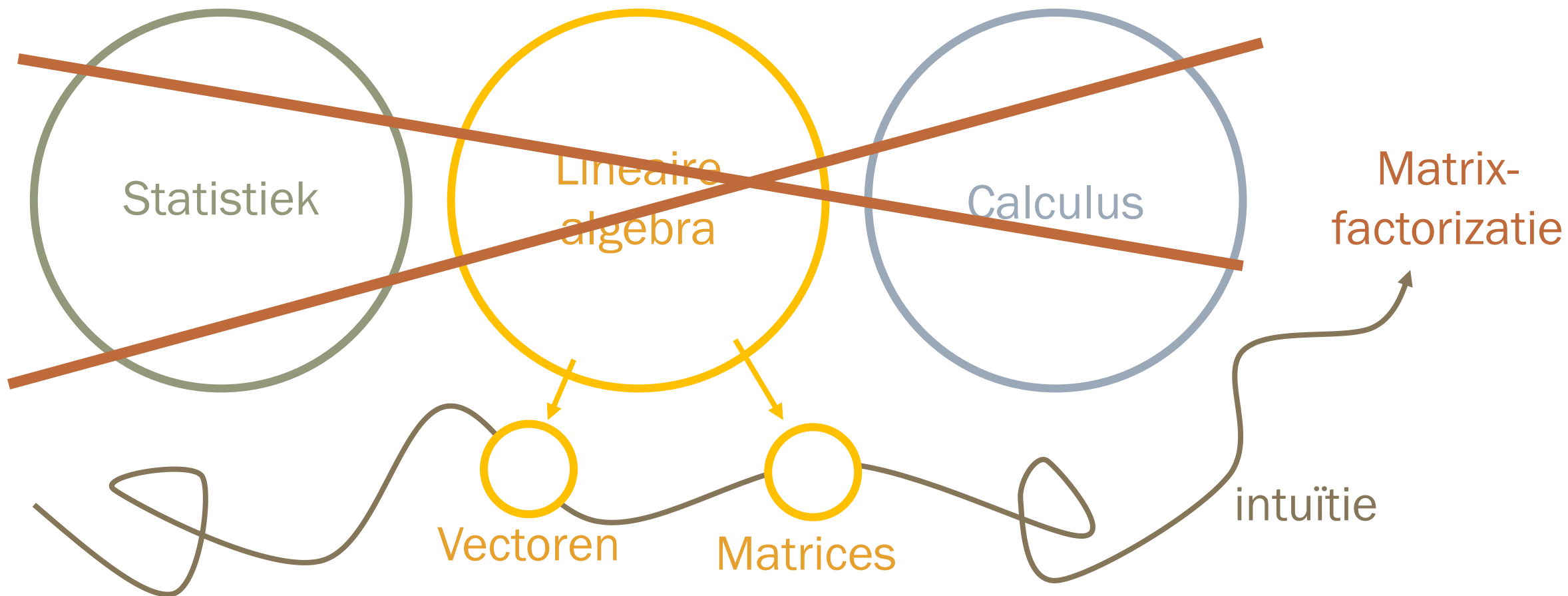




Collectieve Intelligentie

SIMON PAUW

MATRICES EN INPRODUCT



Vandaag

Module 4:

- 1 Comedy films lijken op comedy films
 - One hot encoding
 - Jaccard
- 2 Films die lijken op films die je goed vind, vind je waarschijnlijk ook goed

Module 5:

- 1 Mensen die van comedy films houden, vinden een comedy film waarschijnlijk goed

Cut out the middle man: profielen matchen

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
A.I. Artificial Intelligence	0.67	0.46	0.22
Ace Ventura: Pet Detective	0.05	0.18	0.95
Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35

	drama	thriller	comedy
userId			
6	0.71	-0.65	0.56
7	0.85	0.22	0.18
8	0.89	-0.75	0.71
10	-0.02	0.20	0.02
11	0.94	0.33	0.07
12	0.94	0.18	0.29
13	0.75	0.75	0.29
14	0.07	0.04	0.49
15	0.52	0.42	-0.13
16	0.51	0.42	-0.31

Dat kan. Met het matrix inproduct

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
A.I. Artificial Intelligence	0.67	0.46	0.22
Ace Ventura: Pet Detective	0.05	0.18	0.95
Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35

	drama	thriller	comedy
userId			
6	0.71	-0.65	0.56
7	0.85	0.22	0.18
8	0.89	-0.75	0.71
10	-0.02	0.20	0.02
11	0.94	0.33	0.07
12	0.94	0.18	0.29
13	0.75	0.75	0.29
14	0.07	0.04	0.49
15	0.52	0.42	-0.13
16	0.51	0.42	-0.31

Hoe deelnemen?



Klik op het geprojecteerd scherm om de vraag te activeren



Ga naar **wooclap.com**

Voor de code van het evenement
in de bovenste banner in

Eveneme
ntcode

CI03



[Deelnamelink kopiëren](#)

Vector inproduct

$$a = \begin{pmatrix} 2 \\ 2 \\ 3 \\ 5 \end{pmatrix} \quad b = \begin{pmatrix} 1 \\ 0 \\ 1 \\ 1 \end{pmatrix}$$

$$a \cdot b = ?$$

a.b = ?

- 1 (2, 0, 3, 5) 35% 11
- 2 12 0% 0
- 3 10 61% 19 ✓
Klik op het geprojecteerd scherm om de vraag te activeren
- 4 (2, 2, 3, 5) 0% 0
- 5 Geen van de bovenstaande antwoorden 0% 0
- 6 Wat is een vectorinproduct? 3% 1

