Een Uitbreiding op Adaptieve Tensor-decomposities bij het Clusteren van Tijdreeksen

Wetenschappelijke vorming

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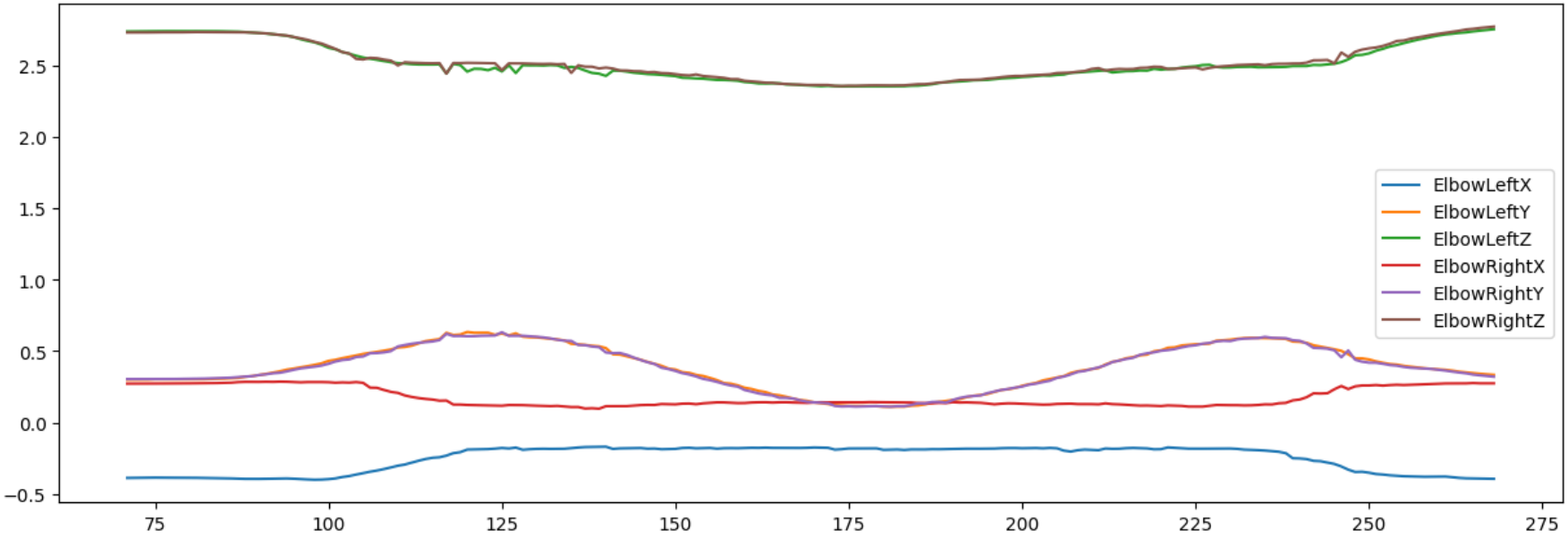
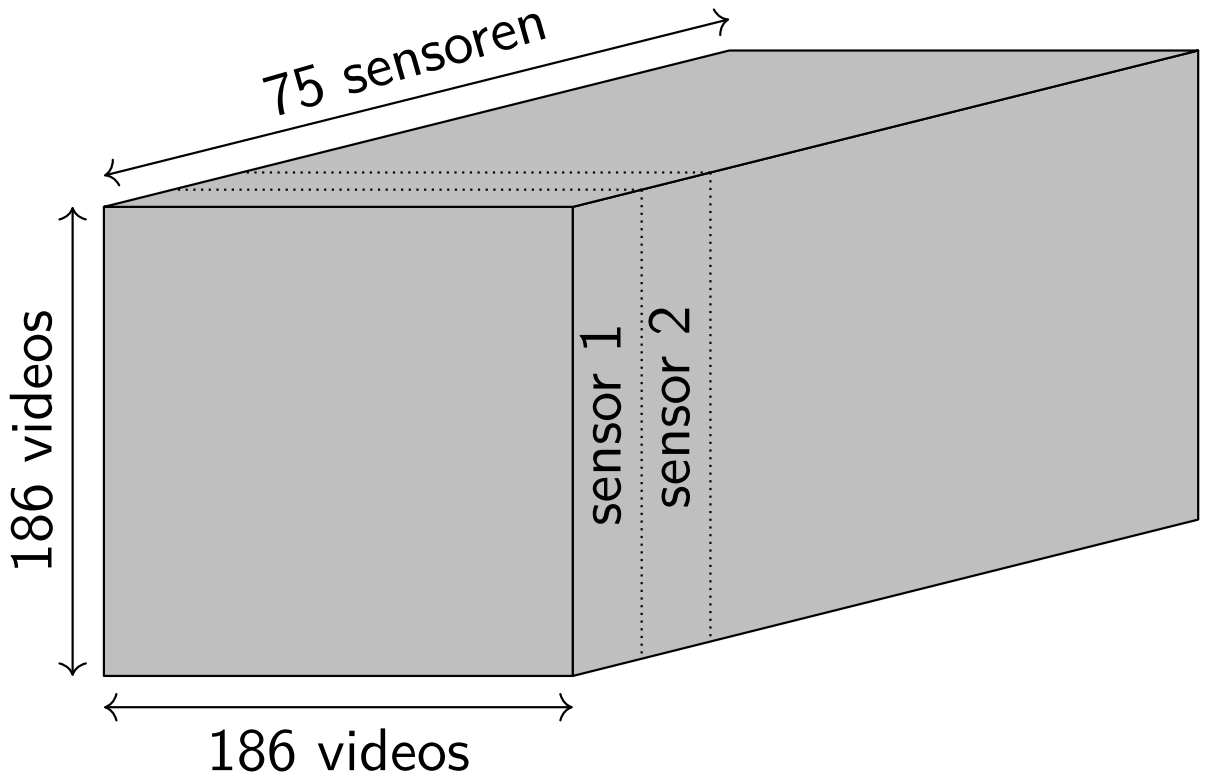
Tijdsreeksen clusteren



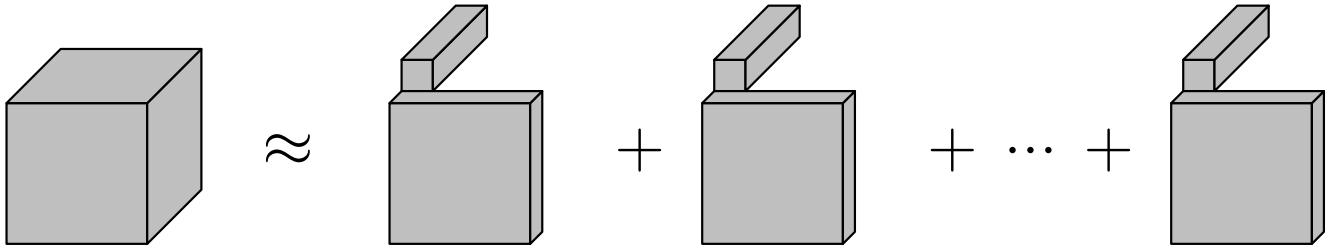
- AMIE dataset
- Dynamic Time Warping: DTW-afstand

