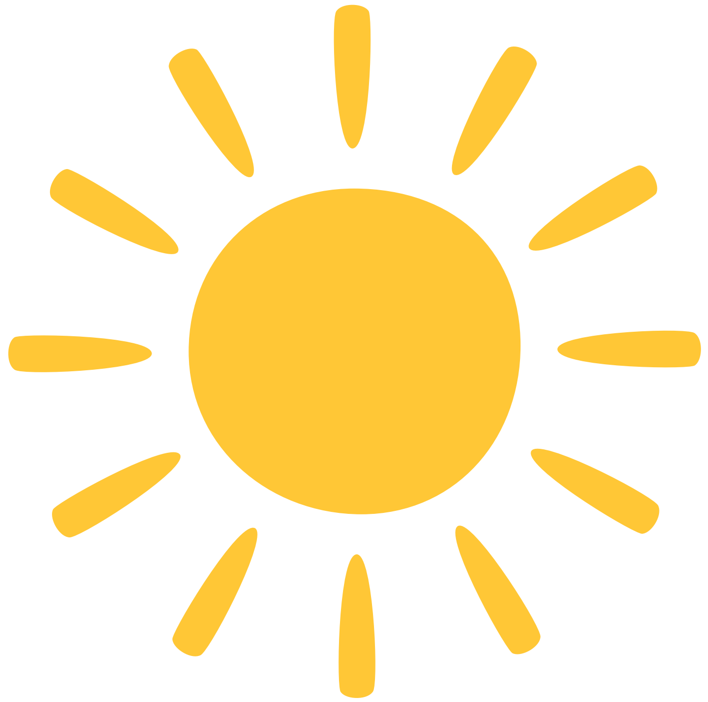
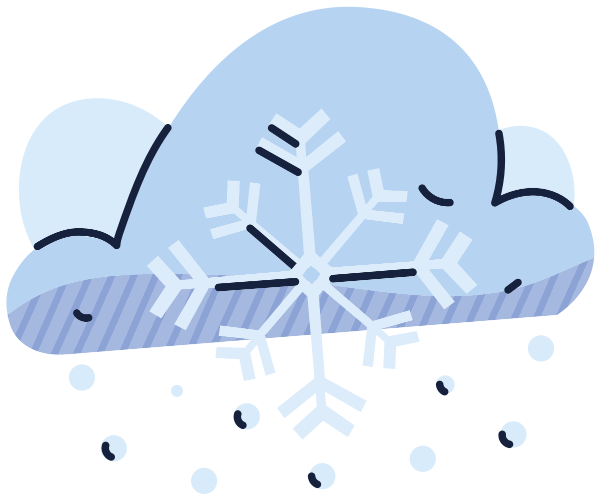


