PRACTICAL

MACHINE LEARNING

RECOMMENDER ENGINE AND ANOMALY DETECTION

Seth Juarez

sethj@devexpress.com

@sethjuarez

Analytics Program Manager

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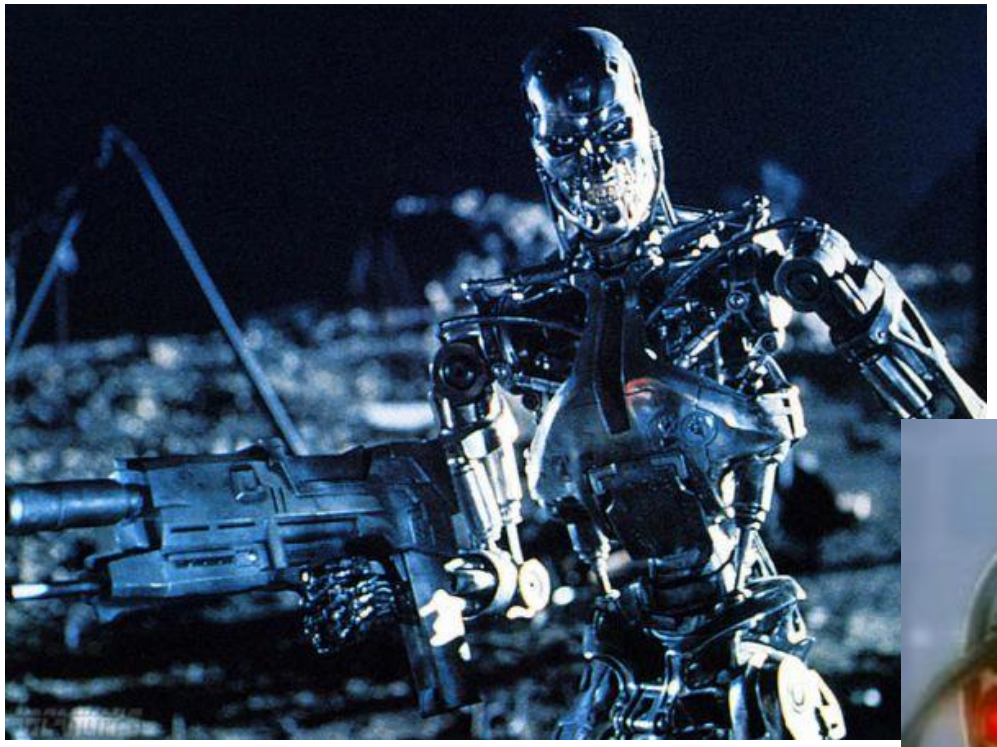