De afstandstensor

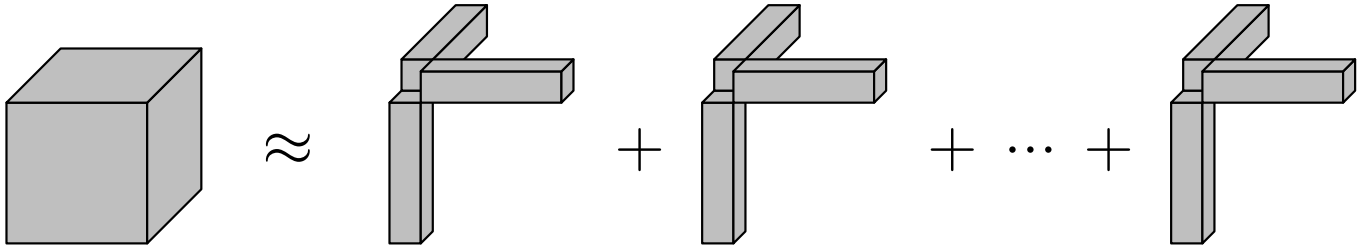


Voorgaande methodes

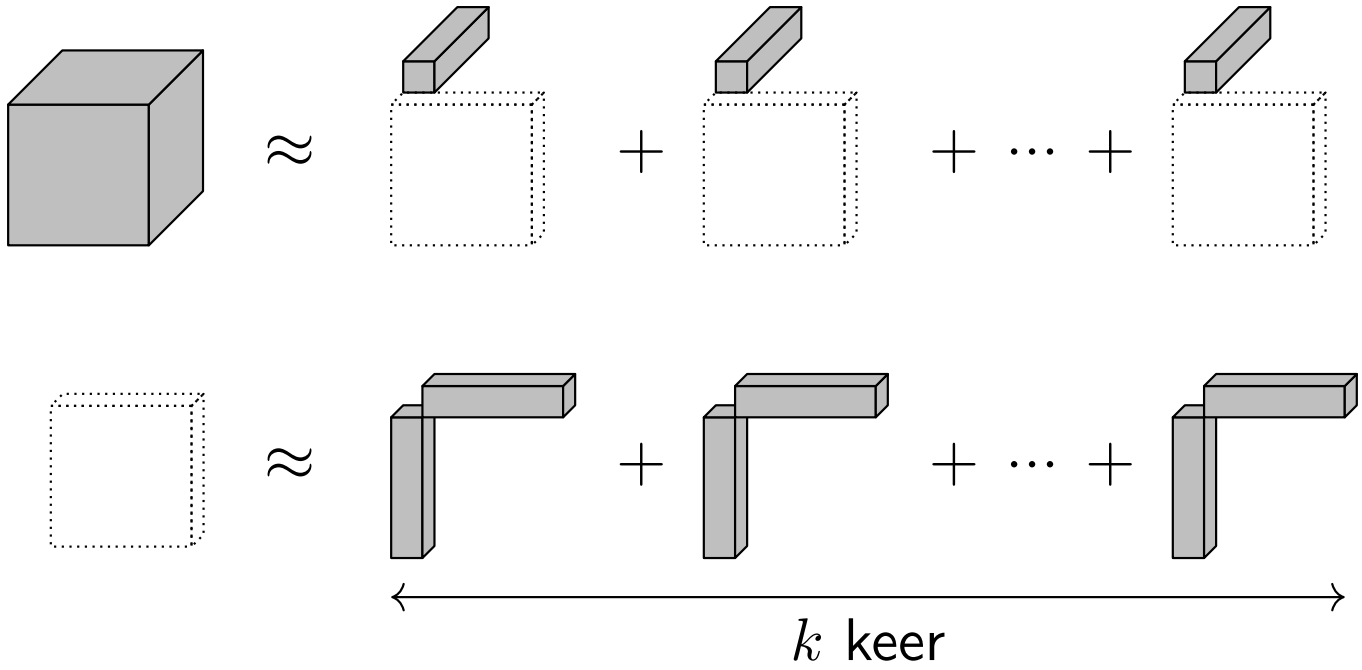
De matrix methode: Matrix ACA-T

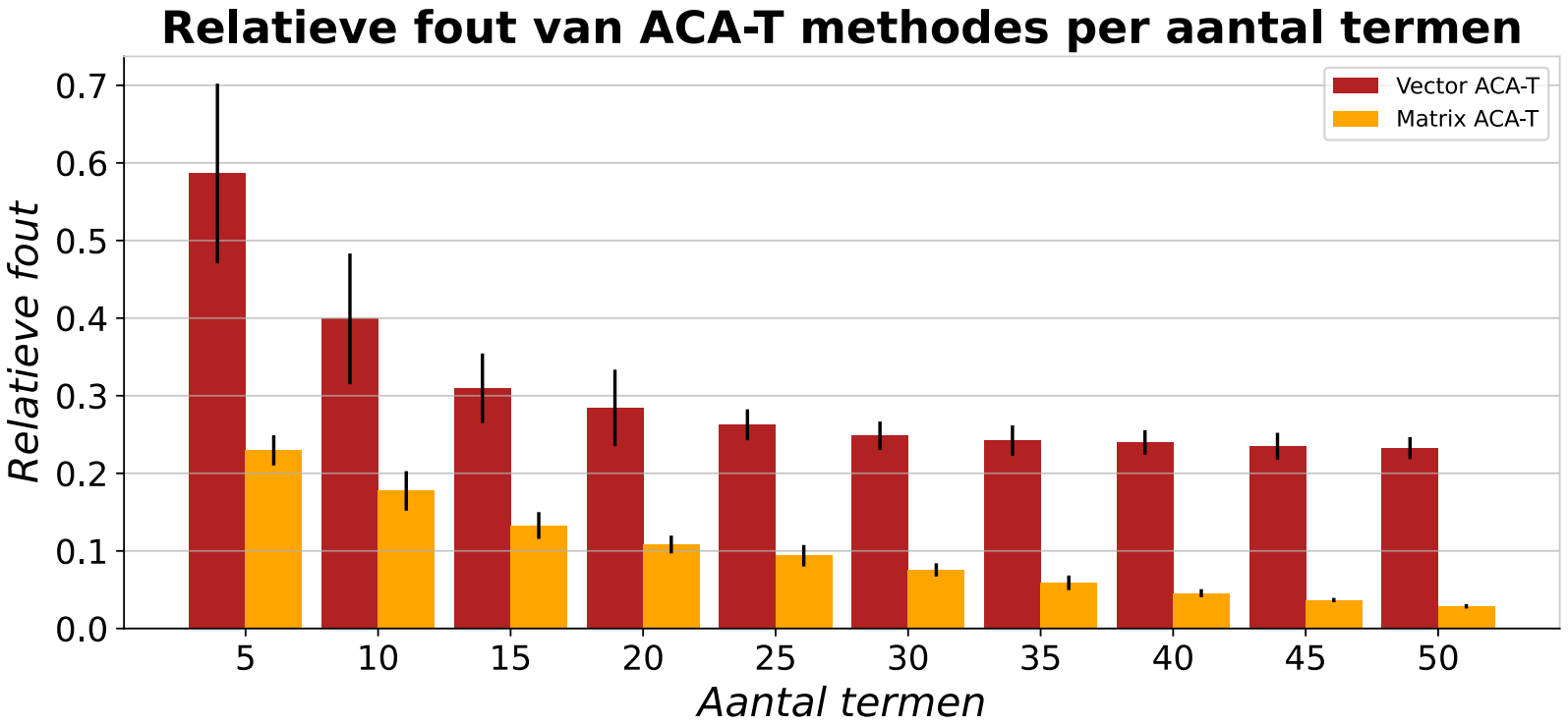


De vectoren methode: Vector ACA-T

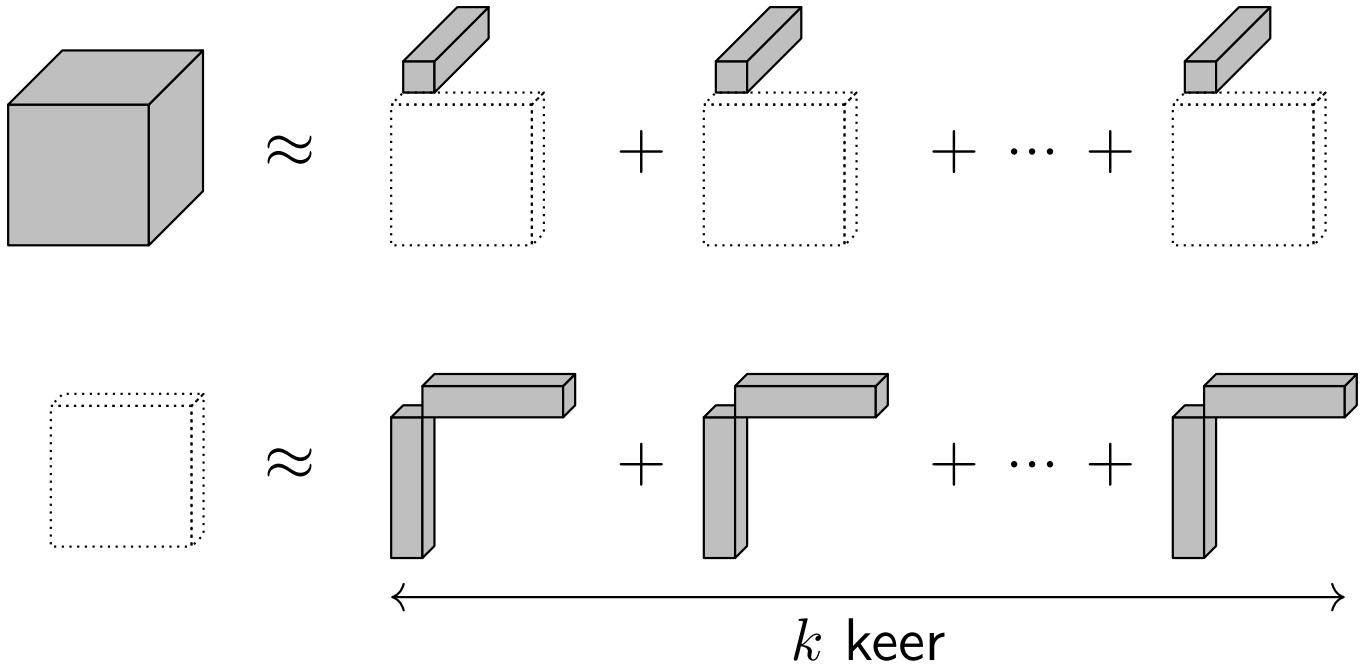


Onze methode: Vector ACA-T type k




Relatieve fout van ACA-T methodes per aantal termen
Vector ACA-T
Matrix ACA-T
Relatieve fout
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
5
10
15
20
25
30
35
40
45
50
Aantal termen