Herhaling vector inproduct

	Meike	Lars	Rudolf
<i>Titanic</i>	0.9	0.5	0.9
<i>Luca</i>	0.7	0.8	0.7
<i>The Great Dictator</i>	1.0	0.3	0.8

$$\cos(l, d) = \frac{\sum_{i=1}^n l_i \cdot d_i}{\sqrt{\sum_{i=1}^n l_i^2} \cdot \sqrt{\sum_{i=1}^n d_i^2}}$$

$$\cos(\text{Luca}, \text{The Great Dictator}) = \frac{0.7 \cdot 1.0 + 0.8 \cdot 0.3 + 0.7 \cdot 0.8}{\sqrt{0.7 \cdot 0.7 + 0.8 \cdot 0.8 + 0.7 \cdot 0.7} \cdot \sqrt{1.0 \cdot 1.0 + 0.3 \cdot 0.3 + 0.8 \cdot 0.8}}$$


$$l = \begin{pmatrix} 0.7 \\ 0.8 \\ 0.7 \end{pmatrix}$$

$$d = \begin{pmatrix} 1.0 \\ 0.3 \\ 0.8 \end{pmatrix}$$

$$\cos(l, d) = \frac{l \cdot d}{\sqrt{l \cdot l} \cdot \sqrt{d \cdot d}}$$

Inproduct in Pandas: @

```
1 s1 = pd.Series([1, 2, 3])
2 s2 = pd.Series([100, 10, 1])
3
4 inproduct = s1 @ s2
5 print(inproduct)
```



123

Vector inproduct

$$a = \begin{pmatrix} 6 \\ 0 \\ 0 \\ 5 \end{pmatrix} \quad b = \begin{pmatrix} 2 \\ 12 \\ 18 \\ 0 \end{pmatrix}$$

$$a \cdot b = ?$$

a.b = ?

- 1 47 0% 0
- 2 (12, 0, 0, 0) 0% 0
- 3 12 0% 0
Klik op het geprojecteerd scherm om de vraag te activeren
- 4 (12, 12, 18, 5) 0% 0
- 5 Geen van de bovenstaande antwoorden 0% 0

Vector inproduct

$$a = \begin{pmatrix} 6 \\ 1 \\ 1 \\ 5 \end{pmatrix} \quad b = \begin{pmatrix} 3 \\ 2 \\ 1 \end{pmatrix}$$

$$a \cdot b = ?$$

a.b = ?

- 21 30% 9
- 8 0% 0
- Klik op het geprojecteerd scherm om de vraag te activeren 3% 1
- 10 0% 0
- Geen van de bovenstaande antwoorden 67% 20 ✓

Filmgenres als vektoren

	drama	thriller	comedy
movieName			
Babe	1	0	0
Inception	1	1	0
A.I. Artificial Intelligence	1	0	0
Ace Ventura: Pet Detective	0	0	1
Bad Boys	1	0	1
Changing Lanes	0	0	0
Dumb & Dumber	0	0	1
Event Horizon	0	1	0
Full Metal Jacket	1	1	0
I, Robot	0	1	0

Filmgenres als vektoren

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
A.I. Artificial Intelligence	0.67	0.46	0.22
Ace Ventura: Pet Detective	0.05	0.18	0.95
Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35

Filmgenres als vectoren

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
A.I. Artificial Intelligence	0.67	0.46	0.22
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Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35

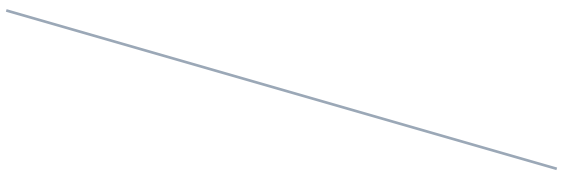
	drama	thriller	comedy
userId			
6	0.71	-0.65	0.56
7	0.85	0.22	0.18
8	0.89	-0.75	0.71
10	-0.02	0.20	0.02
11	0.94	0.33	0.07
12	0.94	0.18	0.29
13	0.75	0.75	0.29
14	0.07	0.04	0.49
15	0.52	0.42	-0.13
16	0.51	0.42	-0.31

Voorspelde ratings

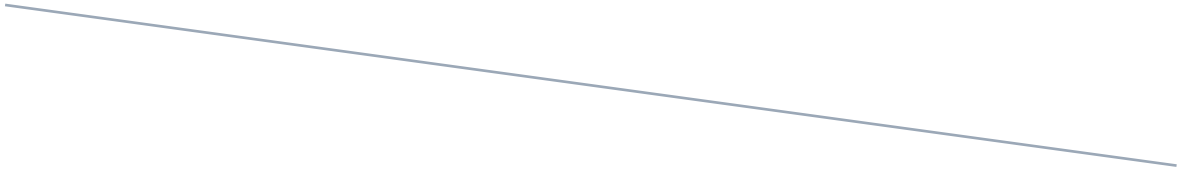
	userId	6	7	8	10	11	12	13	14	15	16
movieName											
Babe	0.62	0.75	0.80	0.04	0.80	0.86	0.84	0.27	0.42	0.34	
Inception	0.10	0.82	0.18	0.18	0.93	0.89	1.29	0.30	0.66	0.57	
A.I. Artificial Intelligence	0.30	0.71	0.41	0.08	0.80	0.78	0.91	0.17	0.51	0.47	
Ace Ventura: Pet Detective	0.45	0.25	0.58	0.05	0.17	0.35	0.45	0.48	-0.02	-0.19	
Bad Boys	0.67	0.84	0.87	0.09	0.86	0.97	1.07	0.45	0.44	0.30	
Changing Lanes	0.26	0.53	0.35	0.08	0.58	0.60	0.75	0.23	0.35	0.28	
Dumb & Dumber	0.45	0.22	0.58	0.05	0.13	0.32	0.42	0.50	-0.06	-0.24	
Event Horizon	-0.44	0.18	-0.50	0.15	0.25	0.16	0.58	0.07	0.30	0.29	
Full Metal Jacket	0.12	0.68	0.19	0.09	0.80	0.72	0.89	0.07	0.57	0.56	
I, Robot	-0.21	0.57	-0.20	0.20	0.67	0.60	1.11	0.24	0.55	0.48	

Filmgenres als vektoren

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
A.I. Artificial Intelligence	0.67	0.46	0.22
Ace Ventura: Pet Detective	0.05	0.18	0.95
Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35


$$m_{\text{inception}} = \begin{pmatrix} 0.63 \\ 0.92 \\ 0.44 \end{pmatrix}$$

Filmgenres als vektoren

$$u_{13} = \begin{pmatrix} 0.75 \\ 0.75 \\ 0.29 \end{pmatrix}$$


	drama	thriller	comedy
userId			
6	0.71	-0.65	0.56
7	0.85	0.22	0.18
8	0.89	-0.75	0.71
10	-0.02	0.20	0.02
11	0.94	0.33	0.07
12	0.94	0.18	0.29
13	0.75	0.75	0.29
14	0.07	0.04	0.49
15	0.52	0.42	-0.13
16	0.51	0.42	-0.31

Filmgenres als vektoren

drama
thriller
comedy

$$u_{13} = \begin{pmatrix} 0.75 \\ 0.75 \\ 0.29 \end{pmatrix}$$

$$m_{\text{inception}} = \begin{pmatrix} 0.63 \\ 0.92 \\ 0.44 \end{pmatrix}$$

Wie prefereert welke film?

