FRP y FRM

Introducción

En esta práctica se construirá la función de regresión poblacional, posteriormente se sacarán múltiples muestras con las cuales se analizará la variabilidad de la muestra por medio de la función de regresión muestral. Es importante recalcar que comúnmente los datos poblacionaes no son conocidos, pero en este ejemplo supondremos que los datos que nos proporcionan son los poblacionales.

Se importan los datos de "marketing" que contienen datos de inversión en tres tipos de medios publicitarios y datos de las ventas:

```
library(datarium)
library(tidymodels)   # package that imports useful packages for modeling
```

```
## -- Attaching packages -------------------------------------- tidymodels 1.0.0 --
## v broom        1.0.0     v recipes      1.0.1
## v dials        1.0.0     v rsample      1.1.0
## v dplyr        1.0.9     v tibble       3.1.7
## v ggplot2      3.3.6     v tidyr        1.2.0
## v infer        1.0.2     v tune         1.0.0
## v modeldata    1.0.0     v workflows    1.0.0
## v parsnip      1.0.0     v workflowsets 1.0.0
## v purrr        0.3.4     v yardstick    1.0.0
## -- Conflicts ----------------------------------------- tidymodels_conflicts() --
## x purrr::discard() masks scales::discard()
## x dplyr::filter()  masks stats::filter()
## x dplyr::lag()     masks stats::lag()
## x recipes::step()  masks stats::step()
## * Search for functions across packages at https://www.tidymodels.org/find/
```

```
library(readr)        # for importing data
```

```
##
## Attaching package: 'readr'
## The following object is masked from 'package:yardstick':
##
##       spec
## The following object is masked from 'package:scales':
##
##       col_factor
```

```
library(dotwhisker)   # visualize regression results

data("marketing", package = "datarium")

marketing <-
  marketing %>%
  gather(company, investment, -sales)
```

```
marketing %>% data.frame()
```

```
##      sales   company investment
## 1   26.52   youtube     276.12
## 2   12.48   youtube      53.40
## 3   11.16   youtube      20.64
## 4   22.20   youtube     181.80
## 5   15.48   youtube     216.96
## 6    8.64   youtube      10.44
## 7   14.16   youtube      69.00
## 8   15.84   youtube     144.24
## 9    5.76   youtube      10.32
## 10  12.72   youtube     239.76
## 11  10.32   youtube      79.32
## 12  20.88   youtube     257.64
## 13  11.04   youtube      28.56
## 14  11.64   youtube     117.00
## 15  22.80   youtube     244.92
## 16  26.88   youtube     234.48
## 17  15.00   youtube      81.36
## 18  29.28   youtube     337.68
## 19  13.56   youtube      83.04
## 20  17.52   youtube     176.76
## 21  21.60   youtube     262.08
## 22  15.00   youtube     284.88
## 23   6.72   youtube      15.84
## 24  18.60   youtube     273.96
## 25  11.64   youtube      74.76
## 26  14.40   youtube     315.48
## 27  18.00   youtube     171.48
## 28  19.08   youtube     288.12
## 29  22.68   youtube     298.56
## 30  12.60   youtube      84.72
## 31  25.68   youtube     351.48
## 32  14.28   youtube     135.48
## 33  11.52   youtube     116.64
## 34  20.88   youtube     318.72
## 35  11.40   youtube     114.84
## 36  15.36   youtube     348.84
## 37  30.48   youtube     320.28
## 38  17.64   youtube      89.64
## 39  12.12   youtube      51.72
## 40  25.80   youtube     273.60
## 41  19.92   youtube     243.00
## 42  20.52   youtube     212.40
## 43  24.84   youtube     352.32
## 44  15.48   youtube     248.28
## 45  10.20   youtube      30.12
## 46  17.88   youtube     210.12
## 47  12.72   youtube     107.64
## 48  27.84   youtube     287.88
## 49  17.76   youtube     272.64
## 50  11.64   youtube      80.28
```

```
## 51  13.68    youtube    239.76
## 52  12.84    youtube    120.48
## 53  27.12    youtube    259.68
## 54  25.44    youtube    219.12
## 55  24.24    youtube    315.24
## 56  28.44    youtube    238.68
## 57   6.60    youtube      8.76
## 58  15.84    youtube    163.44
## 59  28.56    youtube    252.96
## 60  22.08    youtube    252.84
## 61   9.72    youtube     64.20
## 62  29.04    youtube    313.56
## 63  18.84    youtube    287.16
## 64  16.80    youtube    123.24
## 65  21.60    youtube    157.32
## 66  11.16    youtube     82.80
## 67  11.40    youtube     37.80
## 68  16.08    youtube    167.16
## 69  22.68    youtube    284.88
## 70  26.76    youtube    260.16
## 71  21.96    youtube    238.92
## 72  14.88    youtube    131.76
## 73  10.56    youtube     32.16
## 74  13.20    youtube    155.28
## 75  20.40    youtube    256.08
## 76  10.44    youtube     20.28
## 77   8.28    youtube     33.00
## 78  17.04    youtube    144.60
## 79   6.36    youtube      6.48
## 80  13.20    youtube    139.20
## 81  14.16    youtube     91.68
## 82  14.76    youtube    287.76
## 83  13.56    youtube     90.36
## 84  16.32    youtube     82.08
## 85  26.04    youtube    256.20
## 86  18.24    youtube    231.84
## 87  14.40    youtube     91.56
## 88  19.20    youtube    132.84
## 89  15.48    youtube    105.96
## 90  20.04    youtube    131.76
## 91  13.44    youtube    161.16
## 92   8.76    youtube     34.32
## 93  23.28    youtube    261.24
## 94  26.64    youtube    301.08
## 95  13.80    youtube    128.88
## 96  20.28    youtube    195.96
## 97  14.04    youtube    237.12
## 98  18.60    youtube    221.88
## 99  30.48    youtube    347.64
## 100 20.64    youtube    162.24
## 101 14.04    youtube    266.88
## 102 28.56    youtube    355.68
## 103 17.76    youtube    336.24
## 104 17.64    youtube    225.48
```

```
## 105 24.84    youtube    285.84
## 106 23.04    youtube    165.48
## 107  8.64    youtube     30.00
## 108 10.44    youtube    108.48
## 109  6.36    youtube     15.72
## 110 23.76    youtube    306.48
## 111 16.08    youtube    270.96
## 112 26.16    youtube    290.04
## 113 16.92    youtube    210.84
## 114 19.08    youtube    251.52
## 115 17.52    youtube     93.84
## 116 15.12    youtube     90.12
## 117 14.64    youtube    167.04
## 118 11.28    youtube     91.68
## 119 19.08    youtube    150.84
## 120  7.92    youtube     23.28
## 121 18.60    youtube    169.56
## 122  8.40    youtube     22.56
## 123 13.92    youtube    268.80
## 124 18.24    youtube    147.72
## 125 23.64    youtube    275.40
## 126 12.72    youtube    104.64
## 127  7.92    youtube      9.36
## 128 10.56    youtube     96.24
## 129 29.64    youtube    264.36
## 130 11.64    youtube     71.52
## 131  1.92    youtube      0.84
## 132 15.24    youtube    318.24
## 133  6.84    youtube     10.08
## 134 23.52    youtube    263.76
## 135 12.96    youtube     44.28
## 136 13.92    youtube     57.96
## 137 11.40    youtube     30.72
## 138 24.96    youtube    328.44
## 139 11.52    youtube     51.60
## 140 24.84    youtube    221.88
## 141 13.08    youtube     88.08
## 142 23.04    youtube    232.44
## 143 24.12    youtube    264.60
## 144 12.48    youtube    125.52
## 145 13.68    youtube    115.44
## 146 12.36    youtube    168.36
## 147 15.84    youtube    288.12
## 148 30.48    youtube    291.84
## 149 13.08    youtube     45.60
## 150 12.12    youtube     53.64
## 151 19.32    youtube    336.84
## 152 13.92    youtube    145.20
## 153 19.92    youtube    237.12
## 154 22.80    youtube    205.56
## 155 18.72    youtube    225.36
## 156  3.84    youtube      4.92
## 157 18.36    youtube    112.68
## 158 12.12    youtube    179.76
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## 159  8.76   youtube    14.04
