HALE Sports Summer Internship Report

September 23, 2020

Who are we?

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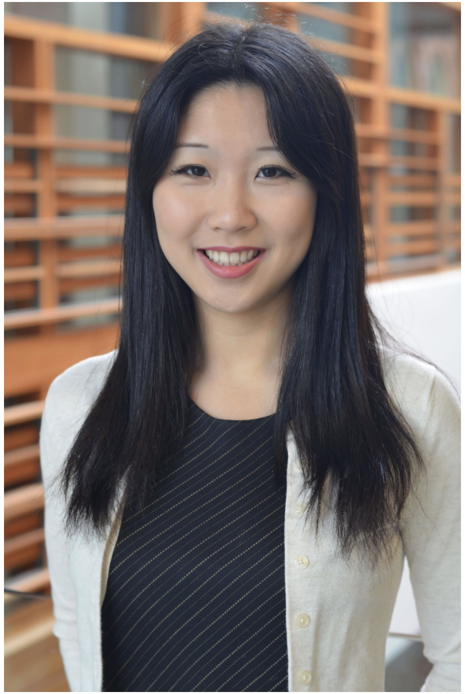

Jenny Wang
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What did we do this summer?

- Place the athletes on our platform into distinct groups by seeing if they have similar patterns in their health data, including:
    - Genetic data
    - Clinical lab data
    - Microbiome data
    - Performance data