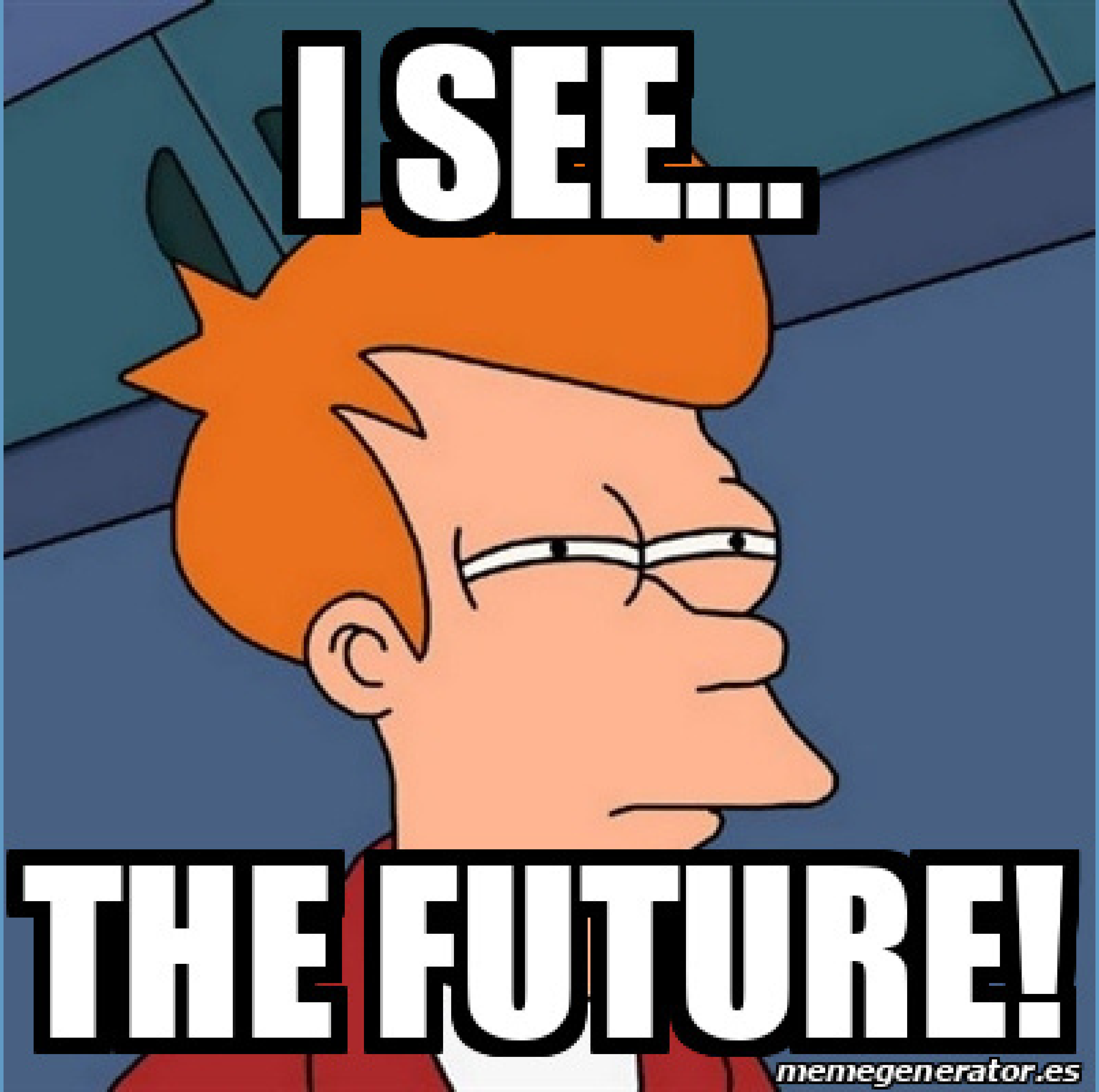


Weather Forecast using Markov Chains

by Serena Ikemhe Elijah

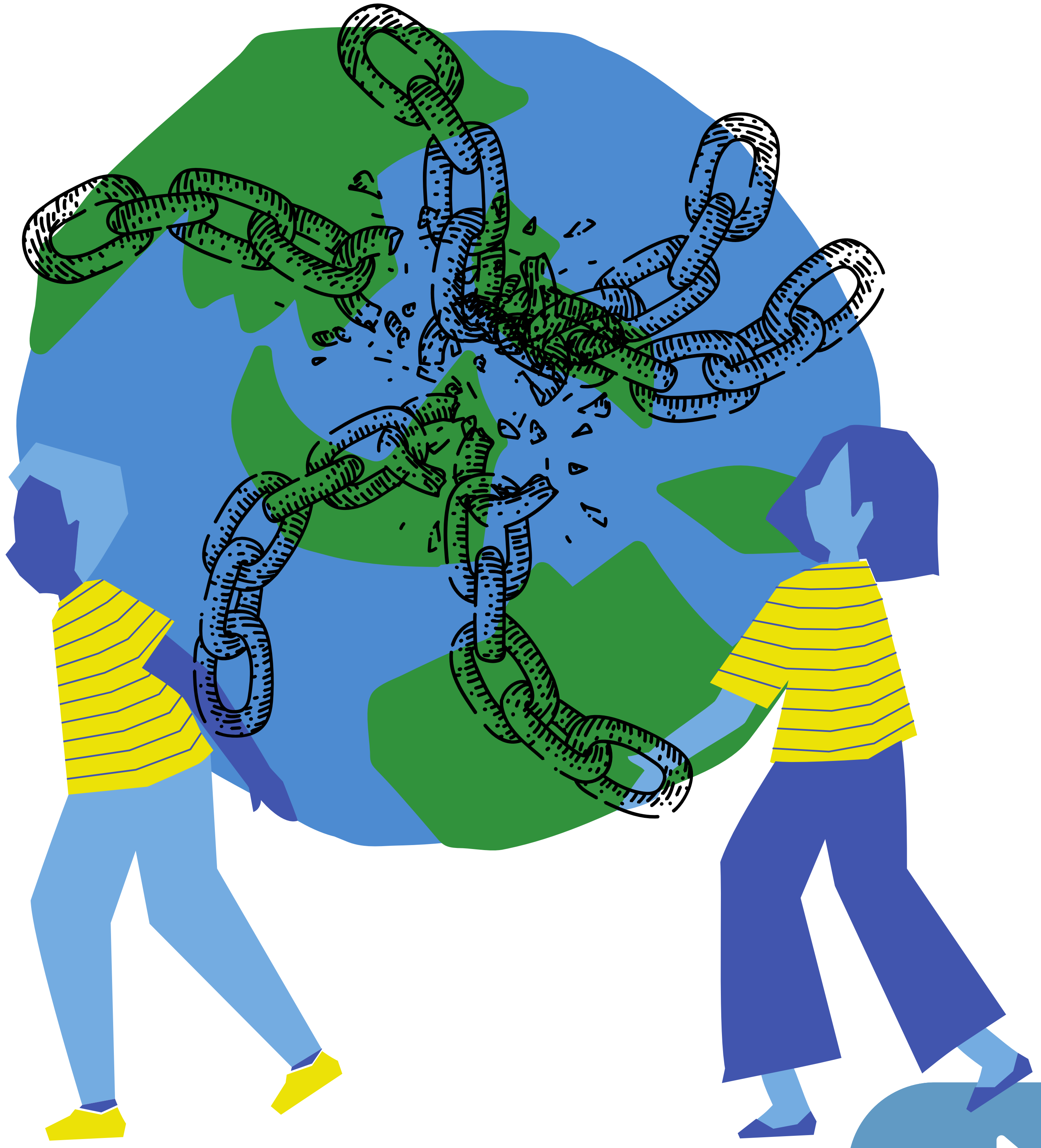
BACKGROUND

- Founding Father: Andrey Andreyevich Markov
- Primarily used to describe the sequence of events
- Known in weather forecasts as a way of predicting the future.


I SEE...
THE FUTURE!
memegenerator.es

••• What are Markov chains?

- A mathematical (probability) approach to predicting the future.
- It is solely reliant on its present state not past state to predict the future.



••• Terminologies

Elements in Markov Chain

- A stochastic matrix is a square matrix whose columns are probability vectors.
- We represent the probability as a probability vector.
- A probability vector is a vector with non-negative entries that add up to 1.