## 160 15.48   youtube   158.04
## 161 17.28   youtube   207.00
## 162 15.96   youtube   102.84
## 163 17.88   youtube   226.08
## 164 21.60   youtube   196.20
## 165 14.28   youtube   140.64
## 166 14.28   youtube   281.40
## 167  9.60   youtube    21.48
## 168 14.64   youtube   248.16
## 169 20.52   youtube   258.48
## 170 18.00   youtube   341.16
## 171 10.08   youtube    60.00
## 172 17.40   youtube   197.40
## 173  9.12   youtube    23.52
## 174 14.04   youtube   202.08
## 175 13.80   youtube   266.88
## 176 32.40   youtube   332.28
## 177 24.24   youtube   298.08
## 178 14.04   youtube   204.24
## 179 14.16   youtube   332.04
## 180 15.12   youtube   198.72
## 181 12.60   youtube   187.92
## 182 14.64   youtube   262.20
## 183 10.44   youtube    67.44
## 184 31.44   youtube   345.12
## 185 21.12   youtube   304.56
## 186 27.12   youtube   246.00
## 187 12.36   youtube   167.40
## 188 20.76   youtube   229.32
## 189 19.08   youtube   343.20
## 190  8.04   youtube    22.44
## 191 12.96   youtube    47.40
## 192 11.88   youtube    90.60
## 193  7.08   youtube    20.64
## 194 23.52   youtube   200.16
## 195 20.76   youtube   179.64
## 196  9.12   youtube    45.84
## 197 11.64   youtube   113.04
## 198 15.36   youtube   212.40
## 199 30.60   youtube   340.32
## 200 16.08   youtube   278.52
## 201 26.52  facebook    45.36
## 202 12.48  facebook    47.16
## 203 11.16  facebook    55.08
## 204 22.20  facebook    49.56
## 205 15.48  facebook    12.96
## 206  8.64  facebook    58.68
## 207 14.16  facebook    39.36
## 208 15.84  facebook    23.52
## 209  5.76  facebook     2.52
## 210 12.72  facebook     3.12
## 211 10.32  facebook     6.96
## 212 20.88  facebook    28.80
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## 213 11.04  facebook    42.12
## 214 11.64  facebook     9.12
## 215 22.80  facebook    39.48
## 216 26.88  facebook    57.24
## 217 15.00  facebook    43.92
## 218 29.28  facebook    47.52
## 219 13.56  facebook    24.60
## 220 17.52  facebook    28.68
## 221 21.60  facebook    33.24
## 222 15.00  facebook     6.12
## 223  6.72  facebook    19.08
## 224 18.60  facebook    20.28
## 225 11.64  facebook    15.12
## 226 14.40  facebook     4.20
## 227 18.00  facebook    35.16
## 228 19.08  facebook    20.04
## 229 22.68  facebook    32.52
## 230 12.60  facebook    19.20
## 231 25.68  facebook    33.96
## 232 14.28  facebook    20.88
## 233 11.52  facebook     1.80
## 234 20.88  facebook    24.00
## 235 11.40  facebook     1.68
## 236 15.36  facebook     4.92
## 237 30.48  facebook    52.56
## 238 17.64  facebook    59.28
## 239 12.12  facebook    32.04
## 240 25.80  facebook    45.24
## 241 19.92  facebook    26.76
## 242 20.52  facebook    40.08
## 243 24.84  facebook    33.24
## 244 15.48  facebook    10.08
## 245 10.20  facebook    30.84
## 246 17.88  facebook    27.00
## 247 12.72  facebook    11.88
## 248 27.84  facebook    49.80
## 249 17.76  facebook    18.96
## 250 11.64  facebook    14.04
## 251 13.68  facebook     3.72
## 252 12.84  facebook    11.52
## 253 27.12  facebook    50.04
## 254 25.44  facebook    55.44
## 255 24.24  facebook    34.56
## 256 28.44  facebook    59.28
## 257  6.60  facebook    33.72
## 258 15.84  facebook    23.04
## 259 28.56  facebook    59.52
## 260 22.08  facebook    35.40
## 261  9.72  facebook     2.40
## 262 29.04  facebook    51.24
## 263 18.84  facebook    18.60
## 264 16.80  facebook    35.52
## 265 21.60  facebook    51.36
## 266 11.16  facebook    11.16
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## 267 11.40  facebook    29.52
## 268 16.08  facebook    17.40
## 269 22.68  facebook    33.00
## 270 26.76  facebook    52.68
## 271 21.96  facebook    36.72
## 272 14.88  facebook    17.16
## 273 10.56  facebook    39.60
## 274 13.20  facebook     6.84
## 275 20.40  facebook    29.52
## 276 10.44  facebook    52.44
## 277  8.28  facebook     1.92
## 278 17.04  facebook    34.20
## 279  6.36  facebook    35.88
## 280 13.20  facebook     9.24
## 281 14.16  facebook    32.04
## 282 14.76  facebook     4.92
## 283 13.56  facebook    24.36
## 284 16.32  facebook    53.40
## 285 26.04  facebook    51.60
## 286 18.24  facebook    22.08
## 287 14.40  facebook    33.00
## 288 19.20  facebook    48.72
## 289 15.48  facebook    30.60
## 290 20.04  facebook    57.36
## 291 13.44  facebook     5.88
## 292  8.76  facebook     1.80
## 293 23.28  facebook    40.20
## 294 26.64  facebook    43.80
## 295 13.80  facebook    16.80
## 296 20.28  facebook    37.92
## 297 14.04  facebook     4.20
## 298 18.60  facebook    25.20
## 299 30.48  facebook    50.76
## 300 20.64  facebook    50.04
## 301 14.04  facebook     5.16
## 302 28.56  facebook    43.56
## 303 17.76  facebook    12.12
## 304 17.64  facebook    20.64
## 305 24.84  facebook    41.16
## 306 23.04  facebook    55.68
## 307  8.64  facebook    13.20
## 308 10.44  facebook     0.36
## 309  6.36  facebook     0.48
## 310 23.76  facebook    32.28
## 311 16.08  facebook     9.84
## 312 26.16  facebook    45.60
## 313 16.92  facebook    18.48
## 314 19.08  facebook    24.72
## 315 17.52  facebook    56.16
## 316 15.12  facebook    42.00
## 317 14.64  facebook    17.16
## 318 11.28  facebook     0.96
## 319 19.08  facebook    44.28
## 320  7.92  facebook    19.20
```

```
## 321 18.60   facebook      32.16
## 322  8.40   facebook      26.04
## 323 13.92   facebook       2.88
## 324 18.24   facebook      41.52
## 325 23.64   facebook      38.76
## 326 12.72   facebook      14.16
## 327  7.92   facebook      46.68
## 328 10.56   facebook       0.00
## 329 29.64   facebook      58.80
## 330 11.64   facebook      14.40
## 331  1.92   facebook      47.52
## 332 15.24   facebook       3.48
## 333  6.84   facebook      32.64
## 334 23.52   facebook      40.20
## 335 12.96   facebook      46.32
## 336 13.92   facebook      56.40
## 337 11.40   facebook      46.80
## 338 24.96   facebook      34.68
## 339 11.52   facebook      31.08
## 340 24.84   facebook      52.68
## 341 13.08   facebook      20.40
## 342 23.04   facebook      42.48
## 343 24.12   facebook      39.84
## 344 12.48   facebook       6.84
## 345 13.68   facebook      17.76
## 346 12.36   facebook       2.28
## 347 15.84   facebook       8.76
## 348 30.48   facebook      58.80
## 349 13.08   facebook      48.36
## 350 12.12   facebook      30.96
## 351 19.32   facebook      16.68
## 352 13.92   facebook      10.08
## 353 19.92   facebook      27.96
## 354 22.80   facebook      47.64
## 355 18.72   facebook      25.32
## 356  3.84   facebook      13.92
## 357 18.36   facebook      52.20
## 358 12.12   facebook       1.56
## 359  8.76   facebook      44.28
## 360 15.48   facebook      22.08
## 361 17.28   facebook      21.72
## 362 15.96   facebook      42.96
## 363 17.88   facebook      21.72
## 364 21.60   facebook      44.16
## 365 14.28   facebook      17.64
## 366 14.28   facebook       4.08
## 367  9.60   facebook      45.12
## 368 14.64   facebook       6.24
## 369 20.52   facebook      28.32
## 370 18.00   facebook      12.72
## 371 10.08   facebook      13.92
## 372 17.40   facebook      25.08
## 373  9.12   facebook      24.12
## 374 14.04   facebook       8.52
```