- Trial and error process: end product came together in several stages

Outline

1. Data table basics
2. Terminology
3. Cluster analysis
4. Subject matter expert report

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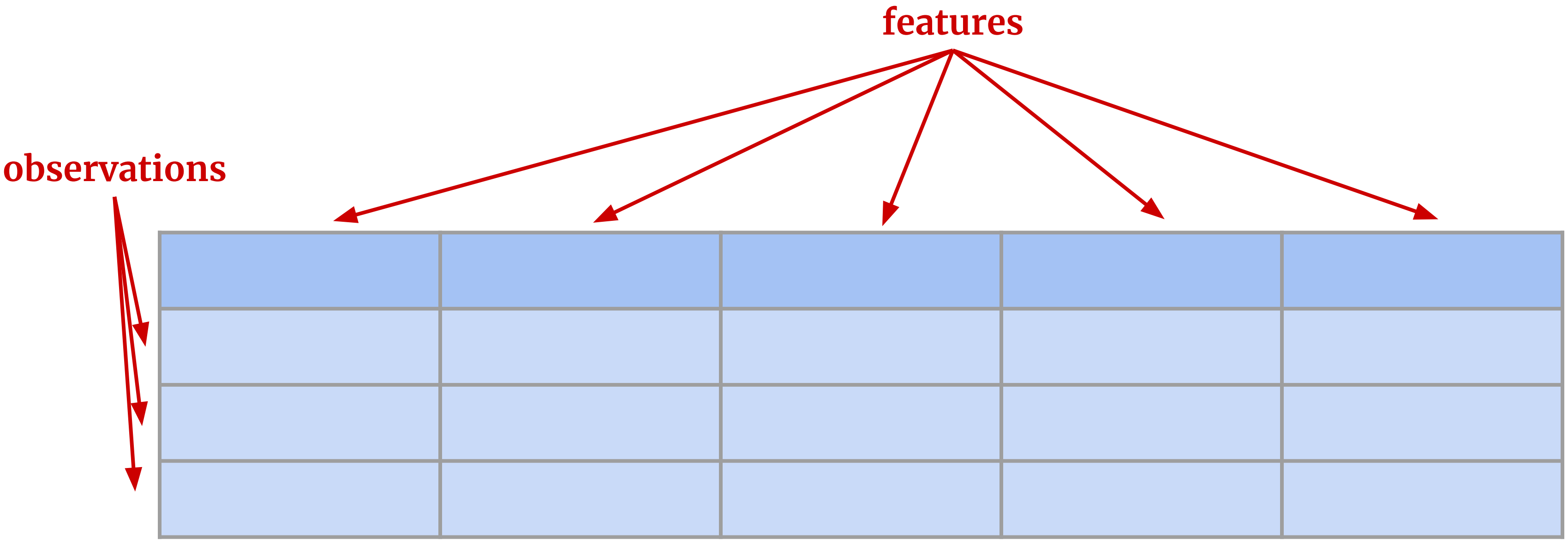
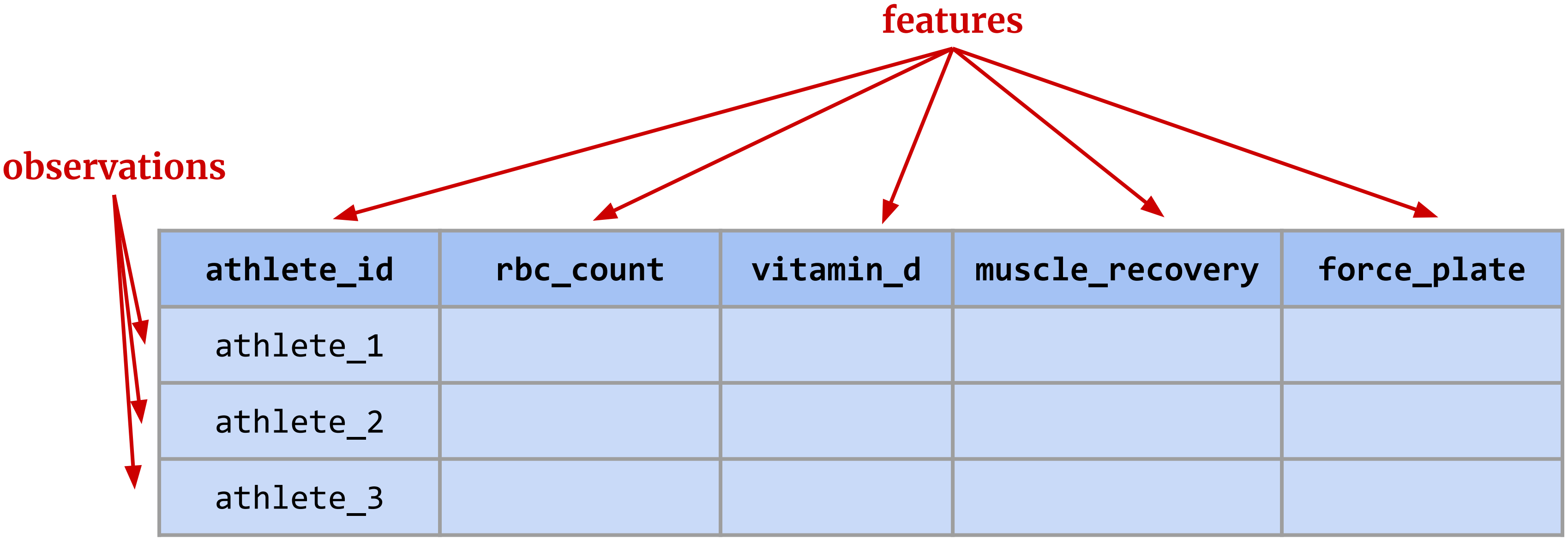
Data table basics



features

observations

Data table basics



features

observations

athlete_id	rbc_count	vitamin_d	muscle_recovery	force_plate
athlete_1				
athlete_2				
athlete_3				

