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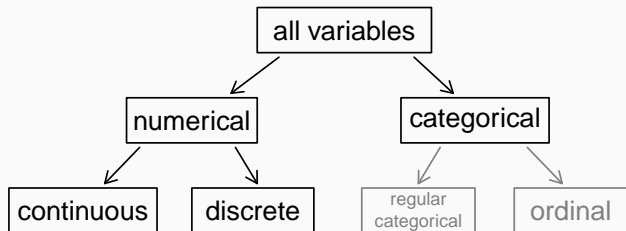
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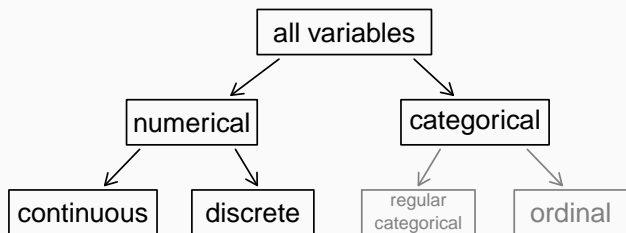
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- **Data matrix:** A collection of data with each row a case and each column a variable.
- **Case:** An observational unit.
- **Variable:** A characteristic (usually one of many) that is measured from each case.

Types of variables



- Numerical variables take values that can be added, subtracted, and averaged in a sensible way.
- Discrete numerical variables take on values with jumps e.g. counts, “how many”.
- Continuous numerical variables take on values without jumps e.g. weights, heights, “how much”.

Types of variables 2



- Categorical variables do not take values that can be added, subtracted, and averaged in a sensible way.