- 1 13 ♥ Inception / 14 ♥ Inception 8% 2
- 2 13 ♥ Inception / 14 ♥ Dumb & Dumber 92% 24
Klik op het geprojecteerd scherm om de vraag te activeren
- 3 13 ♥ Dumb & Dumber / 14 ♥ Inception 0% 0
- 4 13 ♥ Dumb & Dumber / 14 ♥ Dumb & Dumber 0% 0

Wie prefereert welke film?

$$u_{13} = \begin{pmatrix} 0.75 \\ 0.75 \\ 0.29 \end{pmatrix}$$

$$u_{14} = \begin{pmatrix} 0.07 \\ 0.04 \\ 0.49 \end{pmatrix}$$

$$m_{inception} = \begin{pmatrix} 0.63 \\ 0.92 \\ 0.44 \end{pmatrix}$$

$$m_{dumb\&dumber} = \begin{pmatrix} 0.00 \\ 0.17 \\ 1.00 \end{pmatrix}$$

Vraag

Hoe kunnen we aan de hand van twee vectoren een rating voorspellen?

drama
thriller
comedy

$$u_{13} = \begin{pmatrix} 0.75 \\ 0.75 \\ 0.29 \end{pmatrix}$$

$$m_{\text{inception}} = \begin{pmatrix} 0.63 \\ 0.92 \\ 0.44 \end{pmatrix}$$

Filmgenres als vektoren

drama
thriller
comedy

$$u_{13} = \begin{pmatrix} 0.75 \\ 0.75 \\ 0.29 \end{pmatrix}$$

$$m_{\text{inception}} = \begin{pmatrix} 0.63 \\ 0.92 \\ 0.44 \end{pmatrix}$$

$$m_{\text{dumb\&dumber}} = \begin{pmatrix} 0.00 \\ 0.17 \\ 1.00 \end{pmatrix}$$

$$\text{predicted rating} = u_{13} \cdot m_{\text{inception}} = 0.75 \cdot 0.63 + 0.75 \cdot 0.92 + 0.29 \cdot 0.44 = 1.29$$

$$\text{predicted rating} = u_{13} \cdot m_{\text{dumb\&dumber}} = 0.75 \cdot 0.00 + 0.75 \cdot 0.17 + 0.29 \cdot 1.00 = 0.42$$

Filmgenres matrix inproduct

	userId	6	7	8	10	11	12	13	14	15	16
movieName											
Babe	
Inception		1.29	.....	.....	.....
A.I. Artificial Intelligence	
Ace Ventura: Pet Detective	
Bad Boys	
Changing Lanes	
Dumb & Dumber	
Event Horizon	
Full Metal Jacket	
I, Robot	

$$\text{predicted rating} = u_{13} \cdot m_{\text{inception}} = 0.75 \cdot 0.63 + 0.75 \cdot 0.92 + 0.29 \cdot 0.44 = 1.2901$$

Filmgenres matrix inproduct

	6	7	8	10	11	12	13	14	15	16
Babe
Inception	1.29	...	...	...
A.I.
Ace Ventura
Bad Boys
Changing Lanes
Dumb & Dumber
Event Horizon
Full Metal Jacket
I, Robot

$$\text{predicted rating} = u_{13} \cdot m_{\text{inception}} = 0.75 \cdot 0.63 + 0.75 \cdot 0.92 + 0.29 \cdot 0.44 = 1.29$$

Filmgenres matrix inproduct

$$\begin{pmatrix} \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots & 1.29 & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots & \dots \end{pmatrix}$$

$$\text{predicted rating} = u_{13} \cdot m_{\text{inception}} = 0.75 \cdot 0.63 + 0.75 \cdot 0.92 + 0.29 \cdot 0.44 = 1.29$$

Filmgenres matrix inproduct

	6	7	8	10	11	12	13	14	15	16
Babe
Inception	1.29	...	...	...
A.I.
Ace Ventura
Bad Boys
Changing Lanes
Dumb & Dumber
Event Horizon
Full Metal Jacket
I, Robot

$$\text{predicted rating} = u_{13} \cdot m_{\text{inception}} = 0.75 \cdot 0.63 + 0.75 \cdot 0.92 + 0.29 \cdot 0.44 = 1.29$$

Filmgenres matrix inproduct

	6	7	8	10	11	12	13	14	15	16
Babe
Inception	$u_{13} \cdot m_{in}$	...	...	...
A.I.
Ace Ventura
Bad Boys
Changing Lanes
Dumb & Dumber
Event Horizon
Full Metal Jacket
I, Robot

$$\text{predicted rating} = u_{13} \cdot m_{inception} = 0.75 \cdot 0.63 + 0.75 \cdot 0.92 + 0.29 \cdot 0.44 = 1.29$$