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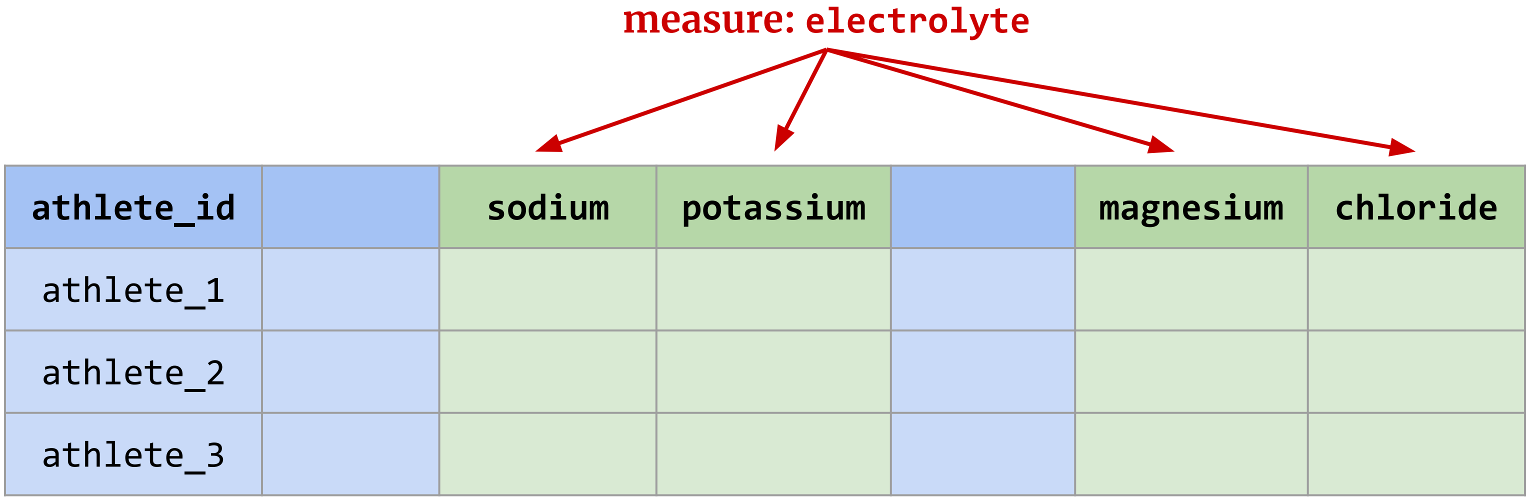
Measure



measure: electrolyte

athlete_id		sodium	potassium		magnesium	chloride
athlete_1						
athlete_2						
athlete_3						

Attribute

- Aspect of sports performance
  - Endurance
  - Strength
  - Power

- Each measure can influence one or more attributes

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Overview

- We do cluster analysis to group together athletes who have similar test results

- Cluster analysis for every measure

Toy example

Red blood cells

athlete_id	hemoglobin	hematocrits
athlete_1	5	2
athlete_2	3	4
athlete_3	3	4
athlete_4	5	2

Toy example

Red blood cells

athlete_id	hemoglobin	hematocrits
athlete_1	5	7
athlete_2	3	4
athlete_3	3	4
athlete_4	5	7

k-modes clustering

- Clustering on categories assigned to numerical values
  - Examples: `in range`, `below range`, `above range`

athlete_id	hemoglobin	hematocrits
athlete_1	above range	above range
athlete_2	in range	in range
athlete_3	in range	in range
athlete_4	above range	above range

k-means clustering

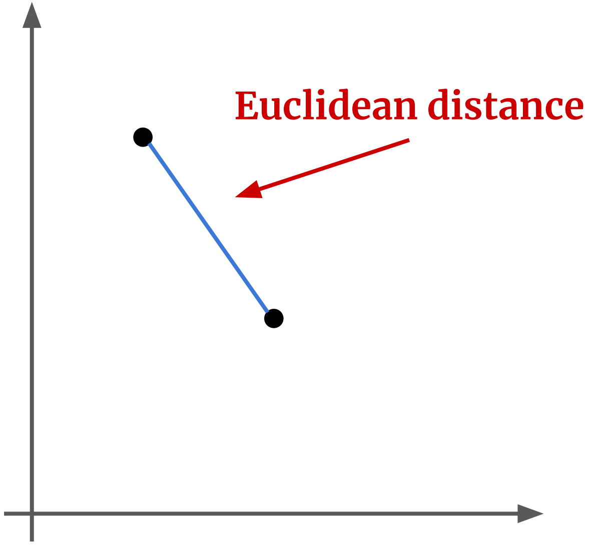
- Categorizing numerical values may cause us to lose important information contained in the numbers themselves