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## 375 13.80   facebook      4.08
## 376 32.40   facebook     58.68
## 377 24.24   facebook     36.24
## 378 14.04   facebook      9.36
## 379 14.16   facebook      2.76
## 380 15.12   facebook     12.00
## 381 12.60   facebook      3.12
## 382 14.64   facebook      6.48
## 383 10.44   facebook      6.84
## 384 31.44   facebook     51.60
## 385 21.12   facebook     25.56
## 386 27.12   facebook     54.12
## 387 12.36   facebook      2.52
## 388 20.76   facebook     34.44
## 389 19.08   facebook     16.68
## 390  8.04   facebook     14.52
## 391 12.96   facebook     49.32
## 392 11.88   facebook     12.96
## 393  7.08   facebook      4.92
## 394 23.52   facebook     50.40
## 395 20.76   facebook     42.72
## 396  9.12   facebook      4.44
## 397 11.64   facebook      5.88
## 398 15.36   facebook     11.16
## 399 30.60   facebook     50.40
## 400 16.08   facebook     10.32
## 401 26.52  newspaper     83.04
## 402 12.48  newspaper     54.12
## 403 11.16  newspaper     83.16
## 404 22.20  newspaper     70.20
## 405 15.48  newspaper     70.08
## 406  8.64  newspaper     90.00
## 407 14.16  newspaper     28.20
## 408 15.84  newspaper     13.92
## 409  5.76  newspaper      1.20
## 410 12.72  newspaper     25.44
## 411 10.32  newspaper     29.04
## 412 20.88  newspaper      4.80
## 413 11.04  newspaper     79.08
## 414 11.64  newspaper      8.64
## 415 22.80  newspaper     55.20
## 416 26.88  newspaper     63.48
## 417 15.00  newspaper    136.80
## 418 29.28  newspaper     66.96
## 419 13.56  newspaper     21.96
## 420 17.52  newspaper     22.92
## 421 21.60  newspaper     64.08
## 422 15.00  newspaper     28.20
## 423  6.72  newspaper     59.52
## 424 18.60  newspaper     31.44
## 425 11.64  newspaper     21.96
## 426 14.40  newspaper     23.40
## 427 18.00  newspaper     15.12
## 428 19.08  newspaper     27.48
```

