	10172.4857
208	Portugal	Europe	2007	78.09800	10642836	20509.6478
209	Puerto Rico	Americas	1977	73.44000	3080828	9770.5249
210	Puerto Rico	Americas	2007	78.74600	3942491	19328.7090
211	Reunion	Africa	1977	67.06400	492095	4319.8041
212	Reunion	Africa	2007	76.44200	798094	7670.1226
213	Romania	Europe	1977	69.46000	21658597	9356.3972
214	Romania	Europe	2007	72.47600	22276056	10808.4756
215	Rwanda	Africa	1977	45.00000	4657072	670.0806
216	Rwanda	Africa	2007	46.24200	8860588	863.0885
217	Sao Tome and Principe	Africa	1977	58.55000	86796	1737.5617
218	Sao Tome and Principe	Africa	2007	65.52800	199579	1598.4351
219	Saudi Arabia	Asia	1977	58.69000	8128505	34167.7626
220	Saudi Arabia	Asia	2007	72.77700	27601038	21654.8319
221	Senegal	Africa	1977	48.87900	5260855	1561.7691
222	Senegal	Africa	2007	63.06200	12267493	1712.4721
223	Serbia	Europe	1977	70.30000	8686367	12980.6696
224	Serbia	Europe	2007	74.00200	10150265	9786.5347

225	Sierra Leone	Africa	1977	36.78800	3140897	1348.2852
226	Sierra Leone	Africa	2007	42.56800	6144562	862.5408
227	Singapore	Asia	1977	70.79500	2325300	11210.0895
228	Singapore	Asia	2007	79.97200	4553009	47143.1796
229	Slovak Republic	Europe	1977	70.45000	4827803	10922.6640
230	Slovak Republic	Europe	2007	74.66300	5447502	18678.3144
231	Slovenia	Europe	1977	70.97000	1746919	15277.0302
232	Slovenia	Europe	2007	77.92600	2009245	25768.2576
233	Somalia	Africa	1977	41.97400	4353666	1450.9925
234	Somalia	Africa	2007	48.15900	9118773	926.1411
235	South Africa	Africa	1977	55.52700	27129932	8028.6514
236	South Africa	Africa	2007	49.33900	43997828	9269.6578
237	Spain	Europe	1977	74.39000	36439000	13236.9212
238	Spain	Europe	2007	80.94100	40448191	28821.0637
239	Sri Lanka	Asia	1977	65.94900	14116836	1348.7757
240	Sri Lanka	Asia	2007	72.39600	20378239	3970.0954
241	Sudan	Africa	1977	47.80000	17104986	2202.9884
242	Sudan	Africa	2007	58.55600	42292929	2602.3950
243	Swaziland	Africa	1977	52.53700	551425	3781.4106
244	Swaziland	Africa	2007	39.61300	1133066	4513.4806
245	Sweden	Europe	1977	75.44000	8251648	18855.7252
246	Sweden	Europe	2007	80.88400	9031088	33859.7484
247	Switzerland	Europe	1977	75.39000	6316424	26982.2905
248	Switzerland	Europe	2007	81.70100	7554661	37506.4191
249	Syria	Asia	1977	61.19500	7932503	3195.4846
250	Syria	Asia	2007	74.14300	19314747	4184.5481
251	Taiwan	Asia	1977	70.59000	16785196	5596.5198
252	Taiwan	Asia	2007	78.40000	23174294	28718.2768
253	Tanzania	Africa	1977	49.91900	17129565	962.4923
254	Tanzania	Africa	2007	52.51700	38139640	1107.4822
255	Thailand	Asia	1977	62.49400	44148285	1961.2246
256	Thailand	Asia	2007	70.61600	65068149	7458.3963
257	Togo	Africa	1977	52.88700	2308582	1532.7770
258	Togo	Africa	2007	58.42000	5701579	882.9699
259	Trinidad and Tobago	Americas	1977	68.30000	1039009	7899.5542
260	Trinidad and Tobago	Americas	2007	69.81900	1056608	18008.5092
261	Tunisia	Africa	1977	59.83700	6005061	3120.8768
262	Tunisia	Africa	2007	73.92300	10276158	7092.9230
263	Turkey	Europe	1977	59.50700	42404033	4269.1223
264	Turkey	Europe	2007	71.77700	71158647	8458.2764
265	Uganda	Africa	1977	50.35000	11457758	843.7331
266	Uganda	Africa	2007	51.54200	29170398	1056.3801
267	United Kingdom	Europe	1977	72.76000	56179000	17428.7485

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268           United Kingdom    Europe 2007 79.42500   60776238 33203.2613
269           United States   Americas 1977 73.38000  220239000 24072.6321
270           United States   Americas 2007 78.24200  301139947 42951.6531
271                  Uruguay  Americas 1977 69.48100    2873520  6504.3397
272                  Uruguay  Americas 2007 76.38400    3447496 10611.4630
273                Venezuela  Americas 1977 67.45600   13503563 13143.9510
274                Venezuela  Americas 2007 73.74700   26084662 11415.8057
275                  Vietnam      Asia 1977 55.76400   50533506   713.5371
276                  Vietnam      Asia 2007 74.24900   85262356  2441.5764
277       West Bank and Gaza      Asia 1977 60.76500    1261091  3682.8315
278       West Bank and Gaza      Asia 2007 73.42200    4018332  3025.3498
279              Yemen, Rep.      Asia 1977 44.17500    8403990  1829.7652
280              Yemen, Rep.      Asia 2007 62.69800   22211743  2280.7699
281                   Zambia    Africa 1977 51.38600    5216550  1588.6883
282                   Zambia    Africa 2007 42.38400   11746035  1271.2116
283                 Zimbabwe    Africa 1977 57.67400    6642107   685.5877
284                 Zimbabwe    Africa 2007 43.48700   12311143   469.7093
```

```
gapminder_1977 <- gapminder %>% filter(year==1977 | year==2007)

ggplot(gapminder_1977) +
  geom_point(aes(x = gdpPercap, y = lifeExp, color=continent), alpha=0.7) +
  facet_wrap(~year)
```