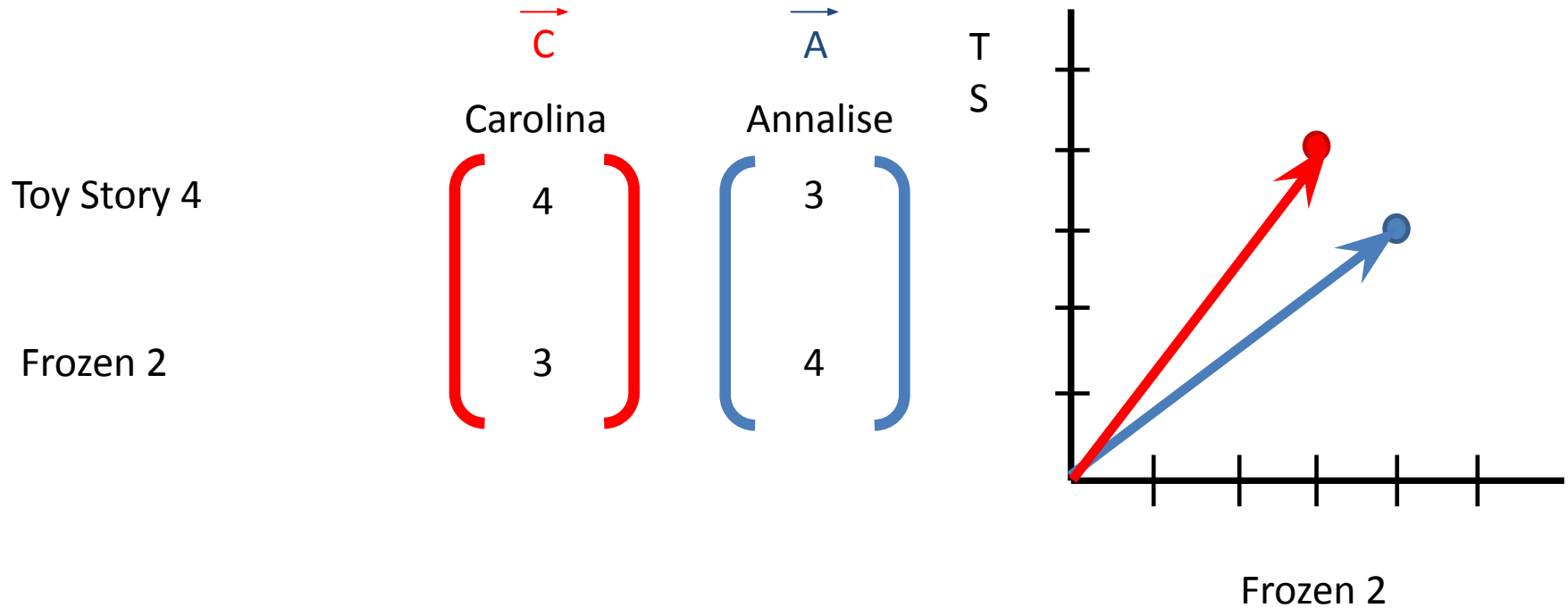


# — Recommender Systems

*Patrick Wales-Dinan*

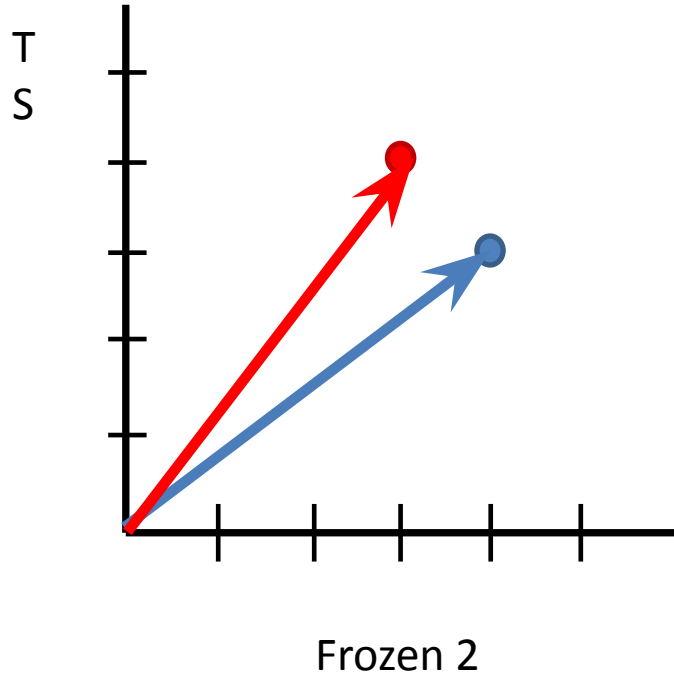
# Movie/TV Ratings



## Cosine Similarity

$$\frac{\vec{C}}{\|C\|} \cdot \frac{\vec{A}}{\|A\|}$$

# Vector Magnitude



$$a^2 + b^2 = c^2$$

$$\Rightarrow \sqrt{4^2 + 3^2}$$

$$\Rightarrow \sqrt{16 + 9}$$

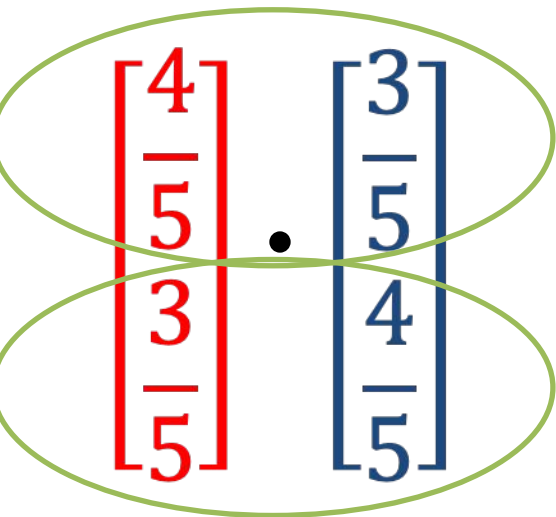
$$\Rightarrow \sqrt{25} \Rightarrow 5 \Rightarrow \|C\| \text{ \& } \|A\|$$