```
## 429 22.68 newspaper      27.48
## 430 12.60 newspaper      48.96
## 431 25.68 newspaper      51.84
## 432 14.28 newspaper      46.32
## 433 11.52 newspaper      36.00
## 434 20.88 newspaper       0.36
## 435 11.40 newspaper       8.88
## 436 15.36 newspaper      10.20
## 437 30.48 newspaper       6.00
## 438 17.64 newspaper      54.84
## 439 12.12 newspaper      42.12
## 440 25.80 newspaper      38.40
## 441 19.92 newspaper      37.92
## 442 20.52 newspaper      46.44
## 443 24.84 newspaper       2.16
## 444 15.48 newspaper      31.68
## 445 10.20 newspaper      51.96
## 446 17.88 newspaper      37.80
## 447 12.72 newspaper      42.84
## 448 27.84 newspaper      22.20
## 449 17.76 newspaper      59.88
## 450 11.64 newspaper      44.16
## 451 13.68 newspaper      41.52
## 452 12.84 newspaper       4.32
## 453 27.12 newspaper      47.52
## 454 25.44 newspaper      70.44
## 455 24.24 newspaper      19.08
## 456 28.44 newspaper      72.00
## 457  6.60 newspaper      49.68
## 458 15.84 newspaper      19.92
## 459 28.56 newspaper      45.24
## 460 22.08 newspaper      11.16
## 461  9.72 newspaper      25.68
## 462 29.04 newspaper      65.64
## 463 18.84 newspaper      32.76
## 464 16.80 newspaper      10.08
## 465 21.60 newspaper      34.68
## 466 11.16 newspaper       1.08
## 467 11.40 newspaper       2.64
## 468 16.08 newspaper      12.24
## 469 22.68 newspaper      13.20
## 470 26.76 newspaper      32.64
## 471 21.96 newspaper      46.44
## 472 14.88 newspaper      38.04
## 473 10.56 newspaper      23.16
## 474 13.20 newspaper      37.56
## 475 20.40 newspaper      15.72
## 476 10.44 newspaper     107.28
## 477  8.28 newspaper      24.84
## 478 17.04 newspaper      17.04
## 479  6.36 newspaper      11.28
## 480 13.20 newspaper      27.72
## 481 14.16 newspaper      26.76
## 482 14.76 newspaper      44.28
```