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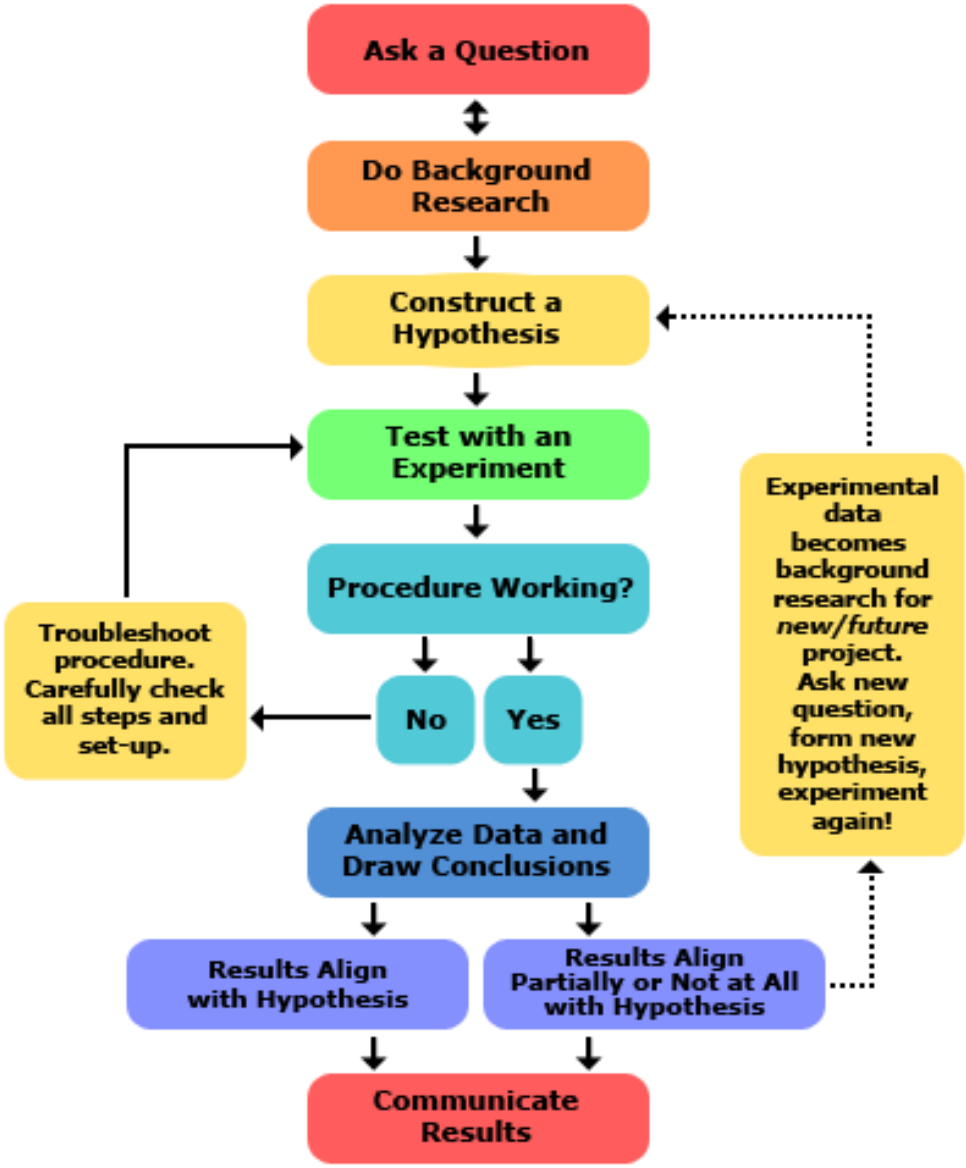
agenda

- a word about data science
- what is machine learning?
- recommender systems
- unsupervised learning – organization
  - k-means
  - hierarchical clustering
- anomaly detection (motivation)

data science

- key word: science
- try stuff
- it (might not | won't) work the first time



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http://www.sciencebuddies.org/science-fair-projects/project_scientific_method.shtml

machine learning

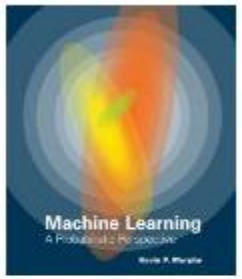
- finding (and exploiting) patterns in data
- replacing “human writing code” with “human supplying data”
  - system figures out what the person wants based on examples
  - need to abstract from “training” examples to “test” examples
  - most central issue in ML: generalization

machine learning

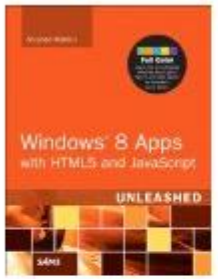
- split into two (ish) areas
  - **supervised learning**
    - predicting the future
    - learn from past examples to predict future
  - **unsupervised learning**
    - understanding the past
    - making sense of data
    - learning structure of data
    - compressing data for consumption

neat applications

Recommendations for You in Books

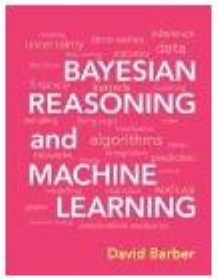


Machine Learning: A Probabilistic...
› Kevin P. Murphy
Hardcover
★★★★½ (16)
~~$90.00~~ $81.00
Why recommended?

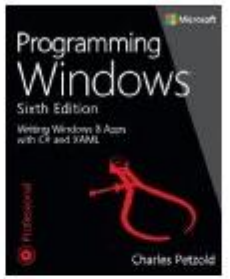


Windows 8 Apps with HTML5 and...
› Stephen Walther
Paperback
★★★★½ (10)
~~$39.99~~ $26.62
Why recommended?