- Clustering on numbers, as opposed to categories

- Put athletes in the same cluster if they are similar

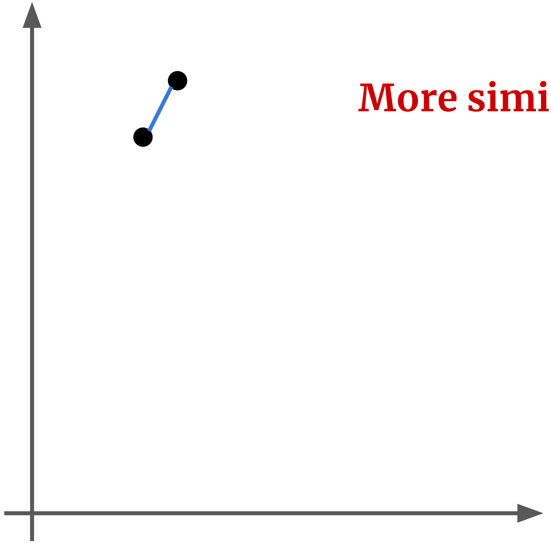
How to decide if numeric observations are similar?

- By looking at the distance between points

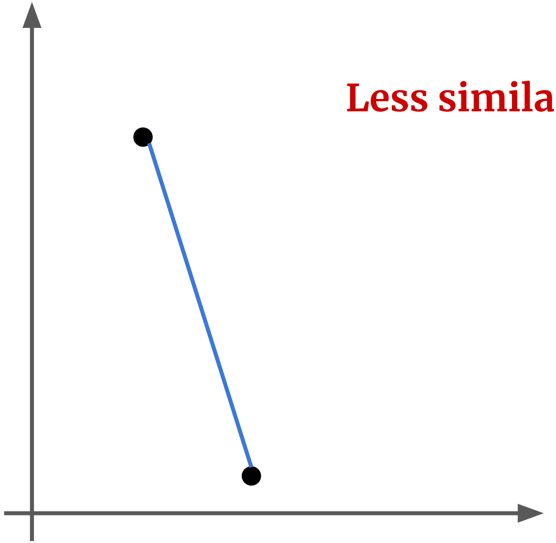


How to decide if numeric observations are similar?

- By looking at the distance between points



More similar



Less similar

Back to our data table...

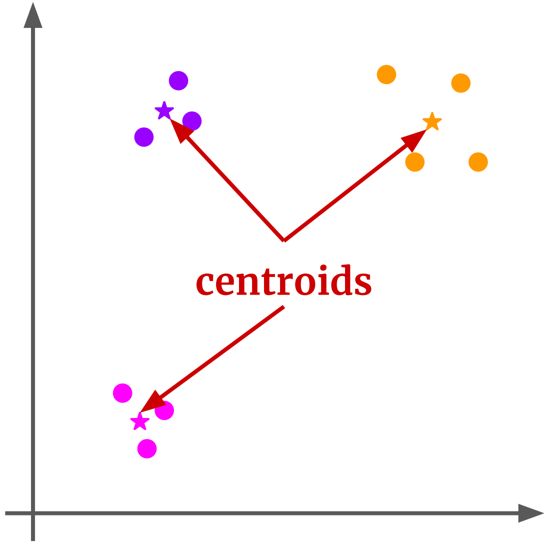
- Each feature would be an “axis”, and each athlete would be a “point”

- Some measures may have 4 or more features, which means 4 or more “axes”

- How do we measure Euclidean distance with so many axes?