```
## 483 13.56 newspaper       39.00
## 484 16.32 newspaper       42.72
## 485 26.04 newspaper       40.56
## 486 18.24 newspaper       78.84
## 487 14.40 newspaper       19.20
## 488 19.20 newspaper       75.84
## 489 15.48 newspaper       88.08
## 490 20.04 newspaper       61.68
## 491 13.44 newspaper       11.16
## 492  8.76 newspaper       39.60
## 493 23.28 newspaper       70.80
## 494 26.64 newspaper       86.76
## 495 13.80 newspaper       13.08
## 496 20.28 newspaper       63.48
## 497 14.04 newspaper        7.08
## 498 18.60 newspaper       26.40
## 499 30.48 newspaper       61.44
## 500 20.64 newspaper       55.08
## 501 14.04 newspaper       59.76
## 502 28.56 newspaper      121.08
## 503 17.76 newspaper       25.68
## 504 17.64 newspaper       21.48
## 505 24.84 newspaper        6.36
## 506 23.04 newspaper       70.80
## 507  8.64 newspaper       35.64
## 508 10.44 newspaper       27.84
## 509  6.36 newspaper       30.72
## 510 23.76 newspaper        6.60
## 511 16.08 newspaper       67.80
## 512 26.16 newspaper       27.84
## 513 16.92 newspaper        2.88
## 514 19.08 newspaper       12.84
## 515 17.52 newspaper       41.40
## 516 15.12 newspaper       63.24
## 517 14.64 newspaper       30.72
## 518 11.28 newspaper       17.76
## 519 19.08 newspaper       95.04
## 520  7.92 newspaper       26.76
## 521 18.60 newspaper       55.44
## 522  8.40 newspaper       60.48
## 523 13.92 newspaper       18.72
## 524 18.24 newspaper       14.88
## 525 23.64 newspaper       89.04
## 526 12.72 newspaper       31.08
## 527  7.92 newspaper       60.72
## 528 10.56 newspaper       11.04
## 529 29.64 newspaper        3.84
## 530 11.64 newspaper       51.72
## 531  1.92 newspaper       10.44
## 532 15.24 newspaper       51.60
## 533  6.84 newspaper        2.52
## 534 23.52 newspaper       54.12
## 535 12.96 newspaper       78.72
## 536 13.92 newspaper       10.20
```