## Vector Normalization (Unit Vector)

$$\frac{\vec{c}}{\|\vec{c}\|} = \frac{\begin{bmatrix} 4 \\ 3 \end{bmatrix}}{5} = \begin{bmatrix} \frac{4}{5} \\ \frac{3}{5} \end{bmatrix} = \hat{c}$$

So whenever you take any vector and divide it by its magnitude. Then the result of that new vector is the unit vector (or a vector with magnitude = 1)

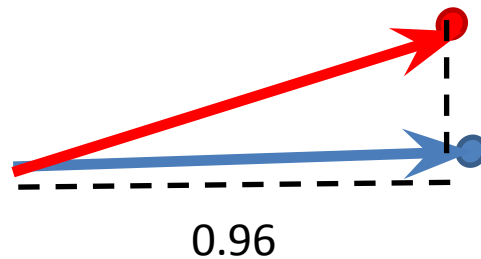
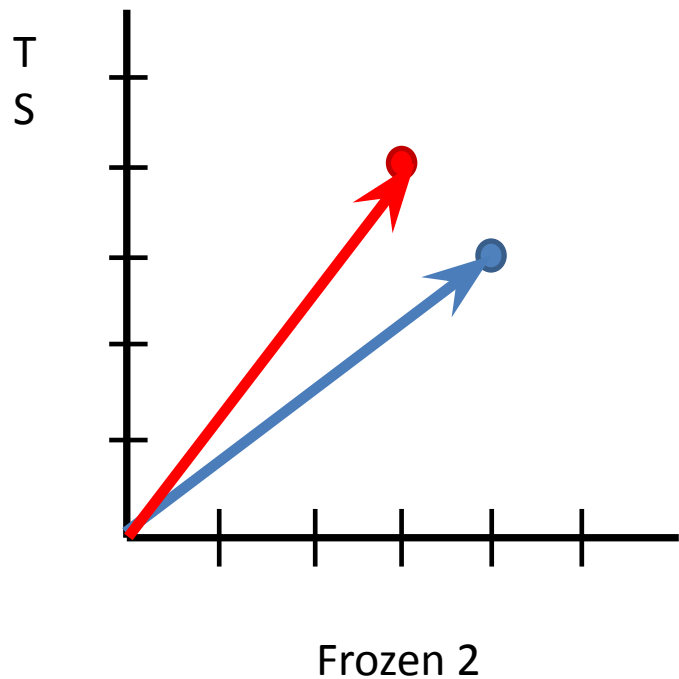
## Dot Product



A diagram illustrating the dot product of two vectors. The first vector is represented by a red column matrix  $\begin{bmatrix} 4 \\ 5 \\ 3 \\ 5 \end{bmatrix}$  and the second vector is represented by a blue column matrix  $\begin{bmatrix} 3 \\ 5 \\ 4 \\ 5 \end{bmatrix}$ . A black dot between the matrices represents the dot product operation. Two green ovals are drawn around the matrices: the top oval encloses the first two elements (4 and 5 from the first vector, 3 and 5 from the second vector), and the bottom oval encloses the last two elements (3 and 5 from the first vector, 4 and 5 from the second vector).

$$\frac{4}{5} * \frac{3}{5} + \frac{3}{5} * \frac{4}{5} = \sim 0.96$$

# Dot Product Intuition



# Why Do We Normalize?

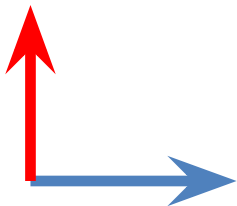
Cosine Sim = 1



Cosine Sim = -1



Cosine Sim = 0





# Content-Based Recommenders

Based on **product features**

| Title                    | Year | Genre            | Director                      | MPAA Rating |
|--------------------------|------|------------------|-------------------------------|-------------|
| Elf                      | 2003 | Christmas/Comedy | Jon Favreau                   | PG          |
| Die Hard                 | 1988 | Christmas/Action | John McTiernan                | R           |
| How to Train Your Dragon | 2010 | Animation/Action | Dean DeBlois<br>Chris Sanders | PG          |

# Collaborative Recommenders: User-Based

Recommendations from **users** with similar **ratings**

|        | Movie 1 | Movie 2 | Movie 3     |
|--------|---------|---------|-------------|
| User 1 | 5       | 1       | Not Watched |
| User 2 | 4       | 1       | 4           |
| User 3 | 1       | 5       | 1           |

# Collaborative Recommenders: User-Based

Recommendations from **users** with similar **purchases**

|        | Movie 1 | Movie 2 | Movie 3     |
|--------|---------|---------|-------------|
| User 1 | 1       | 0       | Not Watched |
| User 2 | 1       | 0       | 1           |
| User 3 | 0       | 1       | 0           |

# Collaborative Recommenders: Item-Based

Recommendations from **products** with similar **ratings/purchases**

|         | User 1 | User 2 | User 3 |
|---------|--------|--------|--------|
| Movie 1 | 4      | 5      | 2      |
| Movie 2 | 2      | 1      | 5      |
| Movie 3 | 5      | 4      | 2      |