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

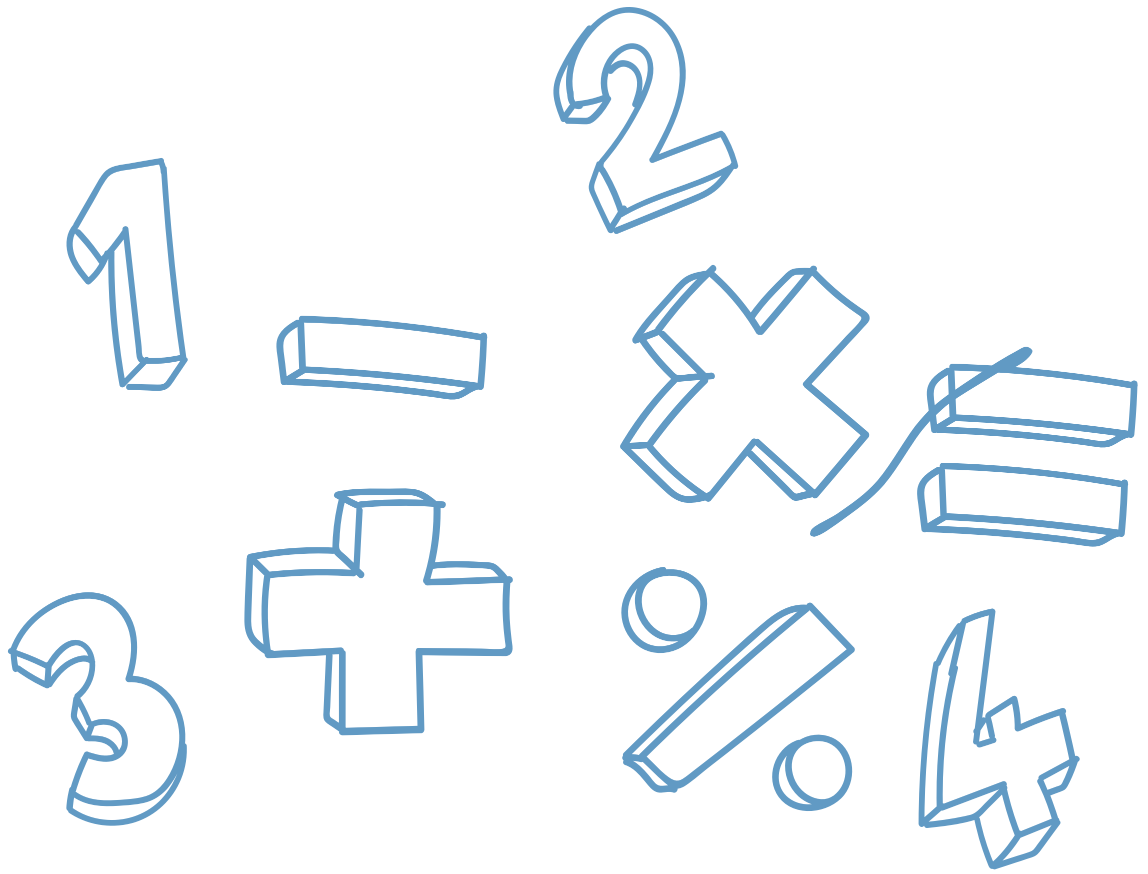
How to use Markov Chain