Practice

```
> mtcars
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda RX4	21.0	6	160.0	110	3.90	2.620	16.46	0	1	4	4
Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875	17.02	0	1	4	4
Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
Hornet Sportabout	18.7	8	360.0	175	3.15	3.440	17.02	0	0	3	2
Valiant	18.1	6	225.0	105	2.76	3.460	20.22	1	0	3	1
Duster 360	14.3	8	360.0	245	3.21	3.570	15.84	0	0	3	4
Merc 240D	24.4	4	146.7	62	3.69	3.190	20.00	1	0	4	2
Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
Merc 280	19.2	6	167.6	123	3.92	3.440	18.30	1	0	4	4
Merc 280C	17.8	6	167.6	123	3.92	3.440	18.90	1	0	4	4
Merc 450SE	16.4	8	275.8	180	3.07	4.070	17.40	0	0	3	3
Merc 450SL	17.3	8	275.8	180	3.07	3.730	17.60	0	0	3	3
Merc 450SLC	15.2	8	275.8	180	3.07	3.780	18.00	0	0	3	3
Cadillac Fleetwood	10.4	8	472.0	205	2.93	5.250	17.98	0	0	3	4

Cases? Variables? Types of Variables?

Variable descriptions

mtcars

A data frame with 32 observations on 11 variables.

[, 1]	mpg	Miles/(US) gallon
[, 2]	cyl	Number of cylinders
[, 3]	disp	Displacement (cu.in.)
[, 4]	hp	Gross horsepower
[, 5]	drat	Rear axle ratio
[, 6]	wt	Weight (1000 lbs)
[, 7]	qsec	1/4 mile time
[, 8]	vs	V/S
[, 9]	am	Transmission (0 = automatic, 1 = manual)
[,10]	gear	Number of forward gears
[,11]	carb	Number of carburetors

Types of variables (cont.)

	gender	sleep (hr)	bedtime	countries	dread
1	male	5	12-2	13	3
2	female	7	10-12	7	2
3	female	5.5	12-2	1	4
4	female	7	12-2		2
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- countries: *numerical, discrete*

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- sleep: *numerical, continuous*
- bedtime: *categorical, ordinal*
- countries: *numerical, discrete*
- dread: *categorical, ordinal - could also be used as numerical*

Practice

What type of variable is a telephone area code?

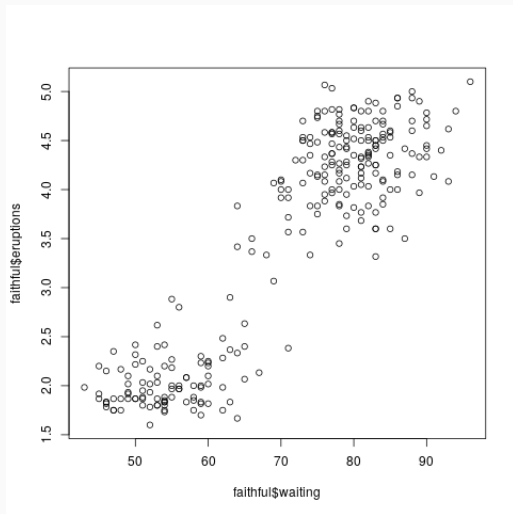
- (a) numerical, continuous
- (b) numerical, discrete
- (c) categorical
- (d) categorical, ordinal

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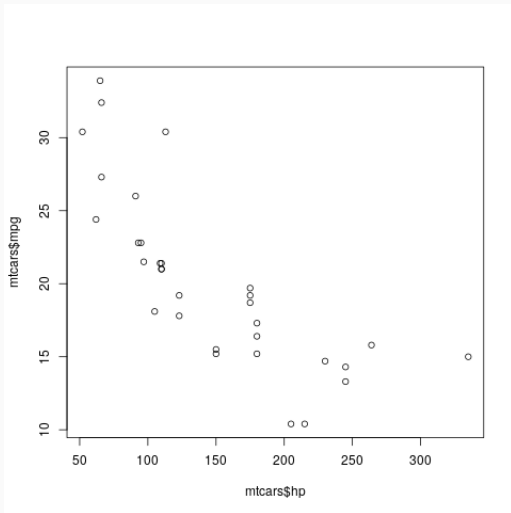
- (a) numerical, continuous
- (b) numerical, discrete
- (c) *categorical*
- (d) categorical, ordinal

Positive association



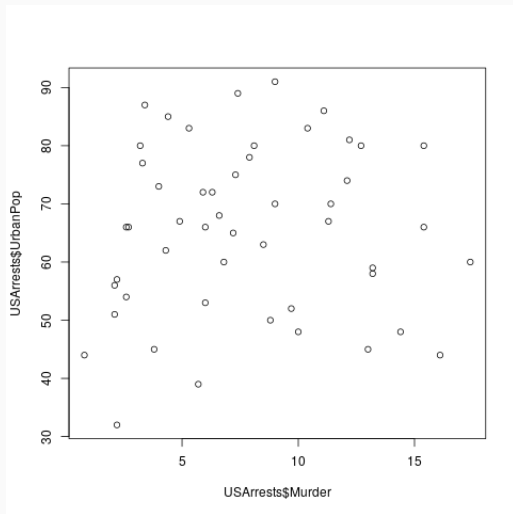
The eruption time (min) vs wait time (min) for 272 cases of Old Faithful.

Negative association



The mpg vs. HP for 32 cars.

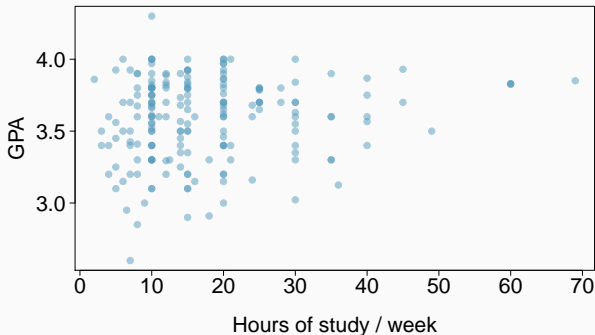
Independent variables



From 1973, murder rate vs urban population proportion (50 states).

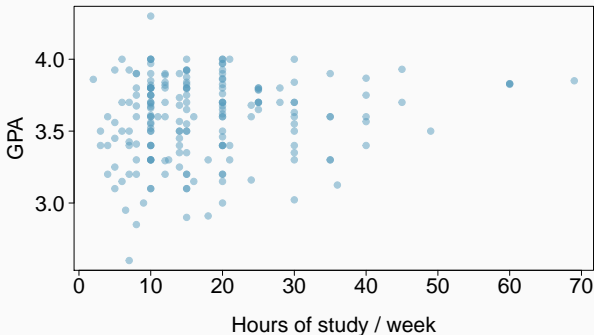
Relationships among variables

Does there appear to be a relationship between GPA and number of hours students study per week?



Relationships among variables

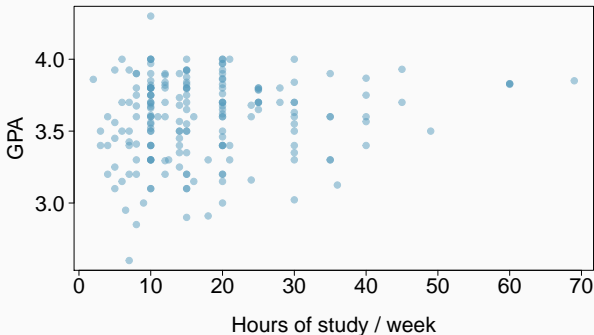
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Can you spot anything unusual about any of the data points?

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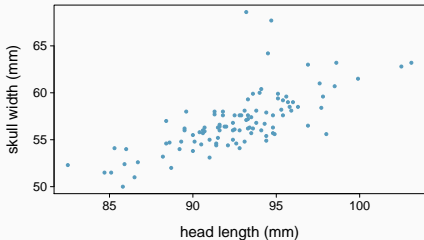


Can you spot anything unusual about any of the data points?

There is one student with GPA > 4.0, this is likely a data error.

Practice

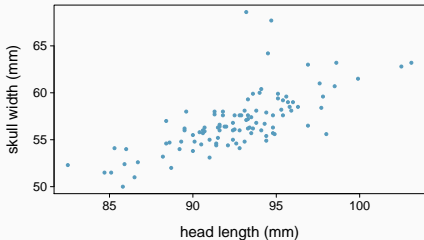
Based on the scatterplot on the right, which of the following statements is correct about the head and skull lengths of possums?



- (a) There is no relationship between head length and skull width, i.e. the variables are independent.
- (b) Head length and skull width are positively associated.
- (c) Skull width and head length are negatively associated.
- (d) A longer head causes the skull to be wider.
- (e) A wider skull causes the head to be longer.

Practice

Based on the scatterplot on the right, which of the following statements is correct about the head and skull lengths of possums?



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Associated vs. independent

- When two variables show some connection with one another, they are called *associated* variables.
 - Associated variables can also be called *dependent* variables and vice-versa.
- If two variables are not associated, i.e. there is no evident connection between the two, then they are said to be *independent*.

Class survey

What would be some interesting questions we could ask everyone in the room?

For each question, what type of variable would be recorded?

Would the survey be anonymous?

Which variables would you expect to be associated? independent?