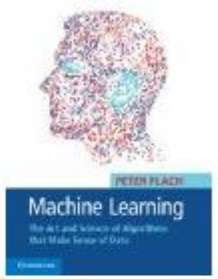
Boosting: Foundations and Algorithms
Robert E. Schapire, Yoav Freund
Hardcover
★★★★☆ (5)
~~$50.00~~ $41.42
Why recommended?



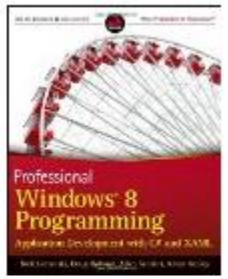
Bayesian Reasoning and Machine Learning
› David Barber
Hardcover
★★★★★ (6)
~~$90.00~~ $81.00
Why recommended?



Programming Windows: Writing Windows...
Charles Petzold
Paperback
★★★★½ (8)
~~$59.99~~ $41.78
Why recommended?



Machine Learning: The Art and Science...
Peter Flach
Paperback
★★★★½ (8)
~~$60.00~~ $54.00
Why recommended?



Professional Windows 8 Programming...
Nick Lecrenski, Doug Holland, ...
Paperback
★★★★½ (6)
~~$44.99~~ $27.71
Why recommended?

› See more recommendations

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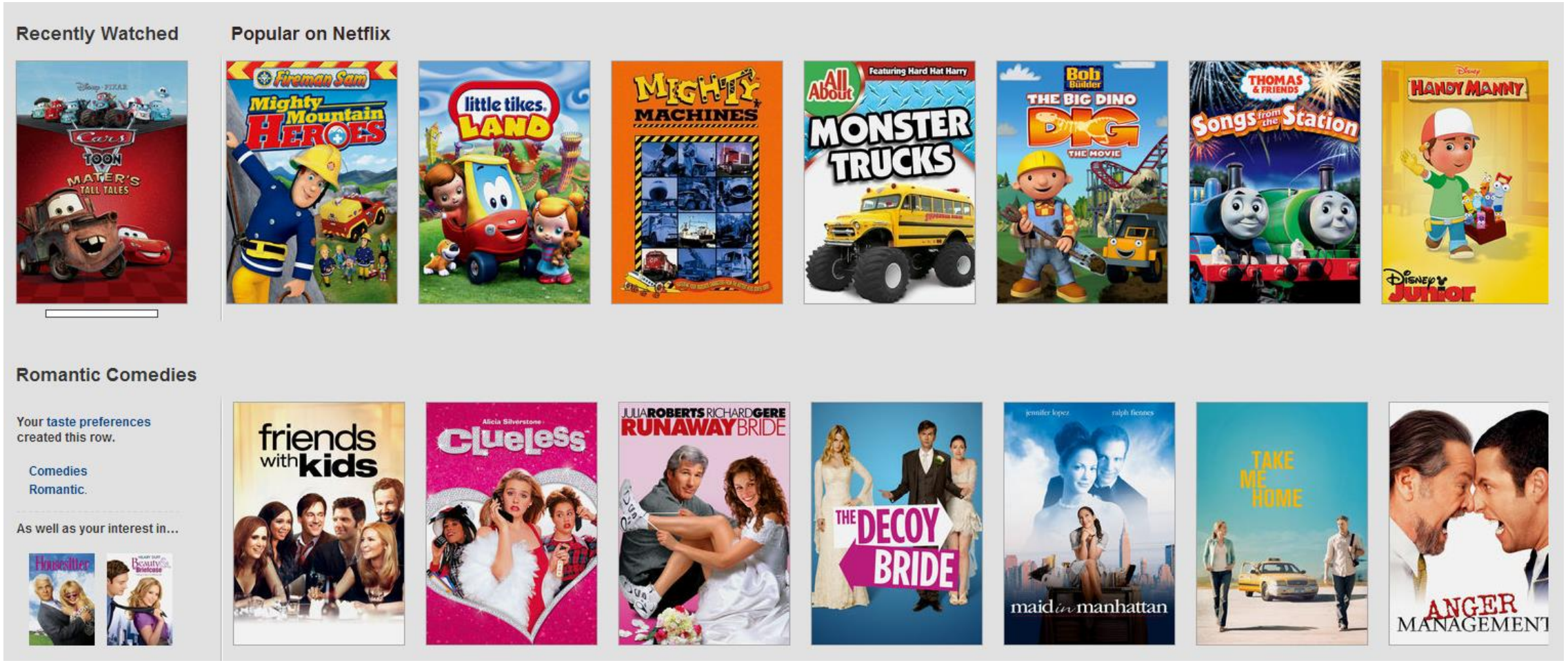
neat applications