Centroids in *k*-means clustering

- Each cluster is “centered” around its respective centroid

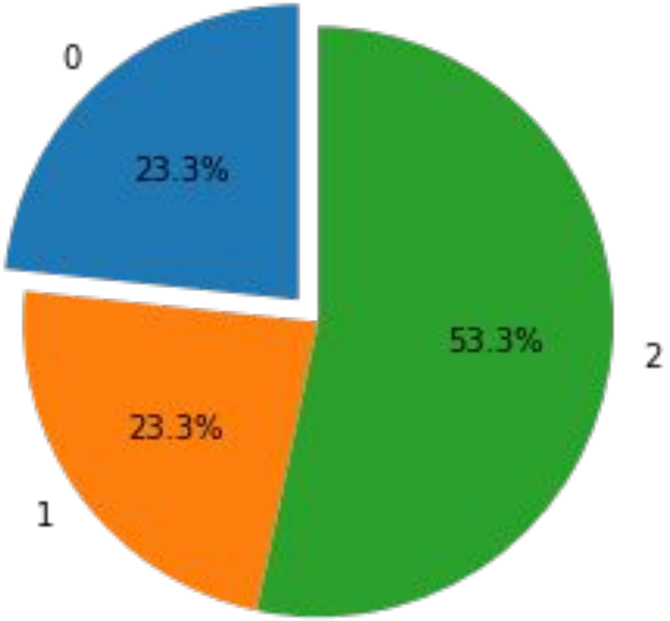


Reporting *k*-means clustering results

Measure: `electrolyte`

cluster	sodium	potassium	magnesium	chloride
cluster_0	140	4.0	2.2	100
cluster_1	110	2.1	0.4	77
cluster_2	180	8.9	5.5	136

Reporting *k*-means clustering results

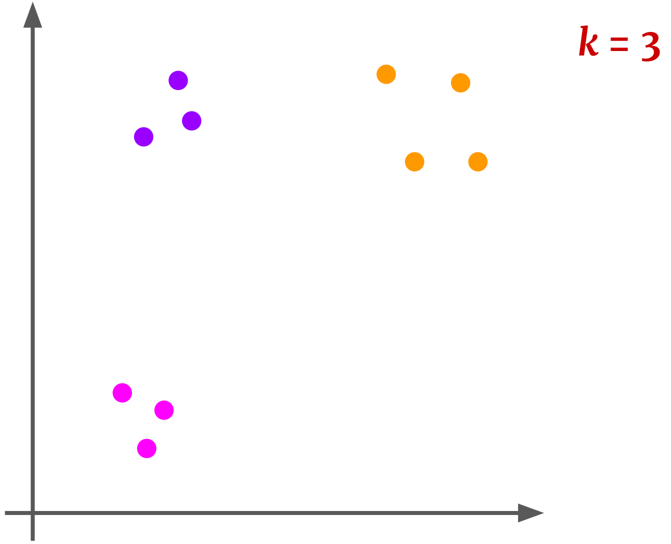


Data of an individual athlete:

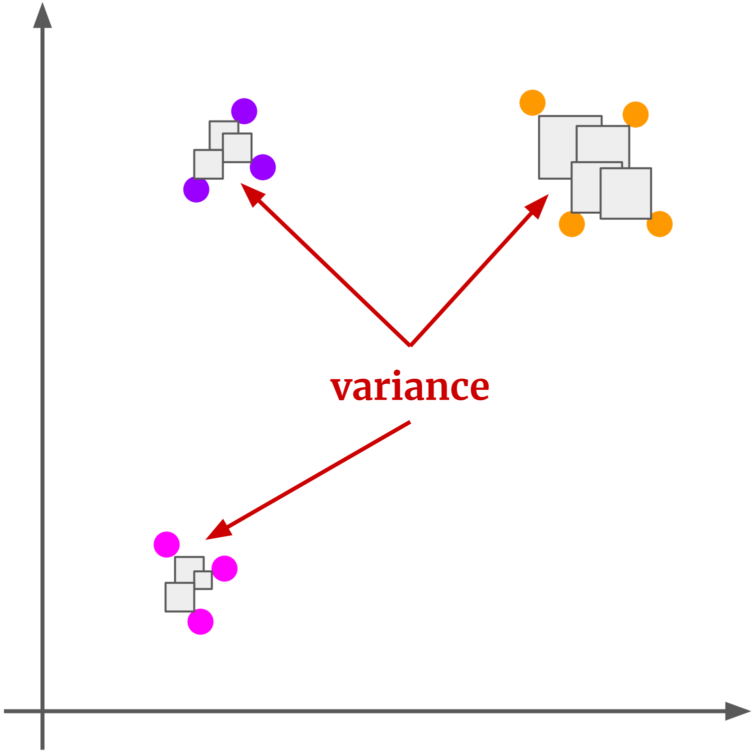
- Sodium: 135
- Potassium: 3.9
- Magnesium: 2.5
- Chloride: 98