Filmgenres als vektoren

drama thriller comedy				drama thriller comedy			
movieName				userId			
Babe	0.74	0.22	0.43	$m_{ba} = \begin{pmatrix} 0.74 \\ 0.22 \\ 0.43 \end{pmatrix}$	$u_6 = \begin{pmatrix} 0.71 \\ -0.6 \\ 0.56 \end{pmatrix}$	6	0.71 -0.65 0.56
Inception	0.63	0.92	0.44	$m_{in} = \begin{pmatrix} 0.63 \\ 0.92 \\ 0.44 \end{pmatrix}$	$u_7 = \begin{pmatrix} 0.85 \\ 0.22 \\ 0.18 \end{pmatrix}$	7	0.85 0.22 0.18
A.I. Artificial Intelligence	0.67	0.46	0.22			8	0.89 -0.75 0.71
Ace Ventura: Pet Detective	0.05	0.18	0.95			10	-0.02 0.20 0.02
Bad Boys	0.71	0.42	0.78			11	0.94 0.33 0.07
Changing Lanes	0.44	0.41	0.38			12	0.94 0.18 0.29
Dumb & Dumber	0.00	0.17	1.00			13	0.75 0.75 0.29
Event Horizon	0.00	0.74	0.08			14	0.07 0.04 0.49
Full Metal Jacket	0.66	0.53	0.00			15	0.52 0.42 -0.13
I, Robot	0.34	1.00	0.35	$m_{ir} = \begin{pmatrix} 0.34 \\ 1.00 \\ 0.35 \end{pmatrix}$	$u_{16} = \begin{pmatrix} 0.51 \\ 0.42 \\ -0.3 \end{pmatrix}$	16	0.51 0.42 -0.31

Filmgenres matrix inproduct

$$m_{ba} = \begin{pmatrix} 0.74 \\ 0.22 \\ 0.43 \end{pmatrix}$$

$$u_6 = \begin{pmatrix} 0.71 \\ -0.6 \\ 0.56 \end{pmatrix}$$

$$m_{in} = \begin{pmatrix} 0.63 \\ 0.92 \\ 0.44 \end{pmatrix}$$

$$u_7 = \begin{pmatrix} 0.85 \\ 0.22 \\ 0.18 \end{pmatrix}$$

$$m_{ir} = \begin{pmatrix} 0.34 \\ 1.00 \\ 0.35 \end{pmatrix}$$

$$u_{16} = \begin{pmatrix} 0.51 \\ 0.42 \\ -0.3 \end{pmatrix}$$

	6	7	...	16
Babe	$u_6 \cdot m_{ba}$	$u_7 \cdot m_{ba}$	\cdots	$u_{16} \cdot m_{ba}$
Inception	$u_6 \cdot m_{in}$	$u_7 \cdot m_{in}$	\cdots	$u_{16} \cdot m_{in}$
...	\vdots	\vdots	\ddots	\vdots
I, Robot	$u_6 \cdot m_{ir}$	$u_7 \cdot m_{ir}$	\cdots	$u_{16} \cdot m_{ir}$

$$u_6 \cdot m_{ba} = 0.71 \cdot 0.74 + -0.6 \cdot 0.22 + 0.56 \cdot 0.43 = 0.62$$

Filmgenres matrix inproduct

	6	7	8	10	11	12	13	14	15	16
Babe	0.62	0.75	0.80	0.04	0.80	0.86	0.84	0.27	0.42	0.34
Inception	0.10	0.82	0.18	0.18	0.93	0.89	1.29	0.30	0.66	0.57
A.I.	0.30	0.71	0.41	0.08	0.80	0.78	0.91	0.17	0.51	0.47
Ace Ventura	0.45	0.25	0.58	0.05	0.17	0.35	0.45	0.48	0.00	-0.2
Bad Boys	0.67	0.84	0.87	0.09	0.86	0.97	1.07	0.45	0.44	0.30
Changing Lanes	0.26	0.53	0.35	0.08	0.58	0.60	0.75	0.23	0.35	0.28
Dumb & Dumber	0.45	0.22	0.58	0.05	0.13	0.32	0.42	0.50	-0.1	-0.2
Event Horizon	-0.4	0.18	-0.5	0.15	0.25	0.16	0.58	0.07	0.30	0.29
Full Metal Jacket	0.12	0.68	0.19	0.09	0.80	0.72	0.89	0.07	0.57	0.56
I, Robot	-0.2	0.57	-0.2	0.20	0.67	0.60	1.11	0.24	0.55	0.48

$$u_{13} \cdot m_{\text{in}} = 0.75 \cdot 0.63 + 0.75 \cdot 0.92 + 0.29 \cdot 0.44 = 1.29$$

Filmgenres als vectoren

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
A.I. Artificial Intelligence	0.67	0.46	0.22
Ace Ventura: Pet Detective	0.05	0.18	0.95
Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35

	drama	thriller	comedy
userId			
6	0.71	-0.65	0.56
7	0.85	0.22	0.18
8	0.89	-0.75	0.71
10	-0.02	0.20	0.02
11	0.94	0.33	0.07
12	0.94	0.18	0.29
13	0.75	0.75	0.29
14	0.07	0.04	0.49
15	0.52	0.42	-0.13
16	0.51	0.42	-0.31

Filmgenres matrix inproduct

	userId	6	7	8	10	11	12	13	14	15	16
movieName											
Babe		0.62	0.75	0.80	0.04	0.80	0.86	0.84	0.27	0.42	0.34
Inception		0.10	0.82	0.18	0.18	0.93	0.89	1.29	0.30	0.66	0.57
A.I. Artificial Intelligence		0.30	0.71	0.41	0.08	0.80	0.78	0.91	0.17	0.51	0.47
Ace Ventura: Pet Detective		0.45	0.25	0.58	0.05	0.17	0.35	0.45	0.48	-0.02	-0.19
Bad Boys		0.67	0.84	0.87	0.09	0.86	0.97	1.07	0.45	0.44	0.30
Changing Lanes		0.26	0.53	0.35	0.08	0.58	0.60	0.75	0.23	0.35	0.28
Dumb & Dumber		0.45	0.22	0.58	0.05	0.13	0.32	0.42	0.50	-0.06	-0.24
Event Horizon		-0.44	0.18	-0.50	0.15	0.25	0.16	0.58	0.07	0.30	0.29
Full Metal Jacket		0.12	0.68	0.19	0.09	0.80	0.72	0.89	0.07	0.57	0.56
I, Robot		-0.21	0.57	-0.20	0.20	0.67	0.60	1.11	0.24	0.55	0.48

$$\text{predicted rating} = u_{13} \cdot m_{\text{in}} = 0.75 \cdot 0.63 + 0.75 \cdot 0.92 + 0.29 \cdot 0.44 = 1.2901$$