```
## 537 11.40 newspaper     11.16
## 538 24.96 newspaper     71.64
## 539 11.52 newspaper     24.60
## 540 24.84 newspaper      2.04
## 541 13.08 newspaper     15.48
## 542 23.04 newspaper     90.72
## 543 24.12 newspaper     45.48
## 544 12.48 newspaper     41.28
## 545 13.68 newspaper     46.68
## 546 12.36 newspaper     10.80
## 547 15.84 newspaper     10.44
## 548 30.48 newspaper     53.16
## 549 13.08 newspaper     14.28
## 550 12.12 newspaper     24.72
## 551 19.32 newspaper     44.40
## 552 13.92 newspaper     58.44
## 553 19.92 newspaper     17.04
## 554 22.80 newspaper     45.24
## 555 18.72 newspaper     11.40
## 556  3.84 newspaper      6.84
## 557 18.36 newspaper     60.60
## 558 12.12 newspaper     29.16
## 559  8.76 newspaper     54.24
## 560 15.48 newspaper     41.52
## 561 17.28 newspaper     36.84
## 562 15.96 newspaper     59.16
## 563 17.88 newspaper     30.72
## 564 21.60 newspaper      8.88
## 565 14.28 newspaper      6.48
## 566 14.28 newspaper    101.76
## 567  9.60 newspaper     25.92
## 568 14.64 newspaper     23.28
## 569 20.52 newspaper     69.12
## 570 18.00 newspaper      7.68
## 571 10.08 newspaper     22.08
## 572 17.40 newspaper     56.88
## 573  9.12 newspaper     20.40
## 574 14.04 newspaper     15.36
## 575 13.80 newspaper     15.72
## 576 32.40 newspaper     50.16
## 577 24.24 newspaper     24.36
## 578 14.04 newspaper     42.24
## 579 14.16 newspaper     28.44
## 580 15.12 newspaper     21.12
## 581 12.60 newspaper      9.96
## 582 14.64 newspaper     32.88
## 583 10.44 newspaper     35.64
## 584 31.44 newspaper     86.16
## 585 21.12 newspaper     36.00
## 586 27.12 newspaper     23.52
## 587 12.36 newspaper     31.92
## 588 20.76 newspaper     21.84
## 589 19.08 newspaper      4.44
## 590  8.04 newspaper     28.08
```

```
## 591 12.96 newspaper      6.96
## 592 11.88 newspaper      7.20
## 593  7.08 newspaper     37.92
## 594 23.52 newspaper      4.32
## 595 20.76 newspaper      7.20
## 596  9.12 newspaper     16.56
## 597 11.64 newspaper      9.72
## 598 15.36 newspaper      7.68
## 599 30.60 newspaper     79.44
## 600 16.08 newspaper     10.44
```

Exploratory Data Analysis

Nos gustaría conocer como se comportan las ventas con respecto a la inversión en distintos medios. Para esto, es conveniente graficar en facets para cada medio:

```
marketing %>%
  ggplot(aes(x = investment, y = sales, group = company, col = company)) +
  geom_point() +
  geom_smooth(method = lm, se = FALSE) +
  facet_wrap(~company, scales = "free_x")+
  theme_minimal()+
  theme(legend.position = "bottom")+
  labs(title = "Relación entre el monto invertido y las ventas",
       subtitle = "Se realizan campañas en tres compañias: youtube, facebook, newspaper",
       caption = "Información recopilada del paquete datarium",
       color = "Compañia",
       x = "Inversión (miles)",
       y = "Venta (millones")+
  scale_color_viridis_d(option = "plasma", end = .7)
```

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

Relación entre el monto invertido y las ventas
Se realizan campañas en tres compañias: youtube, facebook, newspaper
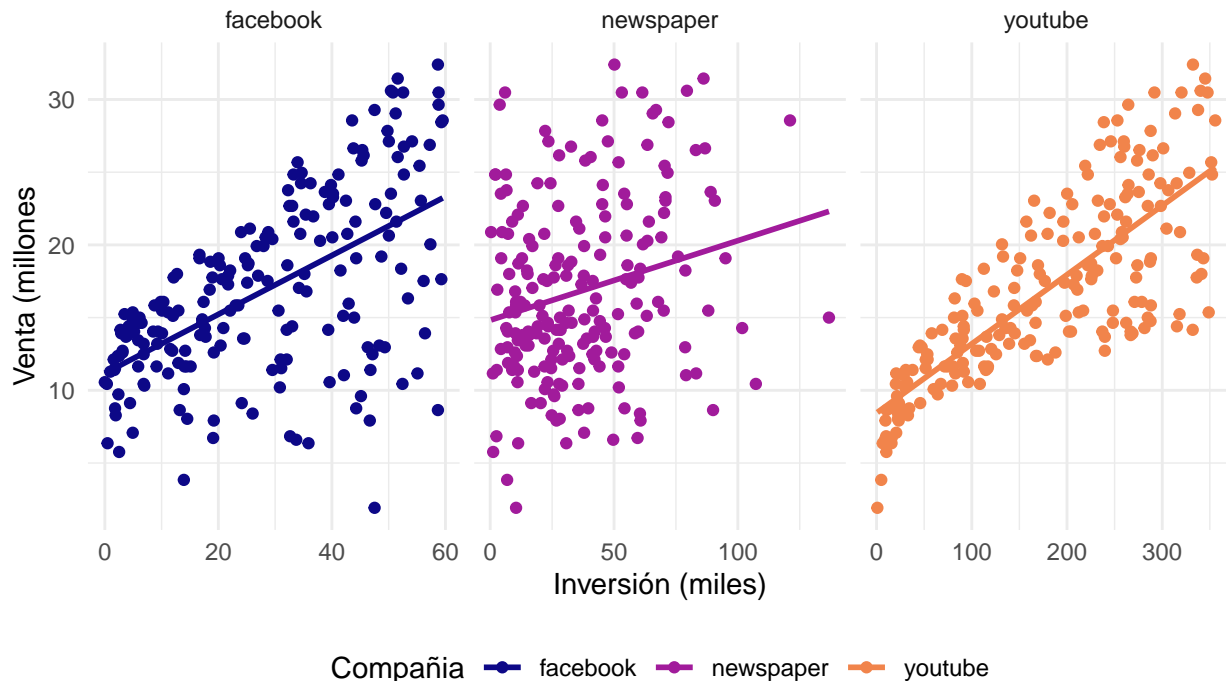
Información recopilada del paquete datarium

Regresión lineal para compañia de Youtube

Por fines ilustrativos, se realizará la regresión lineal solo para datos de youtube. Para esto se ocupa la funciones de linear_reg() y fit():