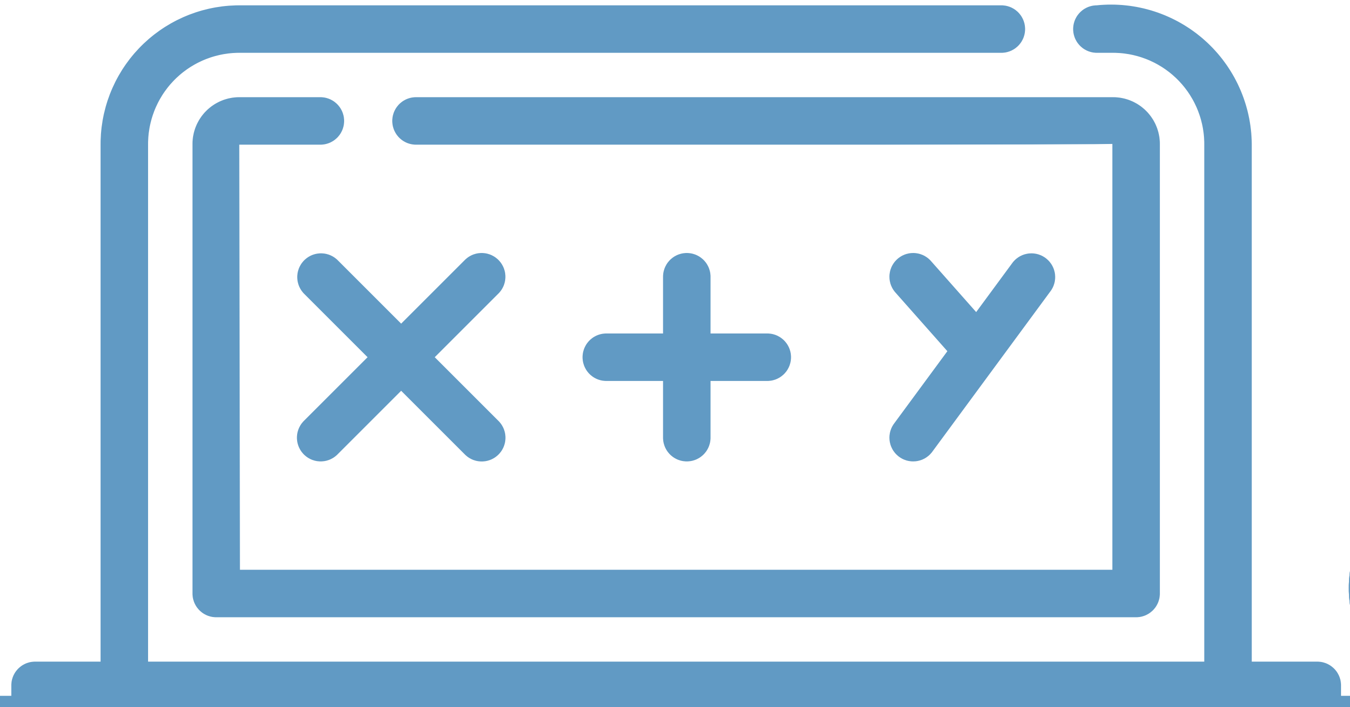
$$\text{Let } x_0 = present\ state\ probability\ vector$$