Filmgenres als vektoren

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
A.I. Artificial Intelligence	0.67	0.46	0.22
Ace Ventura: Pet Detective	0.05	0.18	0.95
Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35

userId	6	7	8	10	11	12	13	14	15	16
drama	0.71	0.85	0.89	-0.02	0.94	0.94	0.75	0.07	0.52	0.51
thriller	-0.65	0.22	-0.75	0.20	0.33	0.18	0.75	0.04	0.42	0.42
comedy	0.56	0.18	0.71	0.02	0.07	0.29	0.29	0.49	-0.13	-0.31

userId	6	7	8	10	11	12	13	14	15	16
drama	0.71	0.85	0.89	-0.02	0.94	0.94	0.75	0.07	0.52	0.51
thriller	-0.65	0.22	-0.75	0.20	0.33	0.18	0.75	0.04	0.42	0.42
comedy	0.56	0.18	0.71	0.02	0.07	0.29	0.29	0.49	-0.13	-0.31

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
A.I. Artificial Intelligence	0.67	0.46	0.22
Ace Ventura: Pet Detective	0.05	0.18	0.95
Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35

userId	6	7	8	10	11	12	13	14	15	16
movieName										
Babe	0.62	0.75	0.80	0.04	0.80	0.86	0.84	0.27	0.42	0.34
Inception	0.10	0.82	0.18	0.18	0.93	0.89	1.29	0.30	0.66	0.57
A.I. Artificial Intelligence	0.30	0.71	0.41	0.08	0.80	0.78	0.91	0.17	0.51	0.47
Ace Ventura: Pet Detective	0.45	0.25	0.58	0.05	0.17	0.35	0.45	0.48	-0.02	-0.19
Bad Boys	0.67	0.84	0.87	0.09	0.86	0.97	1.07	0.45	0.44	0.30
Changing Lanes	0.26	0.53	0.35	0.08	0.58	0.60	0.75	0.23	0.35	0.28
Dumb & Dumber	0.45	0.22	0.58	0.05	0.13	0.32	0.42	0.50	-0.06	-0.24
Event Horizon	-0.44	0.18	-0.50	0.15	0.25	0.16	0.58	0.07	0.30	0.29
Full Metal Jacket	0.12	0.68	0.19	0.09	0.80	0.72	0.89	0.07	0.57	0.56
I, Robot	-0.21	0.57	-0.20	0.20	0.67	0.60	1.11	0.24	0.55	0.48

userId	6	7	8	10	11	12	13	14	15	16
drama	0.71	0.85	0.89	-0.02	0.94	0.94	0.75	0.07	0.52	0.51
thriller	-0.65	0.22	-0.75	0.20	0.33	0.18	0.75	0.04	0.42	0.42
comedy	0.56	0.18	0.71	0.02	0.07	0.29	0.29	0.49	-0.13	-0.31

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
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Ace Ventura: Pet Detective	0.05	0.18	0.95
Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35

	userId	6	7	8	10	11	12	13	14	15	16
movieName											
	Babe	0.62	0.75	0.80	0.04	0.80	0.86	0.84	0.27	0.42	0.34
	Inception	0.10	0.82	0.18	0.18	0.93	0.89	1.29	0.30	0.66	0.57
	A.I. Artificial Intelligence	0.30	0.71	0.41	0.08	0.80	0.78	0.91	0.17	0.51	0.47
	Ace Ventura: Pet Detective	0.45	0.25	0.58	0.05	0.17	0.35	0.45	0.48	-0.02	-0.19
	Bad Boys	0.67	0.84	0.87	0.09	0.86	0.97	1.07	0.45	0.44	0.30
	Changing Lanes	0.26	0.53	0.35	0.08	0.58	0.60	0.75	0.23	0.35	0.28
	Dumb & Dumber	0.45	0.22	0.58	0.05	0.13	0.32	0.42	0.50	-0.06	-0.24
	Event Horizon	-0.44	0.18	-0.50	0.15	0.25	0.16	0.58	0.07	0.30	0.29
	Full Metal Jacket	0.12	0.68	0.19	0.09	0.80	0.72	0.89	0.07	0.57	0.56
	I, Robot	-0.21	0.57	-0.20	0.20	0.67	0.60	1.11	0.24	0.55	0.48

$$u_8 \cdot m_{ir} = 0.89 \cdot 0.34 + -0.75 \cdot 1.00 + 0.71 \cdot 0.35 = -0.20$$

		6	7	8	10	11	12	13	14	15	16
		$\begin{pmatrix} 0.71 & 0.85 & 0.89 \\ -0.6 & 0.22 & -0.7 \\ 0.56 & 0.18 & 0.71 \end{pmatrix}$									
Babe	$\begin{pmatrix} 0.74 & 0.22 & 0.43 \\ 0.63 & 0.92 & 0.44 \\ 0.67 & 0.46 & 0.22 \end{pmatrix}$	$\begin{pmatrix} 0.62 & 0.75 & 0.80 & 0.04 & 0.80 & 0.86 & 0.84 & 0.27 & 0.42 & 0.34 \\ 0.10 & 0.82 & 0.18 & 0.18 & 0.93 & 0.89 & 1.29 & 0.30 & 0.66 & 0.57 \\ 0.30 & 0.71 & 0.41 & 0.08 & 0.80 & 0.78 & 0.91 & 0.17 & 0.51 & 0.47 \\ 0.45 & 0.25 & 0.58 & 0.05 & 0.17 & 0.35 & 0.45 & 0.48 & 0.00 & -0.2 \\ 0.67 & 0.84 & 0.87 & 0.09 & 0.86 & 0.97 & 1.07 & 0.45 & 0.44 & 0.30 \\ 0.26 & 0.53 & 0.35 & 0.08 & 0.58 & 0.60 & 0.75 & 0.23 & 0.35 & 0.28 \\ 0.45 & 0.22 & 0.58 & 0.05 & 0.13 & 0.32 & 0.42 & 0.50 & -0.1 & -0.2 \\ -0.4 & 0.18 & -0.5 & 0.15 & 0.25 & 0.16 & 0.58 & 0.07 & 0.30 & 0.29 \\ 0.12 & 0.68 & 0.19 & 0.09 & 0.80 & 0.72 & 0.89 & 0.07 & 0.57 & 0.56 \\ -0.2 & 0.57 & -0.2 & 0.20 & 0.67 & 0.60 & 1.11 & 0.24 & 0.55 & 0.48 \end{pmatrix}$									
Inception											
A.I.											
Ace Ventura											
Bad Boys											
Changing Lanes											
Dumb & Dumber											
Event Horizon											
Full Metal Jacket											
I, Robot	$\begin{pmatrix} 0.66 & 0.53 & 0.00 \\ 0.34 & 1.00 & 0.35 \end{pmatrix}$										

$$u_8 \cdot m_{ir} = 0.89 \cdot 0.34 + -0.75 \cdot 1.00 + 0.71 \cdot 0.35 = -0.20$$



(i) Wat komt er op de plek van het vraagteken te staan?