```r
marketing_youtube <- marketing %>% filter(company == "youtube")
# 1 - entrenar modelo
lm_fit <-
  linear_reg() %>%
  fit(sales ~ investment, data = marketing_youtube)

# 2 - visualizar y graficar
glance(lm_fit)
```

```
## # A tibble: 1 x 12
##   r.squared adj.r.squared sigma statistic  p.value    df logLik   AIC   BIC
##       <dbl>         <dbl> <dbl>     <dbl>    <dbl> <dbl>  <dbl> <dbl> <dbl>
## 1     0.612         0.610  3.91      312. 1.47e-42     1  -556. 1117. 1127.
## # ... with 3 more variables: deviance <dbl>, df.residual <int>, nobs <int>
```

```r
tidy(lm_fit)
```

```
## # A tibble: 2 x 5
##   term        estimate std.error statistic  p.value
##   <chr>          <dbl>     <dbl>     <dbl>    <dbl>
## 1 (Intercept)   8.44      0.549       15.4 1.41e-35
## 2 investment    0.0475    0.00269     17.7 1.47e-42
```
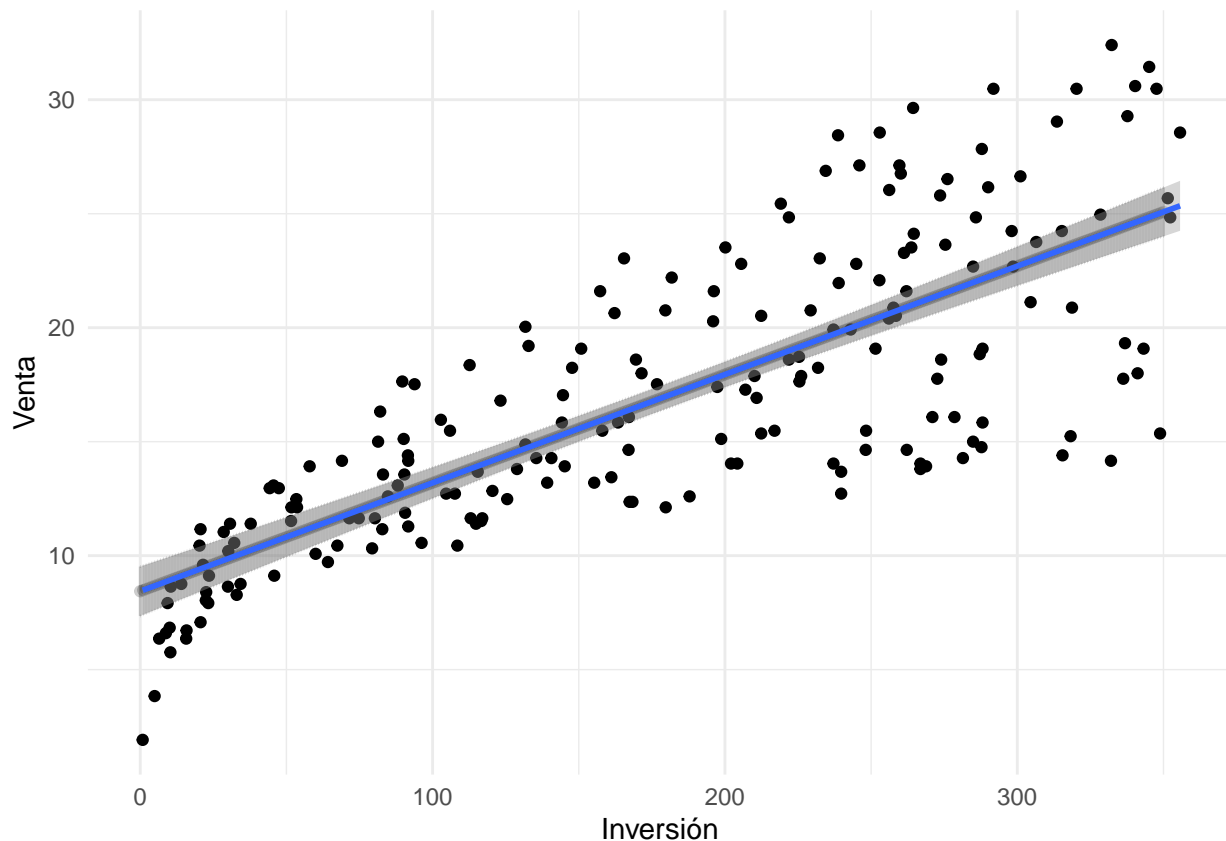
Funcion de Regresión Poblacional (FRP)

¿Cómo se ve la recta de regresión lineal para distintos niveles de X? Para esto, se realiza un grid de 0 a 350 y se realiza la predicción usando el modelo lineal. Esto nos calculará para cada punto x_i el valor de $\hat{y} = \beta_0 + \beta_1 x_i$