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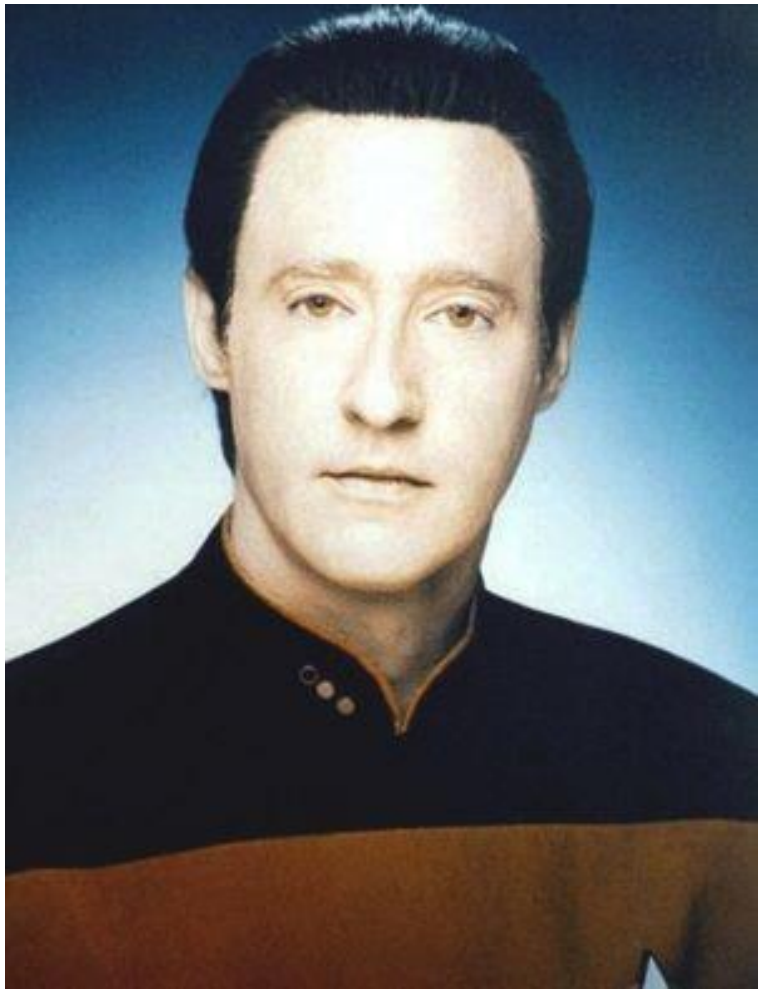

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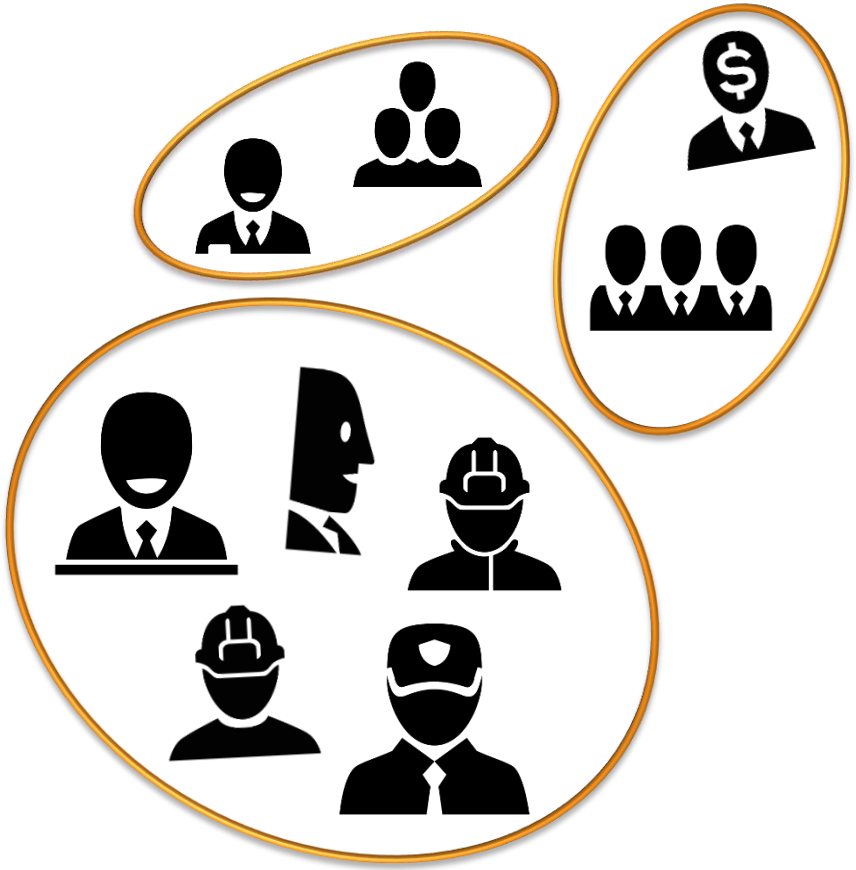
neat applications