Onze methode: Vector ACA-T type k

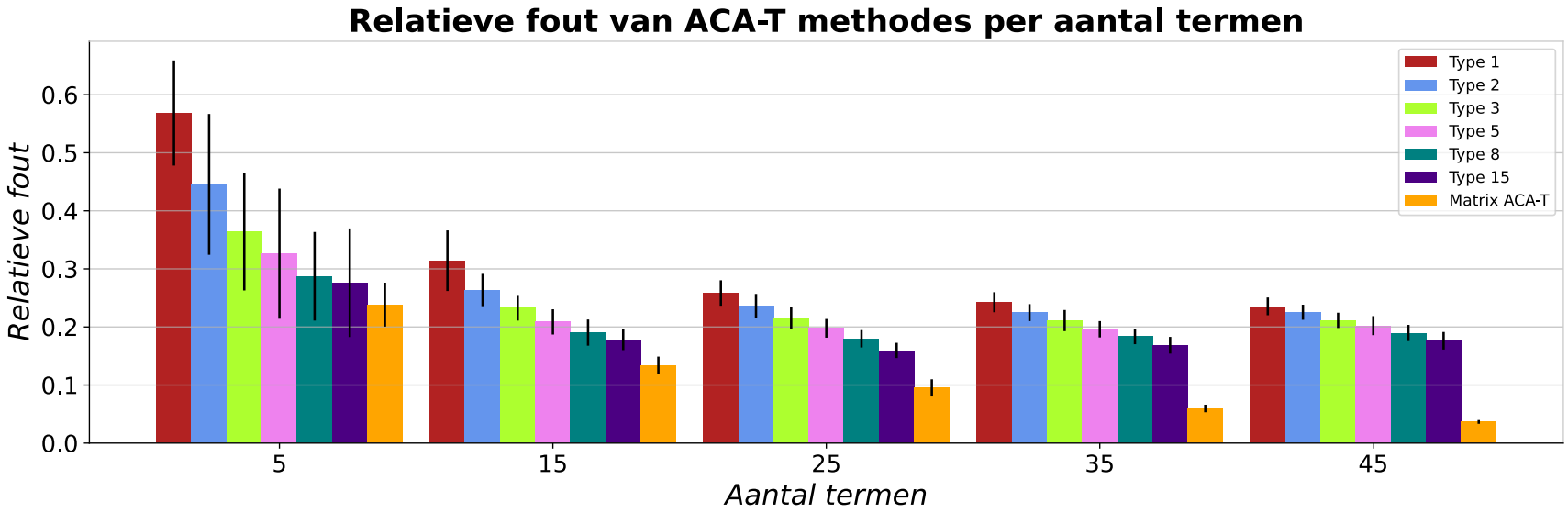


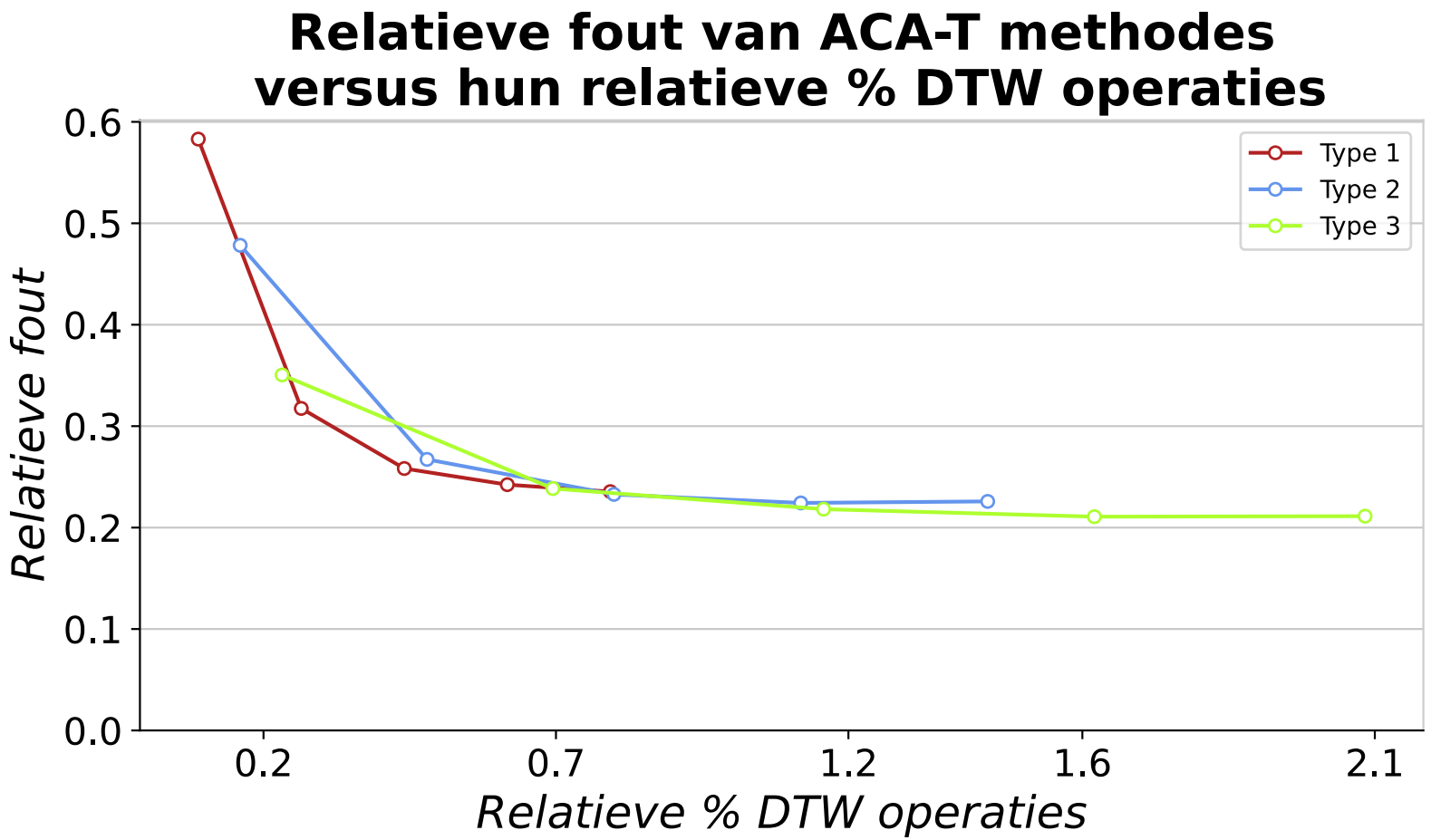
Algorithm Vector ACA-T type k

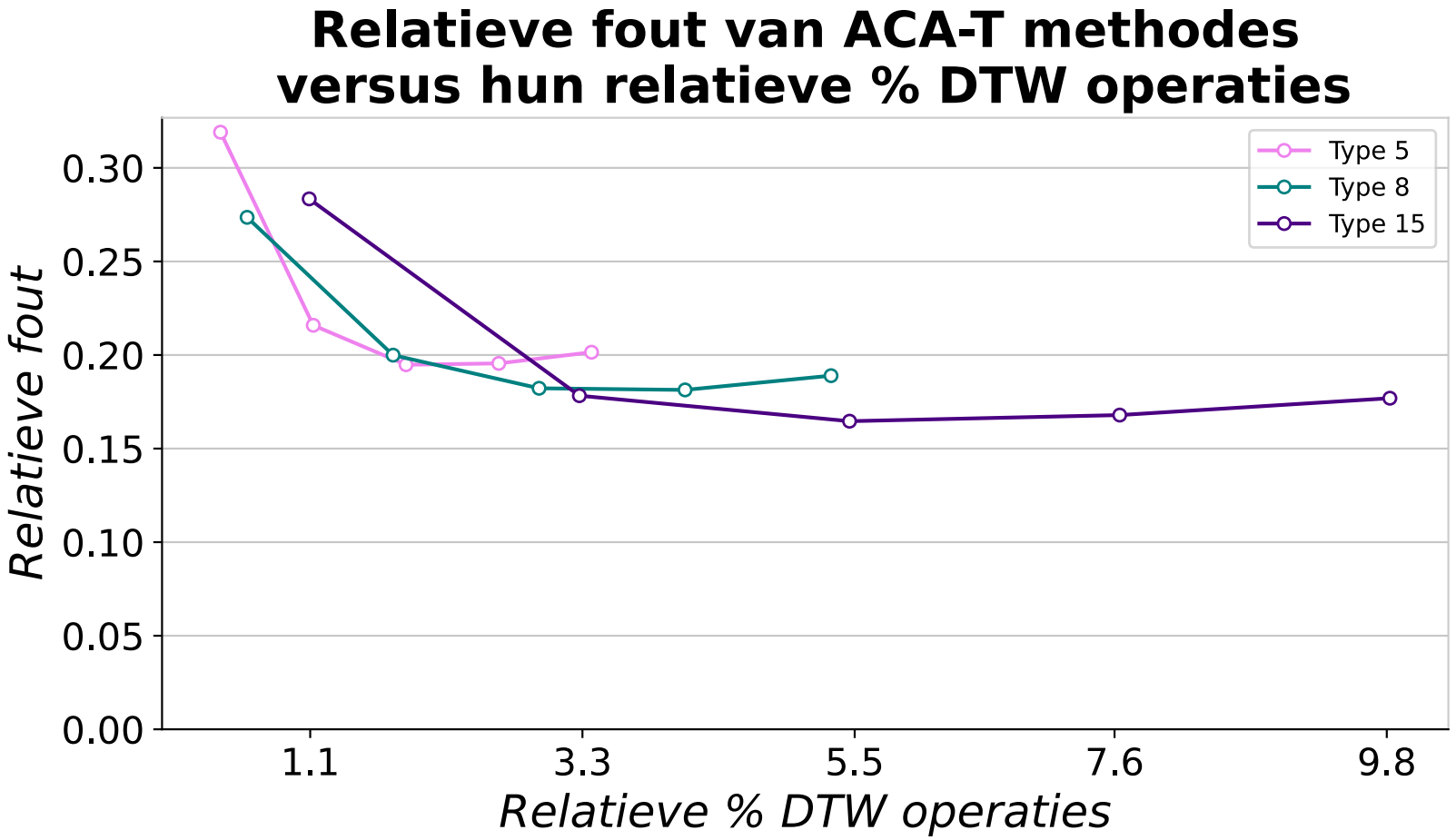
Input
n: aantal termen
k: aantal termen in matrix-decomposities
$tensor \in \mathbb{R}^{K \times N \times M}$: datastructuur die elementen in de tensor kan berekenen
Output
$decomp$: datastructuur met vectoren