```r
new_points <- expand.grid(investment = 0:350)
mean_pred <- predict(lm_fit, new_data = new_points)
conf_int_pred <-
  predict(
    object = lm_fit,
    new_data = new_points,
    type = "conf_int",
    level = .95
  )

plot_data <-
  new_points %>%
  bind_cols(mean_pred) %>%
  bind_cols(conf_int_pred)

ggplot(plot_data, aes(x = investment)) +
  geom_point(data = marketing_youtube, aes(x = investment, y = sales))+
  geom_point(aes(y = .pred), alpha = 0.2) +
  geom_errorbar(aes(ymin = .pred_lower,
                    ymax = .pred_upper),
                width = .2, alpha = 0.2) +
  geom_smooth(data = marketing_youtube,aes(x = investment, y = sales), method = "lm")+
  labs(y = "Venta", x = "Inversión") +
  theme_minimal()
```

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

Recordemos que supondremos que los datos poblacionales son los datos poblacionales, estonces la recta obtenida es la Función de Regresión Poblacional.

Coeficientes de β_0 y β_1

Podemos calcular los coeficientes de β_0 y β_1 con las formulas:

```
# 5 - ¿cómo se ven los coeficientes con las fórmulas?
b1 <- cov(marketing_youtube$sales,marketing_youtube$investment)/var(marketing_youtube$investment)
b0 <- mean(marketing_youtube$sales)-b1*mean(marketing_youtube$investment)
b1
```

```
## [1] 0.04753664
```

```
b0
```

```
## [1] 8.439112
```

O obtenerlos directamente con la función de tidy()

```
tidy(lm_fit)
```

```
## # A tibble: 2 x 5
##   term        estimate std.error statistic  p.value
##   <chr>          <dbl>     <dbl>     <dbl>    <dbl>
## 1 (Intercept)   8.44     0.549       15.4 1.41e-35
## 2 investment    0.0475   0.00269     17.7 1.47e-42
```

Función de Regresión Muestral (FRM)

Ahora sacaremos una muestra de tamaño 30 y veremos la recta muestral ajustada. Si se ejecuta varias veces este código, se observará que la línea se mueve dependiendo la muestra obtenida. También, si modificamos el tamaño de muestra, se puede observar que entre más grande sea el tamaño de la muestra, menor variación de la recta de regresión muestral.

```r
marketing_youtube_sample = marketing_youtube[sample(1:nrow(marketing_youtube), size = 30),]

ggplot(plot_data, aes(x = investment)) +
  geom_point(
    data = marketing_youtube,
    aes(x = investment, y = sales), alpha = 0.2)+
  geom_point(
    data = marketing_youtube_sample,
    aes(x = investment, y = sales), alpha = 0.8, color = "firebrick4")+
  geom_smooth(
    data = marketing_youtube,
    aes(x = investment, y = sales), method = "lm", alpha = 0.1)+
  geom_smooth(
    data = marketing_youtube_sample,
    aes(x = investment, y = sales), method = "lm", color = "firebrick4")+
  geom_vline(
    xintercept = mean(marketing_youtube_sample$investment),
    linetype = 2, color = "firebrick4")+
  geom_hline(
    yintercept = mean(marketing_youtube_sample$sales),
    linetype = 2, color = "firebrick4")+
  labs(y = "Venta", x = "Inversión") +
  theme_minimal()
```

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