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  `https://github.com/julianmak/academic-notes`

  The repository principally contains the compiled products rather than the source for size reasons.
- Associated Python code (as Jupyter notebooks mostly) will be held on the same repository. The source data however might be big, so I am going to be naughty and possibly just refer you to where you might get the data if that is the case (e.g. JRA-55 data). I know I should make properly reproducible binders etc., but I didn't...
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# OCES 3301 :

## basic Data Analysis in ocean sciences

Session 2: basic manipulations and statistics

# Outline

(Just overview here; for actual content see Jupyter notebooks)

- basic stats with basic example
- El Nino 3.4 SST data

  $\rightarrow$ demonstration of data

  $\rightarrow$ overview

  $\rightarrow$ some plotting + exercises

# Basic stats

Suppose I have some data samples as the following:

$$x_i = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$$

- **sample size** $N$, the number of samples
- **range**, largest minus smallest of sample
  $\rightarrow$ crude measure of spread

averages (but actually three of these):

1. **mode**, most frequent occurrence
2. **median**, rank these, and find the middle one
3. **mean**, THE average

# Basic stats

$$x_i = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$$

- **lower/upper (25/75 percent) quartile**, rank data, value at which 25/75 percent of data lie below
- **inter-quartile range**, the different between upper and lower quartile

  $\rightarrow$ measures spread

# Basic stats

Summary as a box-and-whisker plot

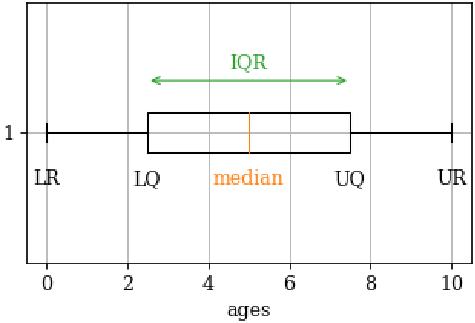



**Figure:** Nobel prize winning box plot.

# Basic stats

$$x_i = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$$

- **mean**, THE average

$$\overline{x} = \frac{x_1 + x_2 + \ldots + x_N}{N} = \frac{1}{N}\sum_{i=1}^{N} x_i$$

$\rightarrow$ sum up, divide by number going into sum

# Basic stats

$$x_i = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$$

- (unadjusted) **variance**

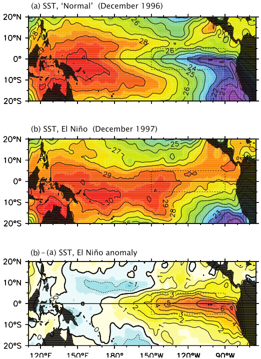
$$s^2 = \frac{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + \ldots + (x_N - \bar{x})^2}{N} = \frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2,$$

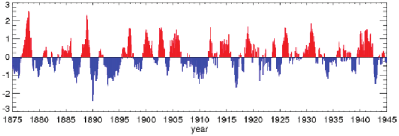
$\rightarrow$ take mean off sample, square each result, sum, divide by number going into sum

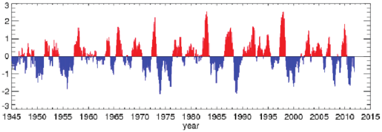
$\rightarrow$ square-root of variance is the **standard deviation (s.t.d.)**

# El-Niño (see also ENVS 3004; probably see also OCES 4001)

- “the little boy”, known to fisherman in South America for a long time
- generally starts around Christmas time
- warming in Eastern equatorial Pacific ocean
- signal in SST in modern day
  → proxy data from **corals**



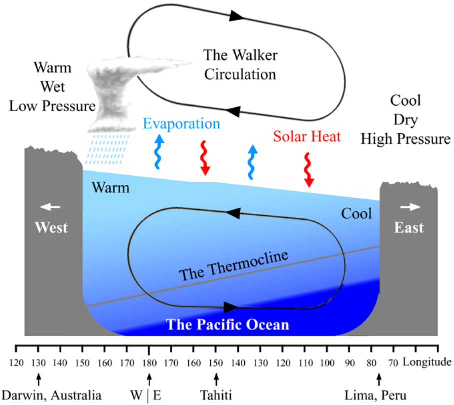
# Southern Oscillation

- discovered by Gilbert Walker (1868–1958)