Omschrijving:

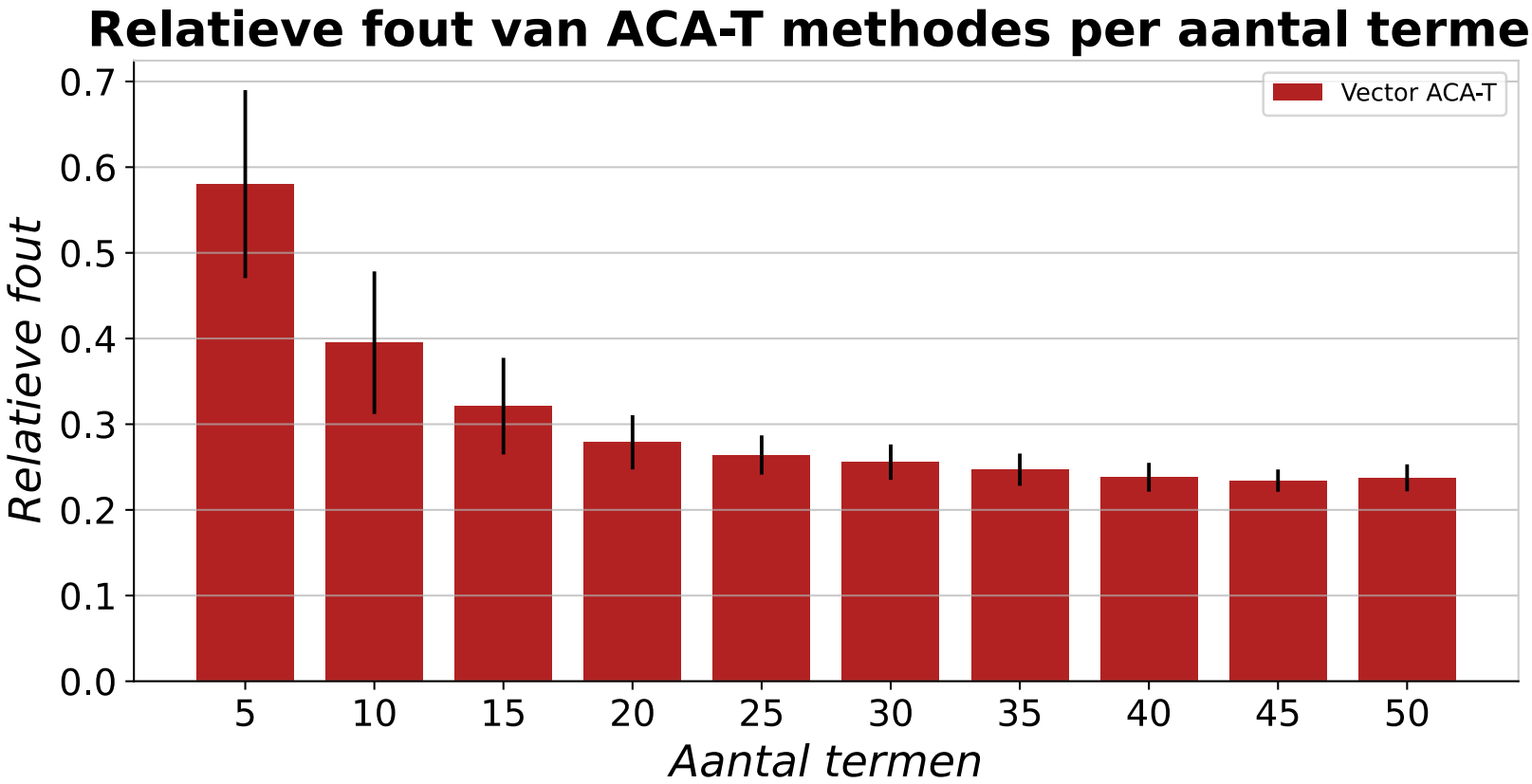
$decomp \leftarrow newTensorDecomp(K, N, M, n)$
$S \leftarrow tensor.sample()$
$\delta \leftarrow max\_abs(S)$
while $decomp.length() < n$ **do**
  $aca\_residu \leftarrow tensor.ACA(decomp.matrix\_at(\delta), k)$ ▷ Bereken Matrix-decompositie
  $tube\_residu \leftarrow tensor.tube\_at(\delta) - decomp.tube\_at(\delta)$ ▷ Bereken Tube
  $decomp.add(\delta, tube\_residu, aca\_residu)$ ▷ Voeg term toe
  $\delta \leftarrow max\_abs(tube\_residu)$ ▷ Kies nieuwe delta
  $tensor.update\_samples(S)$
  $max \leftarrow max\_abs(S)$
  if $max < \delta$ **then**
    $\delta \leftarrow max$
  end if
end while


Relatieve fout van ACA-T methodes per aantal termen
Relatieve fout
0.0
0.1
0.2
0.3
0.4
0.5
0.6
5
15
25
35
45
Aantal termen
Type 1
Type 2
Type 3
Type 5
Type 8
Type 15
Matrix ACA-T

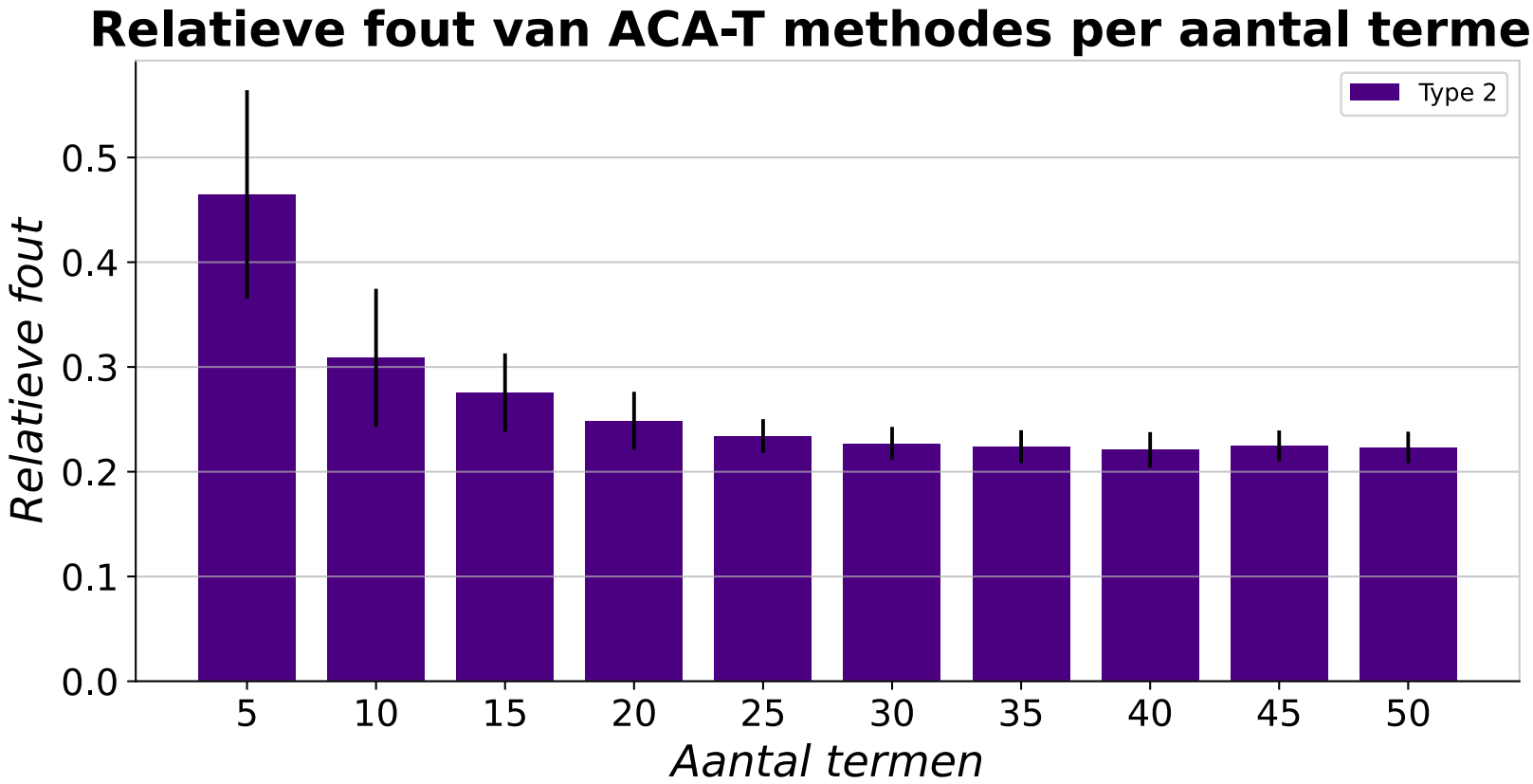

Relatieve fout van ACA-T methodes
versus hun relatieve % DTW operaties
Type 1
Type 2
Type 3
Relatieve fout
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.2
0.7
1.2
1.6
2.1
Relatieve % DTW operaties