Klik op het geprojecteerd scherm om de vraag te activeren

		1	2	3
drama		0.5	0.0	0.0
thriller		0.5	1.0	1.0
comedy		0.0	0.0	1.0
Film 1	$\begin{pmatrix} 1.0 & 0.0 & 0.0 \end{pmatrix}$	0.5	0.0	0.0
Film 2	$\begin{pmatrix} 0.5 & 0.5 & 0.0 \end{pmatrix}$	0.5	?	0.5
Film 3	$\begin{pmatrix} 0.0 & 0.0 & 1.0 \end{pmatrix}$	0.0	0.0	1.0



(ii) Wat komt er op de plek van het vraagteken te staan?



Tijd om te stemmen!

Klik op het geprojecteerd scherm om de vraag te activeren

0

antwoorden gekregen



		1	2	3
	drama	$\begin{pmatrix} 0.5 \\ 0.0 \end{pmatrix}$	$\begin{pmatrix} 0.5 \\ 0.5 \end{pmatrix}$	$\begin{pmatrix} 0.0 \\ 1.0 \end{pmatrix}$
	sci-fi	$\begin{pmatrix} 0.5 \\ 0.0 \end{pmatrix}$	$\begin{pmatrix} 0.0 \\ 0.0 \end{pmatrix}$	$\begin{pmatrix} 0.0 \\ 0.0 \end{pmatrix}$
Film 1	$\begin{pmatrix} 1.0 & 0.0 \\ 0.5 & 1.0 \end{pmatrix}$	$\begin{pmatrix} 0.5 \\ 0.5 \end{pmatrix}$	$\begin{pmatrix} 0.0 \\ ? \end{pmatrix}$	$\begin{pmatrix} 0.0 \\ 0.5 \end{pmatrix}$
Film 2	$\begin{pmatrix} 0.5 & 1.0 \\ 0.0 & 1.0 \end{pmatrix}$	$\begin{pmatrix} 0.5 \\ 0.0 \end{pmatrix}$	$\begin{pmatrix} 0.0 \\ 0.0 \end{pmatrix}$	$\begin{pmatrix} 0.0 \\ 1.0 \end{pmatrix}$
Film 3	$\begin{pmatrix} 1.0 & 0.0 \\ 0.5 & 1.0 \end{pmatrix}$	$\begin{pmatrix} 0.5 \\ 0.5 \end{pmatrix}$	$\begin{pmatrix} 0.0 \\ 0.0 \end{pmatrix}$	$\begin{pmatrix} 0.0 \\ 1.0 \end{pmatrix}$

			6	7	8	10	11	12	13	14	15	16		
			U^T											
			0.71	0.85	0.89	0.00	0.94	0.94	0.75	0.07	0.52	0.51		
			-0.6	0.22	-0.7	0.2	0.33	0.18	0.75	0.04	0.42	0.42		
			0.56	0.18	0.71	0.02	0.07	0.29	0.29	0.49	-0.1	-0.3		
			\hat{R}											
Babe	M	0.74	0.22	0.43	0.62	0.75	0.80	0.04	0.80	0.86	0.84	0.27	0.42	0.34
Inception		0.63	0.92	0.44	0.10	0.82	0.18	0.18	0.93	0.89	1.29	0.30	0.66	0.57
A.I.		0.67	0.46	0.22	0.30	0.71	0.41	0.08	0.80	0.78	0.91	0.17	0.51	0.47
Ace Ventura		0.05	0.18	0.95	0.45	0.25	0.58	0.05	0.17	0.35	0.45	0.48	0.00	-0.2
Bad Boys		0.71	0.42	0.78	0.67	0.84	0.87	0.09	0.86	0.97	1.07	0.45	0.44	0.30
Changing Lanes		0.44	0.41	0.38	0.26	0.53	0.35	0.08	0.58	0.60	0.75	0.23	0.35	0.28
Dumb & Dumber		0.00	0.17	1.00	0.45	0.22	0.58	0.05	0.13	0.32	0.42	0.50	-0.1	-0.2
Event Horizon		0.00	0.74	0.08	-0.4	0.18	-0.5	0.15	0.25	0.16	0.58	0.07	0.30	0.29
Full Metal Jacket		0.66	0.53	0.00	0.12	0.68	0.19	0.09	0.80	0.72	0.89	0.07	0.57	0.56
I, Robot		0.34	1.00	0.35	-0.2	0.57	-0.2	0.20	0.67	0.60	1.11	0.24	0.55	0.48

$$M \cdot U^T = \hat{R}$$

userId	6	7	8	10	11	12	13	14	15	16
drama	0.71	0.85	0.89	-0.02	0.94	0.94	0.75	0.07	0.52	0.51
thriller	-0.65	0.22	-0.75	0.20	0.33	0.18	0.75	0.04	0.42	0.42
comedy	0.56	0.18	0.71	0.02	0.07	0.29	0.29	0.49	-0.13	-0.31