- spam catchers
- ocr (optical character recognition)
- natural language processing
- machine translation
- biology
- medicine
- robotics (Autonomous Systems)
- etc…

RECOMMENDER SYSTEM

recommender systems

- what do people like?



how does knowing people similarity help when recommending something?

recommender systems

- how are things alike?

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how does knowing item similarity
help when recommending something?

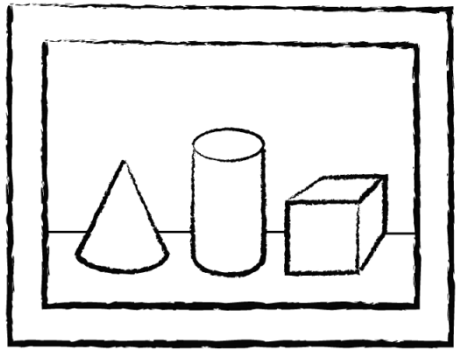
UNSUPERVISED LEARNING

figuring out similarity (among other things)

HOW DOES IT WORK?

pattern

1. data

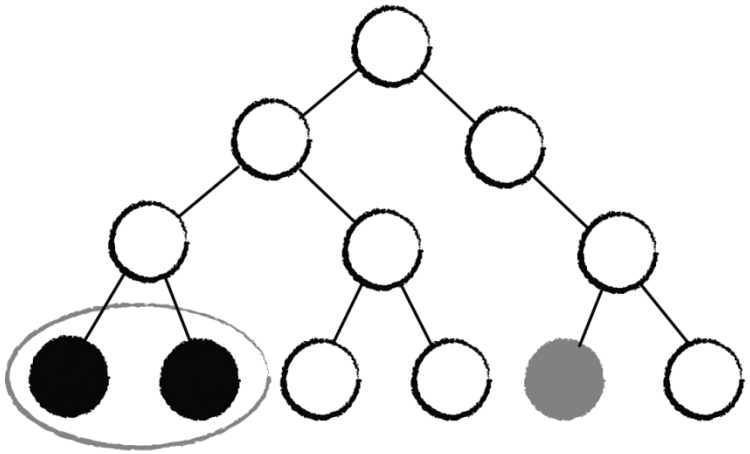


2. maths

$$\begin{bmatrix} 4 & 3 & 1 & 2 & 6 \\ 4 & 3 & 2 & 3 & 8 \\ 5 & 3 & 1 & 2 & 7 \\ 2 & 1 & 5 & 8 & 0 \\ 1 & 0 & 8 & 6 & 4 \end{bmatrix}$$

$$8^{6}5^{6}7^{8}7^{1}$$

$$\begin{bmatrix} X + Y = Z \\ A + B = C \\ X + A = Z \\ B + Y = ? \end{bmatrix}$$



3. model

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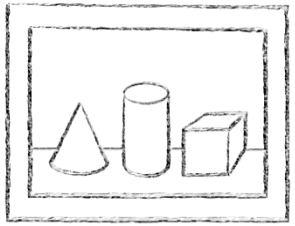
data – example



Grade	GPA	Age	Tall	Friends
A	3.5	16	Yes	12
C	2.0	12	No	3
F	2.1	13	Yes	1
B	3.5	17	Yes	6
D	2.0	18	No	4
A	3.8	15	No	6
D	2.3	14	No	4
B	3.3	17	Yes	8

features

gpa, age, tall, friends

values (x)

[A, 3.5, 16, Yes, 12]

- which students are most similar? how should they be grouped? given a new student, where does she belong?