Relatieve fout van ACA-T methodes
versus hun relatieve % DTW operaties
Type 5
Type 8
Type 15
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Relatieve fout
1.1
3.3
5.5
7.6
9.8
Relatieve % DTW operaties

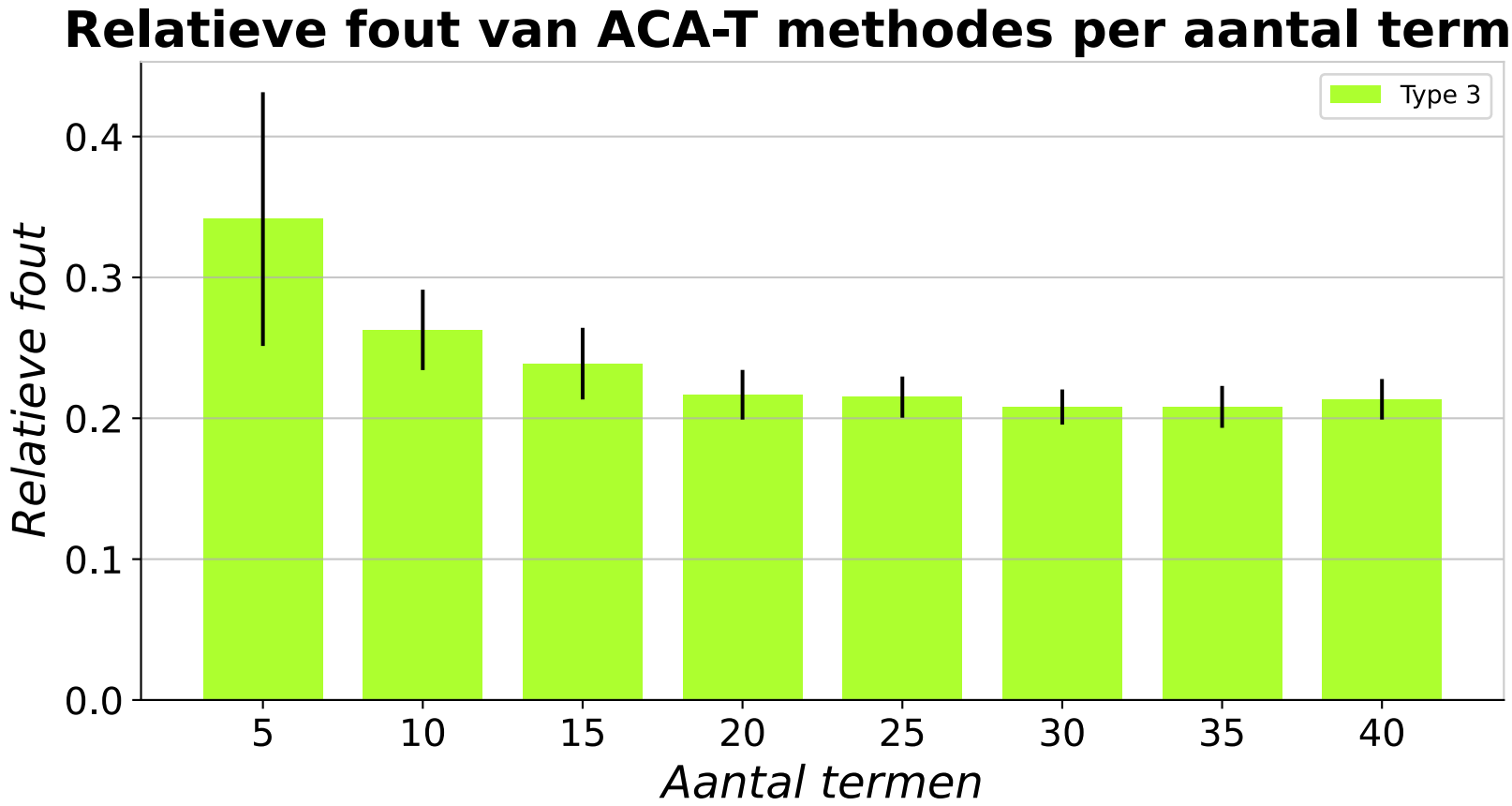
Plateau van type 1 bij 30 termen



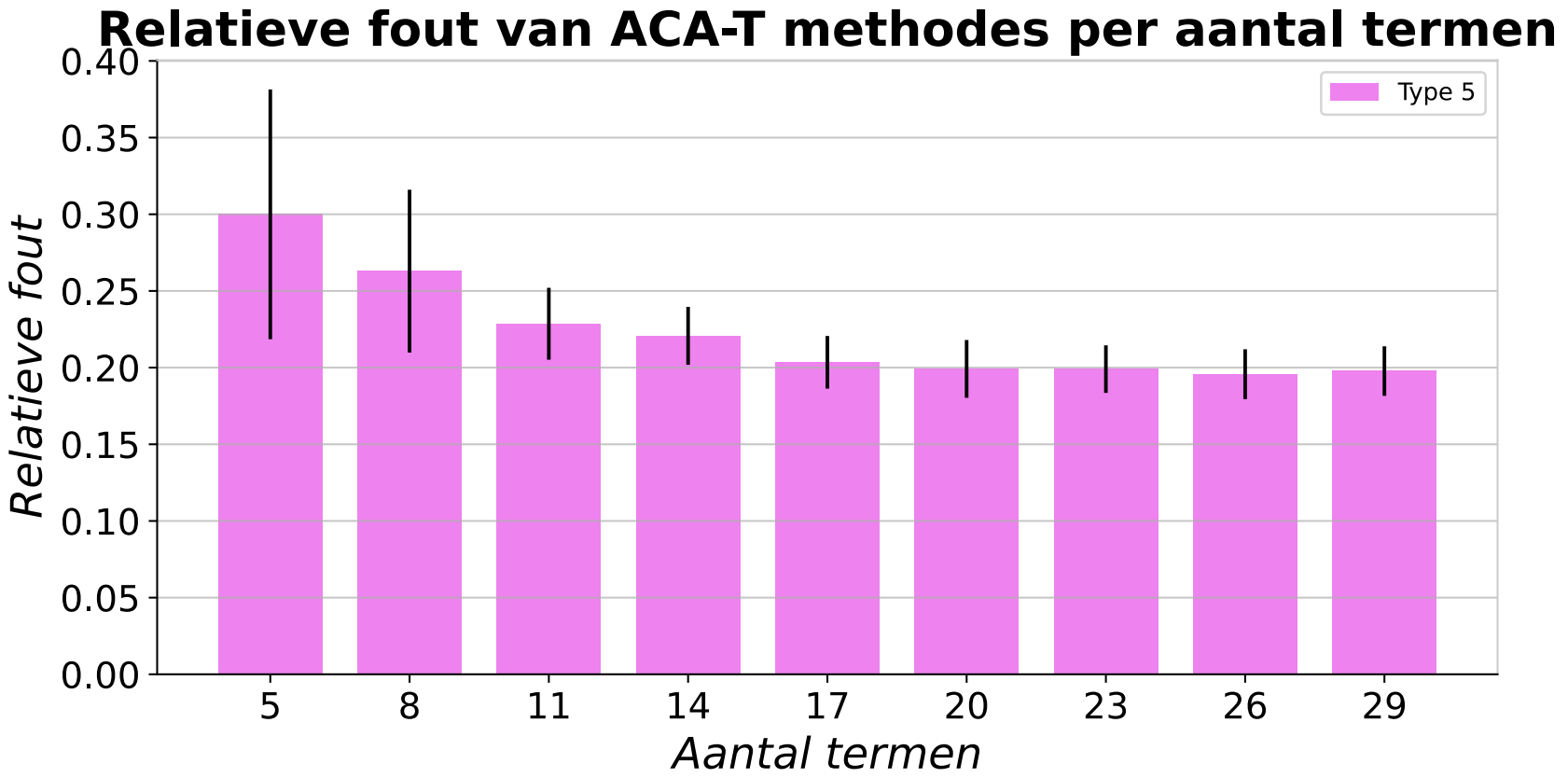
Plateau van type 2 bij 25-30 termen



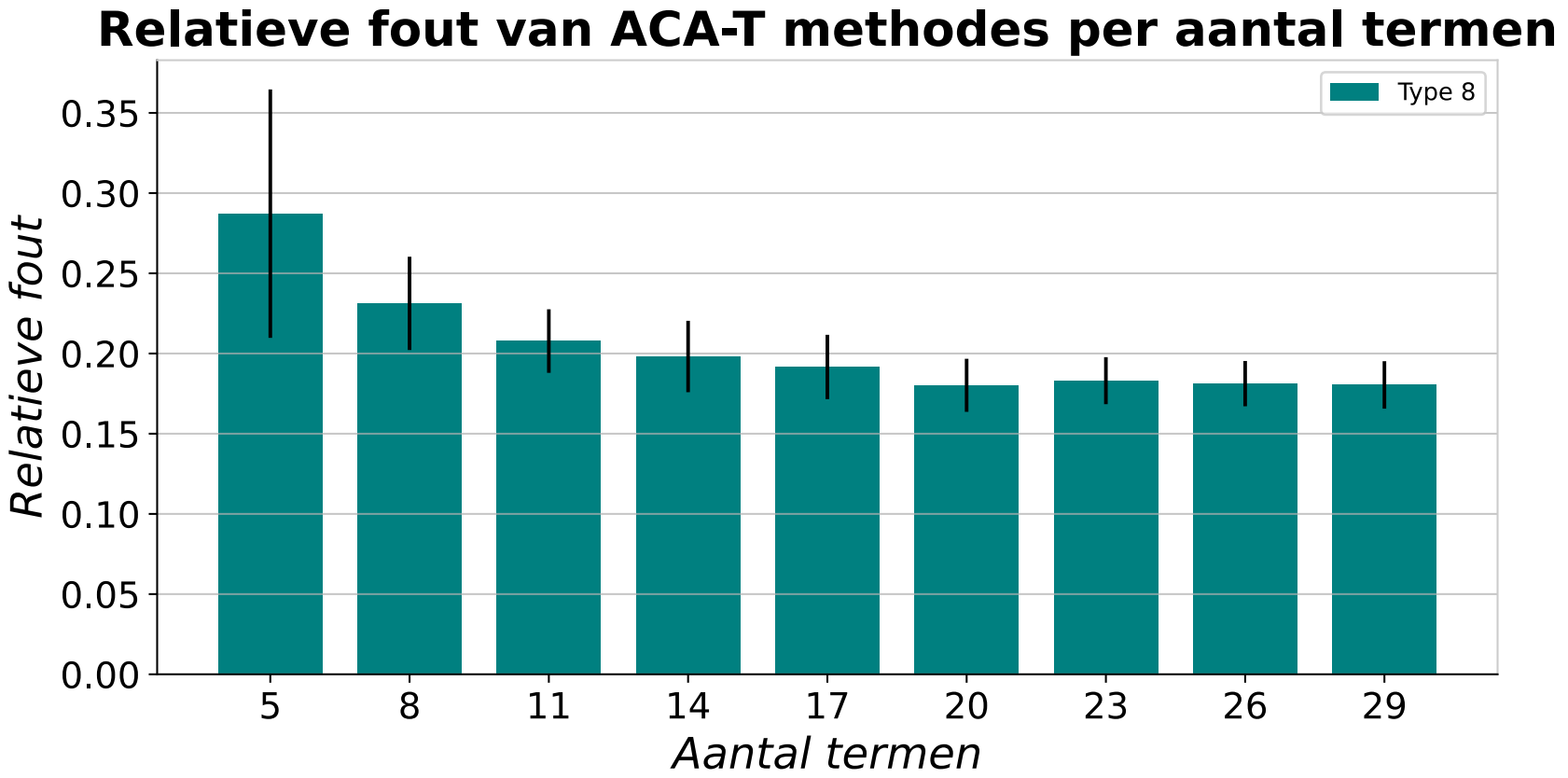
Plateau van type 3 bij 25 termen



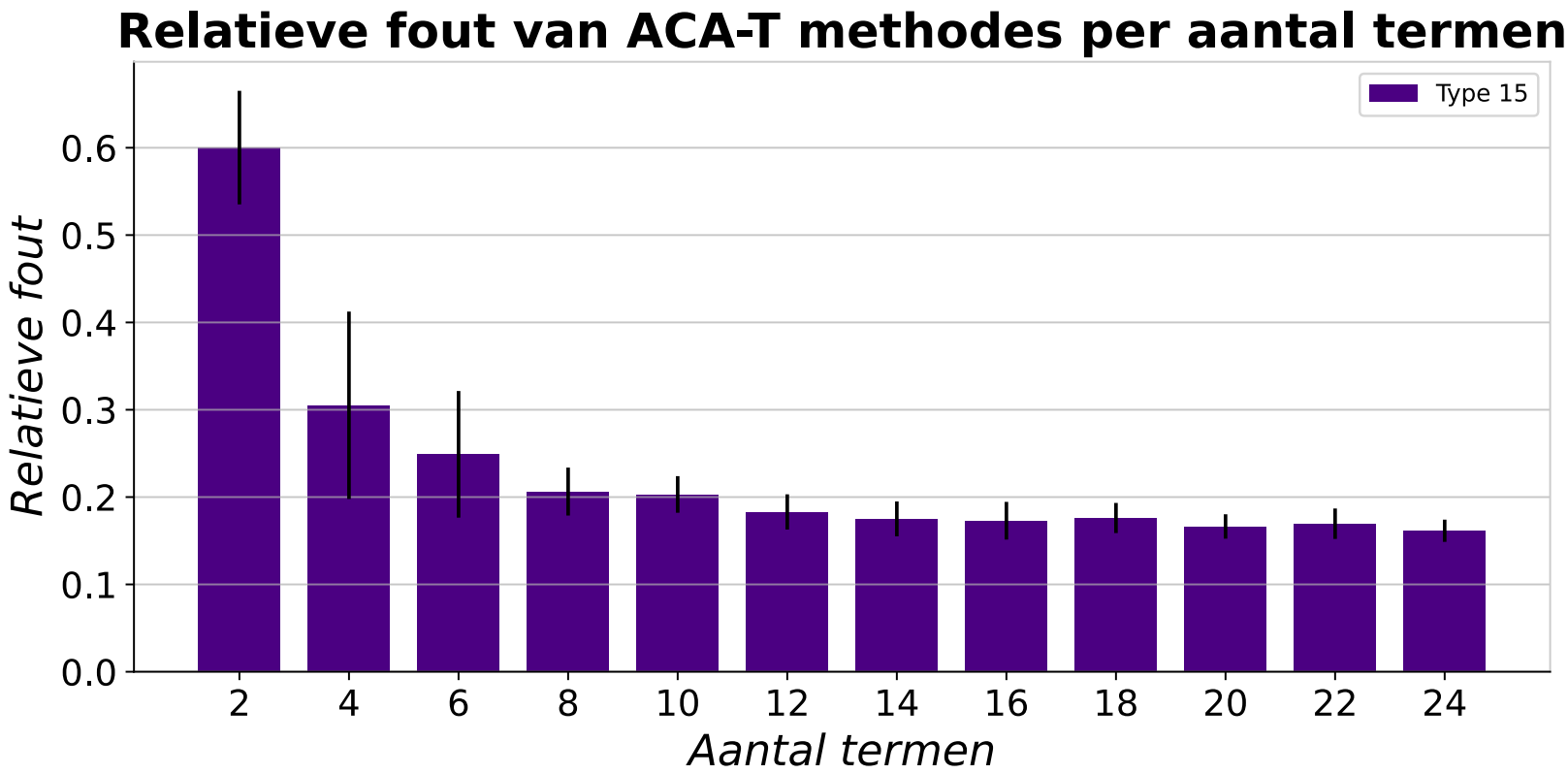