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
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Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35

	userId	6	7	8	10	11	12	13	14	15	16
movieName											
	Babe	0.62	0.75	0.80	0.04	0.80	0.86	0.84	0.27	0.42	0.34
	Inception	0.10	0.82	0.18	0.18	0.93	0.89	1.29	0.30	0.66	0.57
	A.I. Artificial Intelligence	0.30	0.71	0.41	0.08	0.80	0.78	0.91	0.17	0.51	0.47
	Ace Ventura: Pet Detective	0.45	0.25	0.58	0.05	0.17	0.35	0.45	0.48	-0.02	-0.19
	Bad Boys	0.67	0.84	0.87	0.09	0.86	0.97	1.07	0.45	0.44	0.30
	Changing Lanes	0.26	0.53	0.35	0.08	0.58	0.60	0.75	0.23	0.35	0.28
	Dumb & Dumber	0.45	0.22	0.58	0.05	0.13	0.32	0.42	0.50	-0.06	-0.24
	Event Horizon	-0.44	0.18	-0.50	0.15	0.25	0.16	0.58	0.07	0.30	0.29
	Full Metal Jacket	0.12	0.68	0.19	0.09	0.80	0.72	0.89	0.07	0.57	0.56
	I, Robot	-0.21	0.57	-0.20	0.20	0.67	0.60	1.11	0.24	0.55	0.48

```

1 user_matrix_transposed = user_matrix.T
2 predicted_ratings = movie_matrix @ user_matrix_transposed

```

$$B \begin{pmatrix} | & | & \cdots & | \\ b_1 & b_2 & & b_n \\ | & | & & | \end{pmatrix}$$

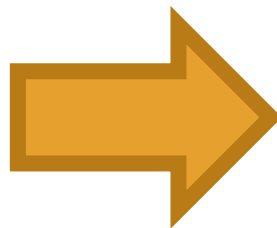
$$A \begin{pmatrix} - & a_1 & - \\ - & a_2 & - \\ & \vdots & \\ - & a_n & - \end{pmatrix} \quad C \begin{pmatrix} a_1 \cdot b_1 & a_1 \cdot b_2 & \cdots & a_1 \cdot b_n \\ a_2 \cdot b_1 & a_2 \cdot b_2 & \cdots & a_2 \cdot b_n \\ \vdots & \vdots & \ddots & \vdots \\ a_n \cdot b_1 & a_n \cdot b_2 & \cdots & a_n \cdot b_n \end{pmatrix}$$

$$A \cdot B = C$$

$$A = \begin{pmatrix} 1.0 & 0.0 \\ 0.5 & 1.0 \\ 0.0 & 1.0 \end{pmatrix}$$

$$B = \begin{pmatrix} 0.5 & 1.0 & 0.0 \\ 0.0 & 0.5 & 1.0 \end{pmatrix}$$

$$A \cdot B = C$$



$$\begin{pmatrix} 0.5 & 1.0 & 0.0 \\ 0.0 & 0.5 & 1.0 \end{pmatrix}$$

$$\begin{pmatrix} 1.0 & 0.0 \\ 0.5 & 1.0 \\ 0.0 & 1.0 \end{pmatrix} \begin{pmatrix} ? & ? & ? \\ ? & ? & ? \\ ? & ? & ? \end{pmatrix}$$



(iii) Wat komt er op de plek van het vraagteken te staan?

$$A = \begin{pmatrix} 1.0 & 0.0 \\ 0.5 & 1.0 \\ 0.0 & 1.0 \end{pmatrix}$$

$$B = \begin{pmatrix} 0.5 & 1.0 & 0.0 \\ 0.0 & 0.5 & 1.0 \end{pmatrix}$$

$$A \cdot B = C$$

$$C = \begin{pmatrix} 0.5 & 0.0 & 0.0 \\ 0.5 & ? & 0.5 \\ 0.0 & 0.0 & 1.0 \end{pmatrix}$$



Klik op het geprojecteerd scherm om de vraag te activeren

1

1.0

1

69

1.0

1

1.0

1.0

1

1

1

1

1

1.0

1

1.0

1.0

1

1

1.0

1.0

1



$$A = \begin{pmatrix} 1.0 & 0.0 \\ 0.5 & 1.0 \\ 0.0 & 1.0 \end{pmatrix}$$

$$B = \begin{pmatrix} 0.5 & 1.0 & 0.6 & 0.2 & 0.0 \\ 0.0 & 0.5 & 0.4 & 0.9 & 1.0 \end{pmatrix}$$

$$A \cdot B = C$$

$$C = \begin{pmatrix} 0.5 & 0.0 & 0.6 & 0.2 & 0.0 \\ 0.5 & 1.0 & 0.7 & 1.0 & 0.5 \\ 0.0 & 0.0 & ? & 0.9 & 1.0 \end{pmatrix}$$

$$A = \begin{pmatrix} 1.0 & 0.0 \\ 0.5 & 1.0 \\ 0.0 & 1.0 \end{pmatrix}$$

$$B = \begin{pmatrix} 0.5 & 1.0 & 0.0 \\ 0.0 & 0.4 & 1.0 \end{pmatrix}$$

$$B \cdot A = C$$

$$C = \begin{pmatrix} 1.0 & 1.0 \\ 0.2 & ? \end{pmatrix}$$

Dimensions

$$A \cdot B = C$$

$$\begin{matrix} & & & & & & B \\ & & & & & & \begin{pmatrix} 0.5 & 1.0 & 0.6 & 0.2 & 0.0 \\ 0.0 & 0.5 & 0.4 & 0.9 & 1.0 \end{pmatrix} \\ & & & & & & \underbrace{\hspace{10em}} \\ & & & & & & b \\ & & & & & & \\ A & \begin{pmatrix} 1.0 & 0.0 \\ 0.5 & 1.0 \\ 0.0 & 1.0 \end{pmatrix} & \underbrace{\hspace{1em}}_h & \underbrace{\begin{pmatrix} 0.5 & 0.0 & 0.6 & 0.2 & 0.0 \\ 0.5 & 1.0 & 0.7 & 1.0 & 0.5 \\ 0.0 & 0.0 & ? & 0.9 & 1.0 \end{pmatrix}}_C \end{matrix}$$

Hoeveel kolommen en rijen heeft C?

$$A = \begin{pmatrix} 1.0 & 0.0 \\ 0.3 & 0.1 \\ 0.1 & 0.2 \\ 1.0 & 0.7 \\ 0.5 & 1.0 \\ 0.0 & 1.0 \end{pmatrix}$$

$$B = \begin{pmatrix} 0.5 & 1.0 & 0.6 & 0.2 & 0.0 \\ 0.0 & 0.5 & 0.4 & 0.9 & 1.0 \end{pmatrix}$$

$$A \cdot B = C$$

Hoeveel kolommen en rijen
heeft C?