  → correlation with monsoon and thus famine and drought in India

  → Companion of the Order of the Star of India in 1911
- winds change directions periodically

  → Walker circulation changes (E-W, part of N-S Hadley circulation)




(Ocean heat source moving affects atmospheric circulation)

# “Normal” + El-Niño event

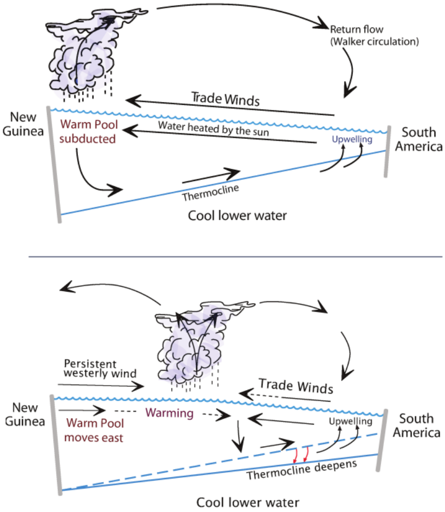



**Figure:** Schematic of ENSO, from Vallis (2019).

# El-Niño 3.4 region

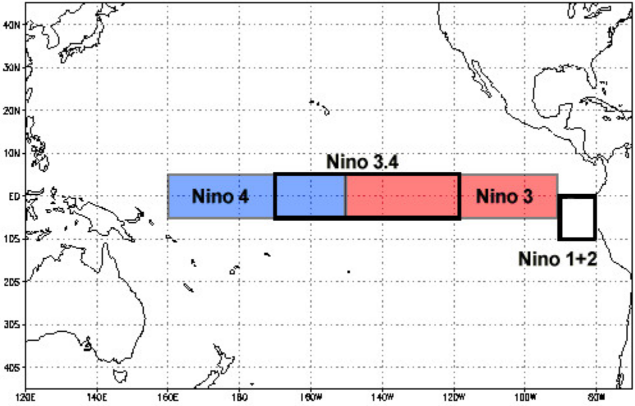



**Figure:** Pre-defined regions related to El-Niño indices. Picture probably (?) from NOAA.

# El-Niño 3.4 SST

Example of time-series data (see S07 and S08 also)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1948 | | 2019 | | | | | | | | | |
| 1948 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 |
| 1949 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 | -99.99 |
| 1950 | 24.55 | 25.06 | 25.87 | 26.28 | 26.18 | 26.46 | 26.29 | 25.88 | 25.74 | 25.69 | 25.47 | 25.29 |
| 1951 | 25.24 | 25.71 | 26.90 | 27.58 | 27.92 | 27.73 | 27.60 | 27.02 | 27.23 | 27.20 | 27.25 | 26.91 |
| 1952 | 26.67 | 26.74 | 27.17 | 27.80 | 27.79 | 27.18 | 26.53 | 26.30 | 26.36 | 26.26 | 25.92 | 26.21 |
| 1953 | 26.74 | 27.00 | 27.57 | 28.04 | 28.28 | 28.12 | 27.43 | 26.94 | 27.01 | 26.87 | 26.88 | 27.00 |
| 1954 | 26.98 | 27.03 | 26.90 | 26.64 | 27.12 | 26.80 | 26.11 | 25.43 | 25.12 | 25.23 | 25.57 | 25.26 |
| 1955 | 25.61 | 25.81 | 26.22 | 26.60 | 26.66 | 26.55 | 26.15 | 25.51 | 25.28 | 24.41 | 24.25 | 24.57 |
| 1956 | 25.34 | 25.76 | 26.46 | 26.85 | 27.13 | 26.81 | 26.23 | 25.68 | 25.73 | 25.75 | 25.56 | 25.71 |
| 1957 | 26.04 | 26.54 | 27.46 | 28.23 | 28.55 | 28.36 | 28.17 | 27.69 | 27.44 | 27.42 | 27.62 | 27.90 |
| 1958 | 28.33 | 28.24 | 28.27 | 28.27 | 28.31 | 27.99 | 27.32 | 26.85 | 26.40 | 26.45 | 26.75 | 26.62 |
| 1959 | 27.07 | 27.18 | 27.47 | 27.88 | 27.70 | 27.37 | 26.44 | 26.09 | 25.92 | 26.24 | 26.04 | 26.18 |