Plateau van type 5 bij 20 termen



Plateau van type 8 bij 20 termen



Plateau van type 15 bij 14 termen

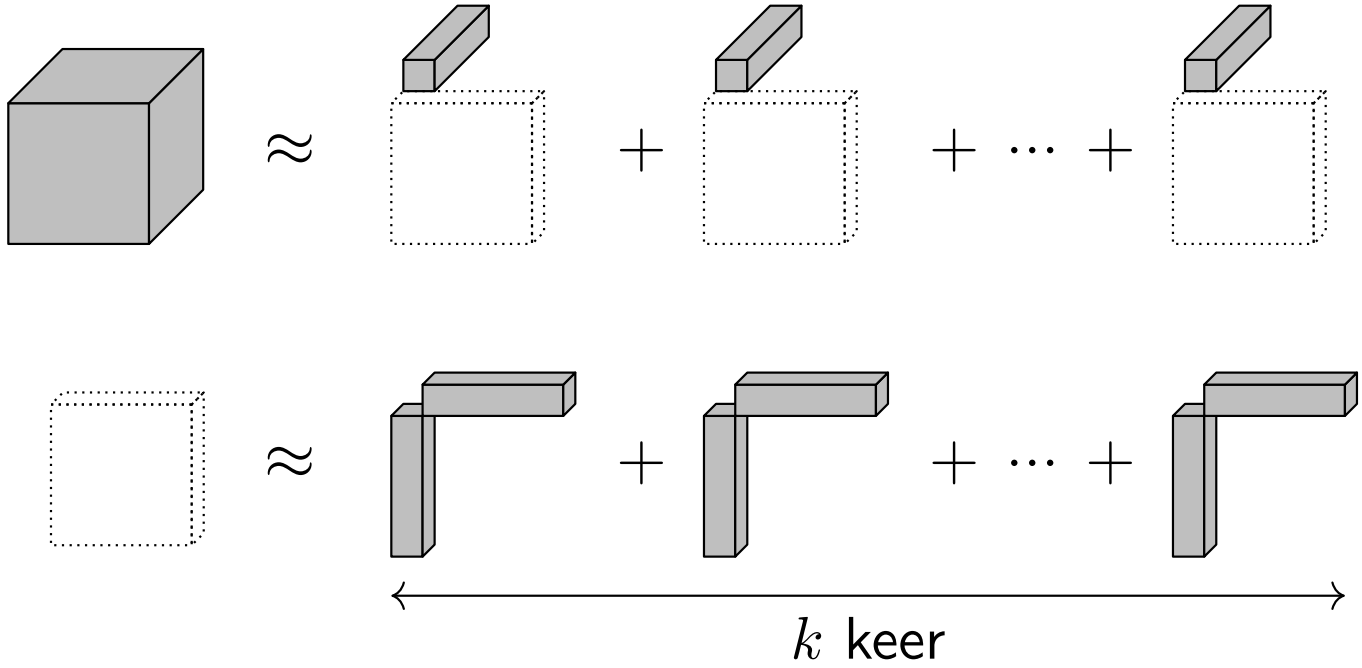


k	Aantal termen
1	30
2	25-30
3	25
5	20
8	20
15	14

Table: Plateau van relatieve fout voor Vector ACA-T type k voor de afstandstensor van de AMIE dataset.

Clusteren

- Gelabelde dataset
- Keuze dimensie
- Vectoren uit decompositie als invoer KMeans

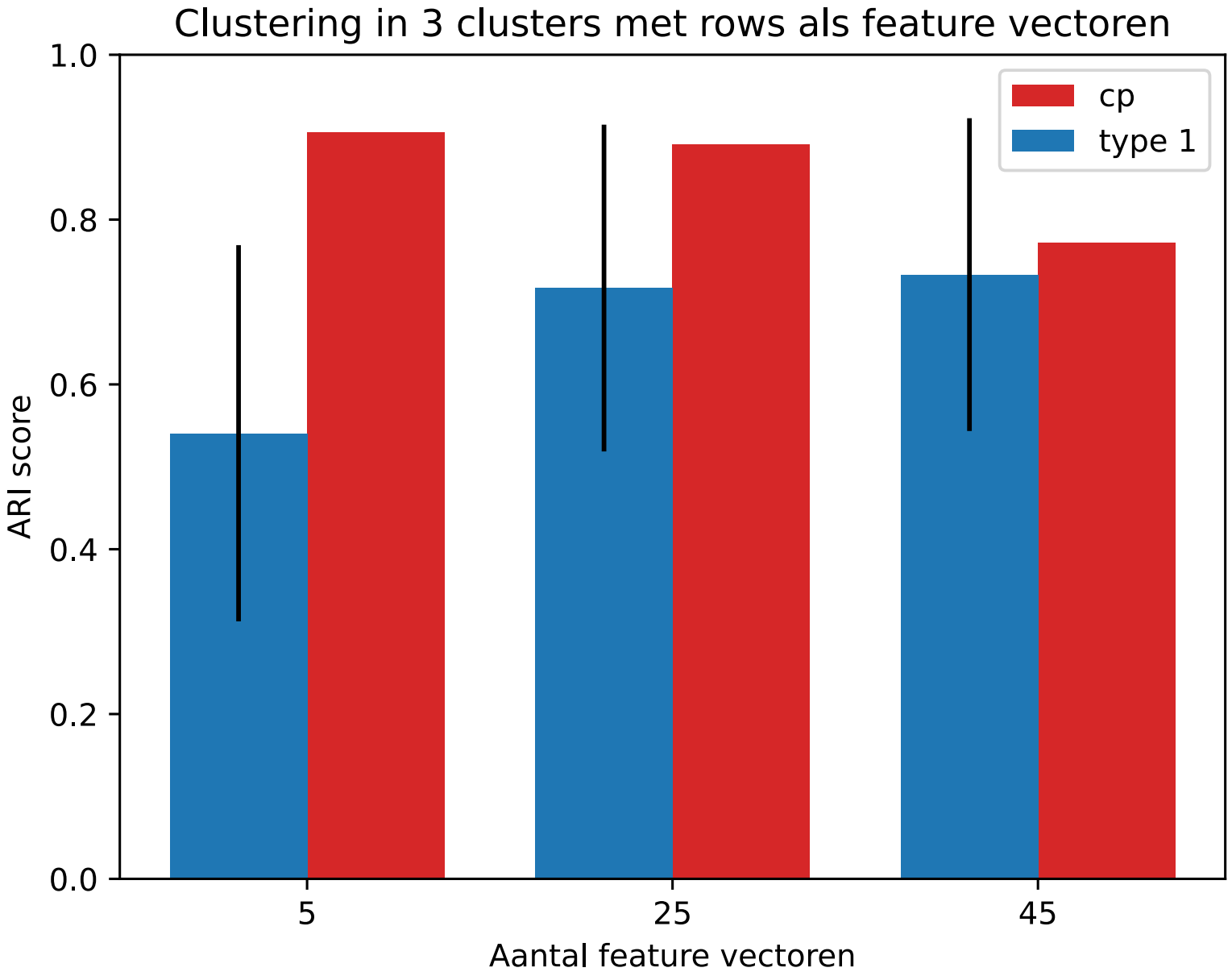