$$x_1 = future\ state\ probability\ vector$$

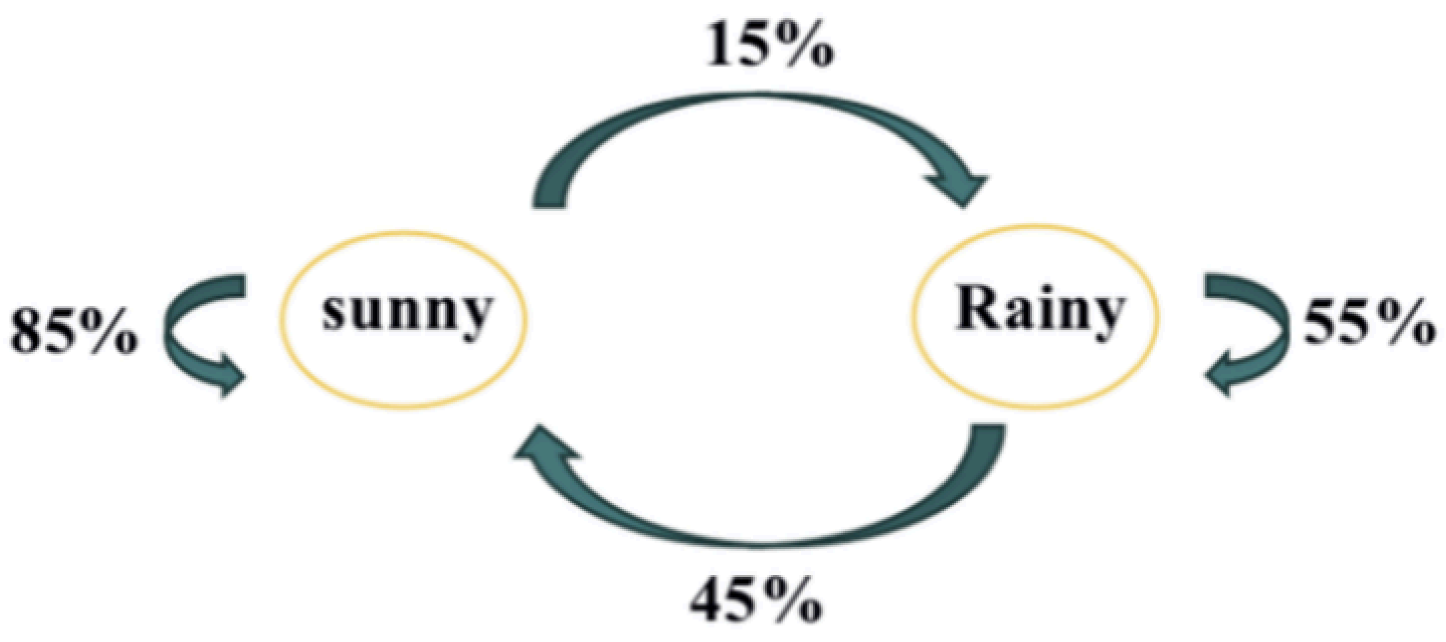
$$S = Stochastic\ matrix$$

$$x_{1_{mx1}} = [S_{mxm}][x_{0_{mx1}}]$$





••• Weather application Example:



$$
\begin{array}{ccc} & S & R & \\ \text{Stochastic Matrix} = & \left[\begin{array}{cc} 0.85 & 0.45 \\ 0.15 & 0.55 \end{array}\right] & \begin{array}{c} S \\ R \end{array} \end{array}
$$

... Calculations

Present state probability vector $Pr_{n=0} = \begin{bmatrix} 0.99 \\ 0.01 \end{bmatrix}$ = 1%

State 1 Probability vector $Pr_{n=1} = \begin{bmatrix} 0.85 & 0.45 \\ 0.15 & 0.55 \end{bmatrix} \begin{bmatrix} 0.99 \\ 0.01 \end{bmatrix} = \begin{bmatrix} 0.846 \\ 0.154 \end{bmatrix}$ = 15%

State 2 Probability vector $Pr_{n=2} = \begin{bmatrix} 0.85 & 0.45 \\ 0.15 & 0.55 \end{bmatrix} \begin{bmatrix} 0.846 \\ 0.154 \end{bmatrix} = \begin{bmatrix} 0.7884 \\ 0.2116 \end{bmatrix}$ =21%

••• Extra Credit

Answer = 21%

$$Pr_{n=3} = \begin{bmatrix} 0.85 & 0.45 \\ 0.15 & 0.55 \end{bmatrix} \begin{bmatrix} 0.7884 \\ 0.2116 \end{bmatrix} = \begin{bmatrix} 0.7884 \\ 0.2116 \end{bmatrix}$$