| 1960 | 26.27 | 26.29 | 26.98 | 27.49 | 27.68 | 27.24 | 26.88 | 26.70 | 26.44 | 26.22 | 26.26 | 26.22 |
| 1961 | 26.23 | 26.56 | 26.94 | 27.36 | 27.75 | 27.67 | 26.89 | 26.19 | 25.78 | 25.71 | 26.07 | 25.97 |
| 1962 | 25.96 | 26.19 | 26.80 | 27.13 | 27.05 | 27.08 | 26.76 | 26.33 | 25.94 | 25.97 | 25.75 | 25.67 |
| 1963 | 25.77 | 26.22 | 27.18 | 27.78 | 27.63 | 27.62 | 27.78 | 27.48 | 27.40 | 27.36 | 27.47 | 27.62 |
| 1964 | 27.34 | 27.13 | 27.02 | 26.95 | 26.82 | 26.59 | 26.33 | 25.60 | 25.32 | 25.37 | 25.26 | 25.23 |
| 1965 | 25.66 | 26.19 | 26.94 | 27.38 | 27.99 | 28.09 | 27.90 | 27.97 | 28.01 | 28.17 | 28.12 | 27.96 |
| 1966 | 27.67 | 27.55 | 28.21 | 28.16 | 27.55 | 27.64 | 27.33 | 26.48 | 26.27 | 26.22 | 26.23 | 26.03 |
| 1967 | 25.88 | 26.11 | 26.50 | 26.74 | 27.35 | 27.47 | 26.97 | 26.44 | 25.86 | 25.97 | 26.08 | 25.95 |
| 1968 | 25.69 | 25.68 | 26.33 | 27.10 | 27.19 | 27.88 | 27.58 | 27.01 | 26.72 | 26.75 | 27.20 | 27.27 |
| 1969 | 27.50 | 27.86 | 27.82 | 28.13 | 28.29 | 27.69 | 27.08 | 27.02 | 27.15 | 27.34 | 27.10 | 26.98 |

**Figure:** Sample content of `elnino34_sst.data`.

# Iris data

Example of categorical + numerical data (multivariate), in `iris.csv`

- from Ronald Fisher's dataset (will see him time and again in this course)
- the "hello world" of statistics and machine learning

**Figure:** *Iris setosa, versicolor, and virginica*, in the iris dataset. Often used in machine learning (e.g. clustering analysis) and useful for demonstrating statistical concepts. Pictures from Wikipedia.

# Palmer Penguin data

Fisher was known to be a proponent of eugenics (whether he was a racist as such is ongoing debate), so if you want an alternative to iris data, there is the penguin data in `penguins.csv`

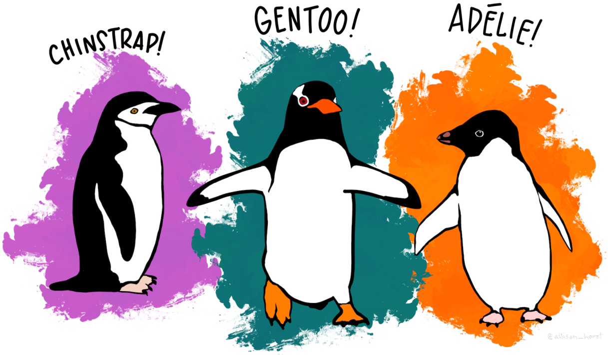



**Figure:** Artwork from Palmer Penguins dataset, by Allison Horst. See `https://allisonhorst.github.io/palmerpenguins/articles/intro.html`.

# Jupyter notebook

Go to 02 Jupyter notebook to play around with these datasets in Python