Clusteren in 3 clusters met tubes als feature vectoren

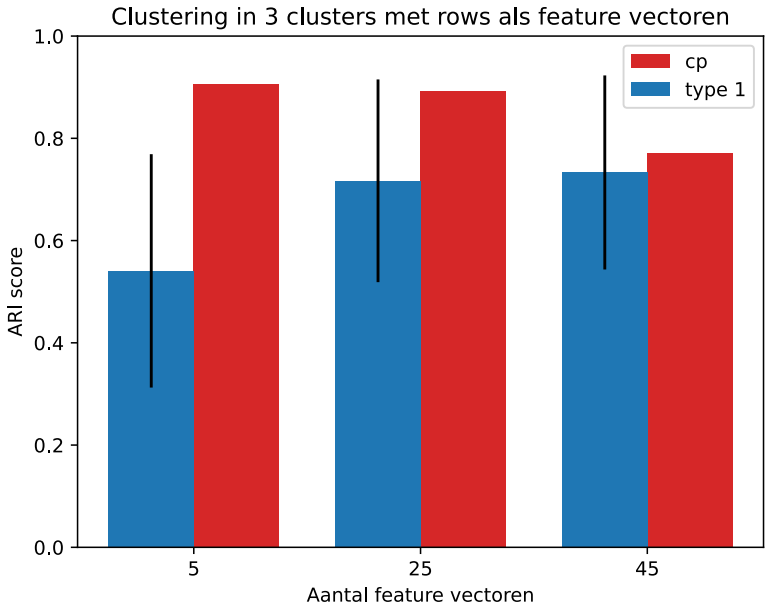
Sensor	Cluster
AnkleLeftX	2
AnkleLeftY	1
AnkleLeftZ	0
AnkleRightX	2
AnkleRightY	1
AnkleRightZ	0
ElbowLeftX	2
ElbowLeftY	1
ElbowLeftZ	0
ElbowRightX	2
ElbowRightY	1
ElbowRightZ	0
FootLeftX	2
FootLeftY	1
FootLeftZ	0
FootRightX	2
FootRightY	1
FootRightZ	0
HandLeftX	2
HandLeftY	1

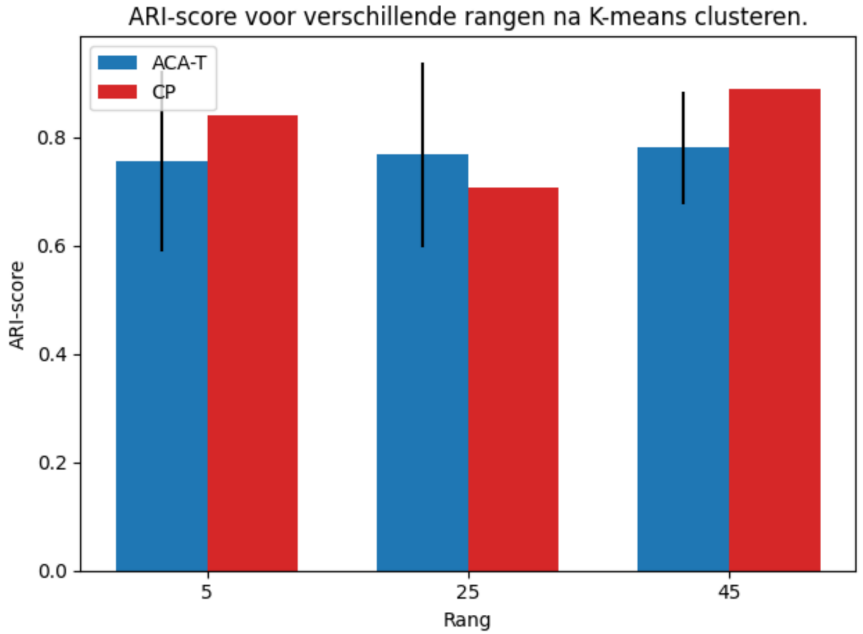
Clusteren in 3 clusters met rijen als feature vectoren