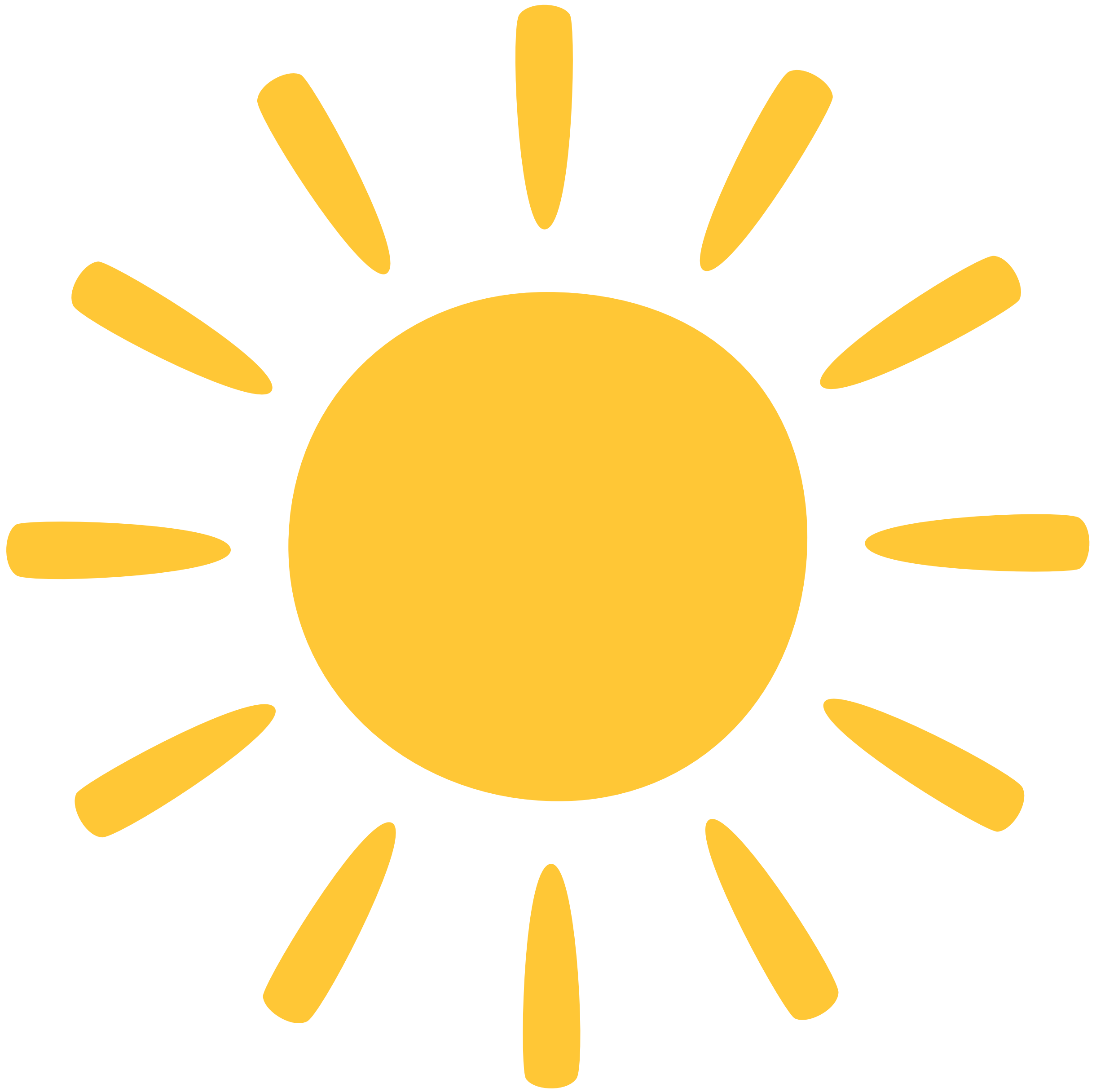
$(7191+0.0693) = .7884$

$(0.1269+0.0847) = .2116$

Steady State Vector

- This is also known as the equilibrum vector
- The result of the product of the stochastic matrix and steady state vector is steady state vector

Hint: Did anyone notice something about State 2 and State 3? ‹suprise gift›



$$x_s = \textit{Stead state probability vector}$$

$$[x_{s_{mx1}}] = [S_{mxm}][x_{s_{mx1}}]$$

‘What happens next is dependent on what happens now‘

In Summary

... References

David C. Lay, Steven R. Lay, Judi J. McDonald. (2022). Linear Algebra and its applications. Pearson Education Limited. Global edition.

GeekDataGuy (2019). Predicting the Weather with Markov Chains. Retrieved from https://towardsdatascience.com/predicting-the-weather-with-markov-chains-a34735f0c4df

...

Questions?