$$A = \begin{pmatrix} 0.5 & 1.0 & 0.6 & 0.2 & 0.0 \\ 0.0 & 0.5 & 0.4 & 0.9 & 1.0 \end{pmatrix}$$

$$B = \begin{pmatrix} 1.0 & 0.0 \\ 0.3 & 0.1 \\ 1.0 & 0.7 \\ 0.5 & 1.0 \\ 0.0 & 1.0 \end{pmatrix}$$

$$A \cdot B = C$$

Hoeveel kolommen en rijen
heeft C?

$$A = \begin{pmatrix} 1.0 & 0.0 \\ 0.3 & 0.1 \\ 0.1 & 0.2 \\ 1.0 & 0.7 \\ 0.5 & 1.0 \\ 0.0 & 1.0 \end{pmatrix}$$

$$B = \begin{pmatrix} 0.5 & 1.0 & 0.6 & 0.2 & 0.0 \\ 0.2 & 0.4 & 0.6 & 0.1 & 0.7 \\ 0.0 & 0.5 & 0.4 & 0.9 & 1.0 \end{pmatrix}$$

$$A \cdot B = C$$

Dimensions

$$A \cdot B = C$$

The diagram illustrates the matrix multiplication $A \cdot B = C$ with dimensions. Matrix A is a 3x2 matrix with dimensions h (rows) and b (columns). Matrix B is a 2x5 matrix with dimensions b (rows) and 5 (columns). The resulting matrix C is a 3x5 matrix with dimensions h (rows) and 5 (columns). The dimensions h and b are indicated by blue brackets and labels. The dimensions b and 5 are indicated by blue brackets and labels. The dimensions h and 5 are indicated by blue brackets and labels.

$$\begin{matrix} A & & B \\ \begin{bmatrix} 1.0 & 0.0 \\ 0.5 & 1.0 \\ 0.0 & 1.0 \end{bmatrix} & \begin{matrix} \text{=} \end{matrix} & \begin{bmatrix} 0.5 & 1.0 & 0.6 & 0.2 & 0.0 \\ 0.0 & 0.5 & 0.4 & 0.9 & 1.0 \end{bmatrix} \\ h & & b \end{matrix}$$
$$C \begin{bmatrix} 0.5 & 0.0 & 0.6 & 0.2 & 0.0 \\ 0.5 & 1.0 & 0.7 & 1.0 & 0.5 \\ 0.0 & 0.0 & ? & 0.9 & 1.0 \end{bmatrix}$$

Wat heb je geleerd

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
A.I. Artificial Intelligence	0.67	0.46	0.22
Ace Ventura: Pet Detective	0.05	0.18	0.95
Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35

	drama	thriller	comedy
userId			
6	0.71	-0.65	0.56
7	0.85	0.22	0.18
8	0.89	-0.75	0.71
10	-0.02	0.20	0.02
11	0.94	0.33	0.07
12	0.94	0.18	0.29
13	0.75	0.75	0.29
14	0.07	0.04	0.49
15	0.52	0.42	-0.13
16	0.51	0.42	-0.31

User matrix op z'n kant

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
A.I. Artificial Intelligence	0.67	0.46	0.22
Ace Ventura: Pet Detective	0.05	0.18	0.95
Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35

userId	6	7	8	10	11	12	13	14	15	16
drama	0.71	0.85	0.89	-0.02	0.94	0.94	0.75	0.07	0.52	0.51
thriller	-0.65	0.22	-0.75	0.20	0.33	0.18	0.75	0.04	0.42	0.42
comedy	0.56	0.18	0.71	0.02	0.07	0.29	0.29	0.49	-0.13	-0.31

userId	6	7	8	10	11	12	13	14	15	16
drama	0.71	0.85	0.89	-0.02	0.94	0.94	0.75	0.07	0.52	0.51
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comedy	0.56	0.18	0.71	0.02	0.07	0.29	0.29	0.49	-0.13	-0.31

	drama	thriller	comedy
movieName			
Babe	0.74	0.22	0.43
Inception	0.63	0.92	0.44
A.I. Artificial Intelligence	0.67	0.46	0.22
Ace Ventura: Pet Detective	0.05	0.18	0.95
Bad Boys	0.71	0.42	0.78
Changing Lanes	0.44	0.41	0.38
Dumb & Dumber	0.00	0.17	1.00
Event Horizon	0.00	0.74	0.08
Full Metal Jacket	0.66	0.53	0.00
I, Robot	0.34	1.00	0.35

	userId	6	7	8	10	11	12	13	14	15	16
movieName											
Babe	0.62	0.75	0.80	0.04	0.80	0.86	0.84	0.27	0.42	0.34	
Inception	0.10	0.82	0.18	0.18	0.93	0.89	1.29	0.30	0.66	0.57	
A.I. Artificial Intelligence	0.30	0.71	0.41	0.08	0.80	0.78	0.91	0.17	0.51	0.47	
Ace Ventura: Pet Detective	0.45	0.25	0.58	0.05	0.17	0.35	0.45	0.48	-0.02	-0.19	
Bad Boys	0.67	0.84	0.87	0.09	0.86	0.97	1.07	0.45	0.44	0.30	
Changing Lanes	0.26	0.53	0.35	0.08	0.58	0.60	0.75	0.23	0.35	0.28	
Dumb & Dumber	0.45	0.22	0.58	0.05	0.13	0.32	0.42	0.50	-0.06	-0.24	
Event Horizon	-0.44	0.18	-0.50	0.15	0.25	0.16	0.58	0.07	0.30	0.29	
Full Metal Jacket	0.12	0.68	0.19	0.09	0.80	0.72	0.89	0.07	0.57	0.56	
I, Robot	-0.21	0.57	-0.20	0.20	0.67	0.60	1.11	0.24	0.55	0.48	

```

1 user_matrix_transposed = user_matrix.T
2 predicted_ratings = movie_matrix @ user_matrix_transposed

```

Vragen?

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