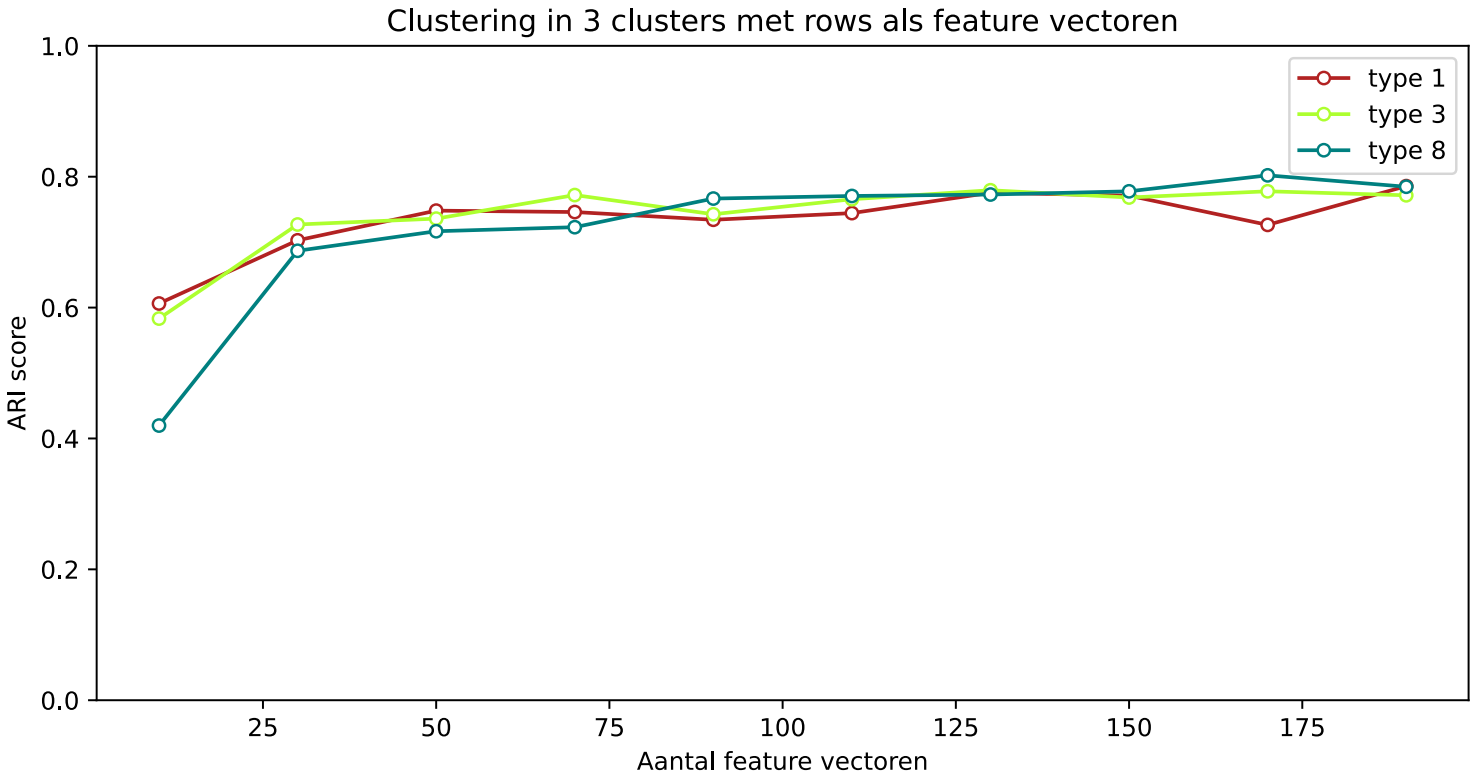
Person	Exercise	Cluster
person8	squat	2
person8	squat	2
person8	squat	2
person8	squat	2
person8	squat	2
person8	squat	2
person8	lunge	0
person8	lunge	0
person8	lunge	0
person8	lunge	0
person8	lunge	0
person8	lunge	0
person8	lunge	0
person8	sidelunge	1
person8	sidelunge	1
person8	sidelunge	1
person8	sidelunge	1
person8	sidelunge	1
person8	sidelunge	1
person1	squat	2

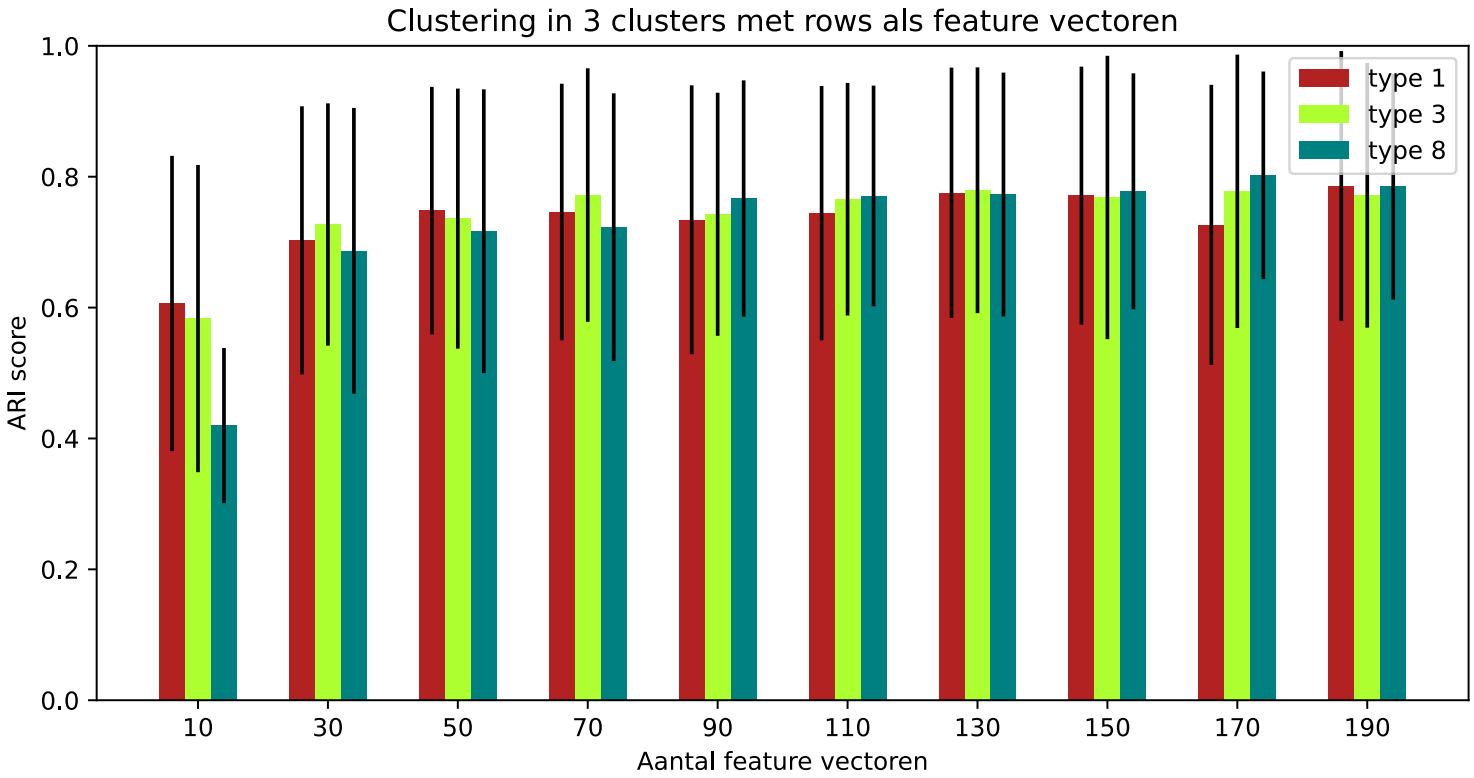

Clustering in 3 clusters met rows als feature vectoren
1.0
0.8
0.6
0.4
0.2
0.0
ARI score
cp
type 1
5
25
45
Aantal feature vectoren

Vergelijking met voorgaande methode






Clustering in 3 clusters met rows als feature vectoren
ARI score
Aantal feature vectoren
type 1
type 3
type 8
1.0
0.8
0.6
0.4
0.2
0.0
25
50
75
100
125
150
175


Clustering in 3 clusters met rows als feature vectoren
ARI score
1.0
0.8
0.6
0.4
0.2
0.0
10
30
50
70
90
110
130
150
170
190
Aantal feature vectoren
type 1
type 3
type 8

Referenties:

- **Masterthesis:** T. Vanhoof, Adaptieve tensor factorisaties om versneld tijdreeksen te clusteren, 2023
- **Dataset:** T. Decroos, K. Schutte, T. Beéck, B. Vanwanseele, and J. Davis. AMIE: Automatic Monitoring of Indoor Exercises: European Conference, ECML PKDD 2018, Dublin, Ireland, September 10-14, 2018, Proceedings, Part III, pages 424–439. 01 2019.