What is *k* and why do we care about it?

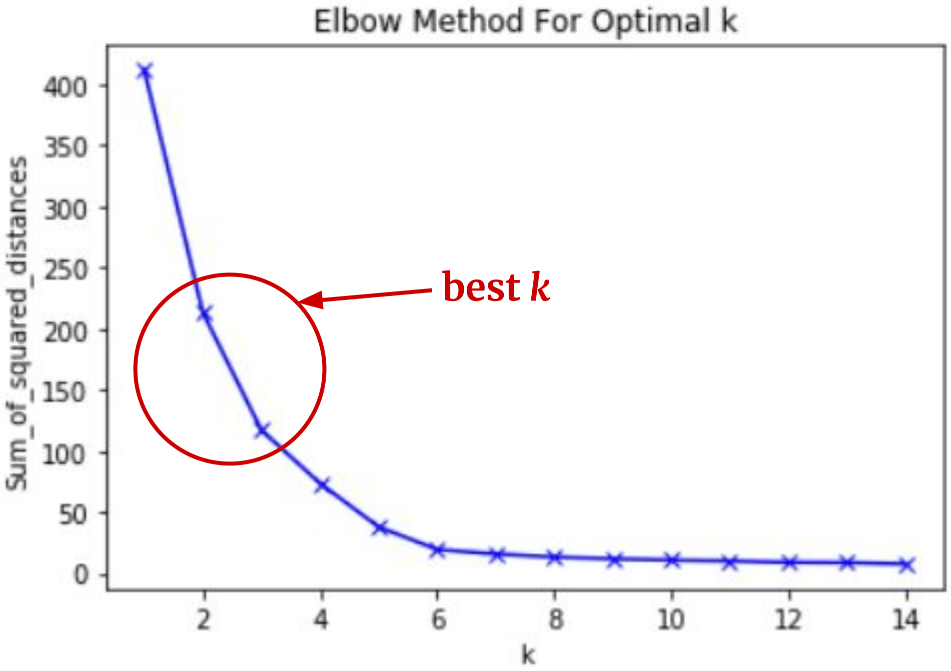
- *k* is the number of clusters we decide to assign to our athletes
- Choose *k* so that it best reflects the patterns in our athletes



Choose *k* by optimizing the variance in the data



Elbow plot



best *k*

Choosing *k* on our platform

- We decide *k* for the user using the elbow method, constraining *k* between 3 and 5

- Let users choose their own *k*

Other methods to choose *k*

- Plenty; most center around the idea of minimizing intra-cluster distances and maximizing inter-cluster distances

- More information here

Mahalanobis distance

- Corrects for effects from correlated features

- Same clustering procedure once pairwise distances are calculated

- Results are not so interpretable...

Cohorts

- Athlete chooses who he or she wants to compare with, and we perform cluster analysis on this cohort as opposed to on everyone

- With raw values, it is hard to say whether a centroid means “in range” or “out of range,” due to variability in demographics

- Cluster centroids are percentile values relative to everyone in the cohort

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Report

- Integrates all of the tools and communicates everything to athletes, physicians, data scientists researchers

Thank you!