DO SOMETHING

code

DISTANCE AND SIMILARITY

math

distance (metric)

- $d : X \times X \to \mathbb{R}$
- Must follow these rules:
  1. $d(x, y) \geq 0$
  2. $d(x, y) = 0 \iff x = y$
  3. $d(x, y) = d(y, x)$
  4. $d(x, z) \leq d(x, y) + d(y, z)$
- Main idea: if I have a Φ and a Ψ how far away are they from each other?
- **closer** – **similar**, **farther** – **dissimilar**

distance

- euclidian distance
- manhattan distance
- cosine distance
- hamming distance

k-means

- how it works
  - initialize K centers
  - find closest (distance) points to K centers
  - set each center to the average of the closest points
  - rinse and repeat until convergence

DEMONSTRATION

k-means

strings?!?!

1. the red dog →
2. cat eats dog →
3. dog eats food →
4. red cat eats →

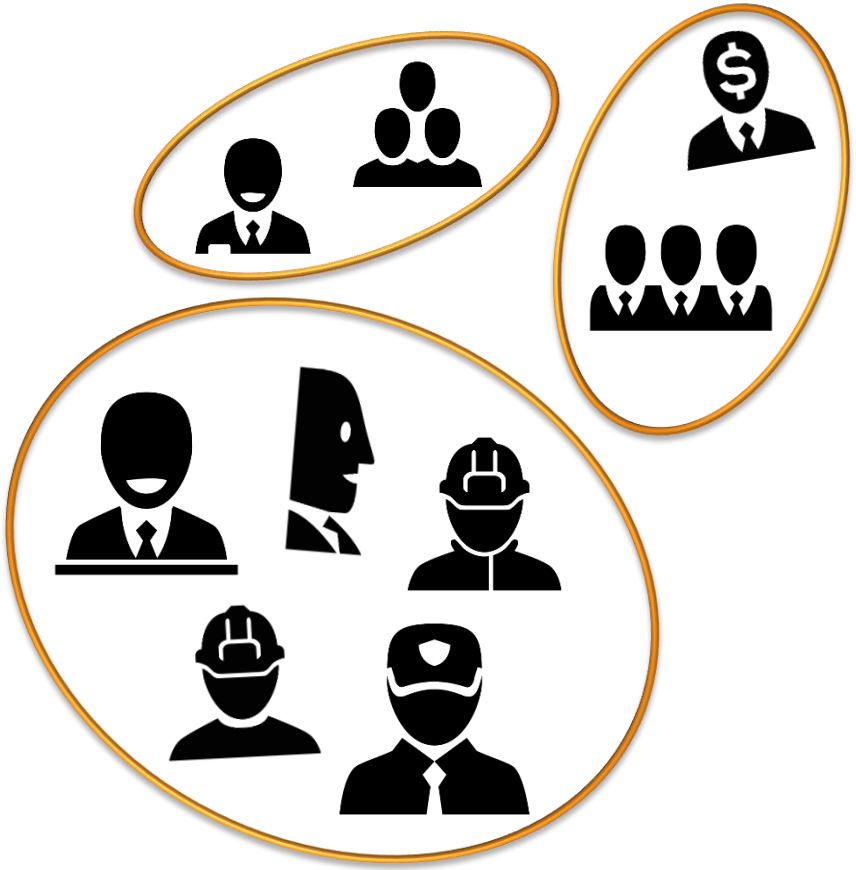
the	red	dog	cat	eats	food
1	1	1	0	0	0
0	0	1	1	1	0
0	0	1	0	1	1
0	1	0	1	1	0

RECOMMENDING

collaborative filtering / content-based filtering

collaborative filtering

- what people who are similar to me like?



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content-based filtering

- what items are similar to the one I chose?

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DEMONSTRATION

collaborative filtering / content-based filtering

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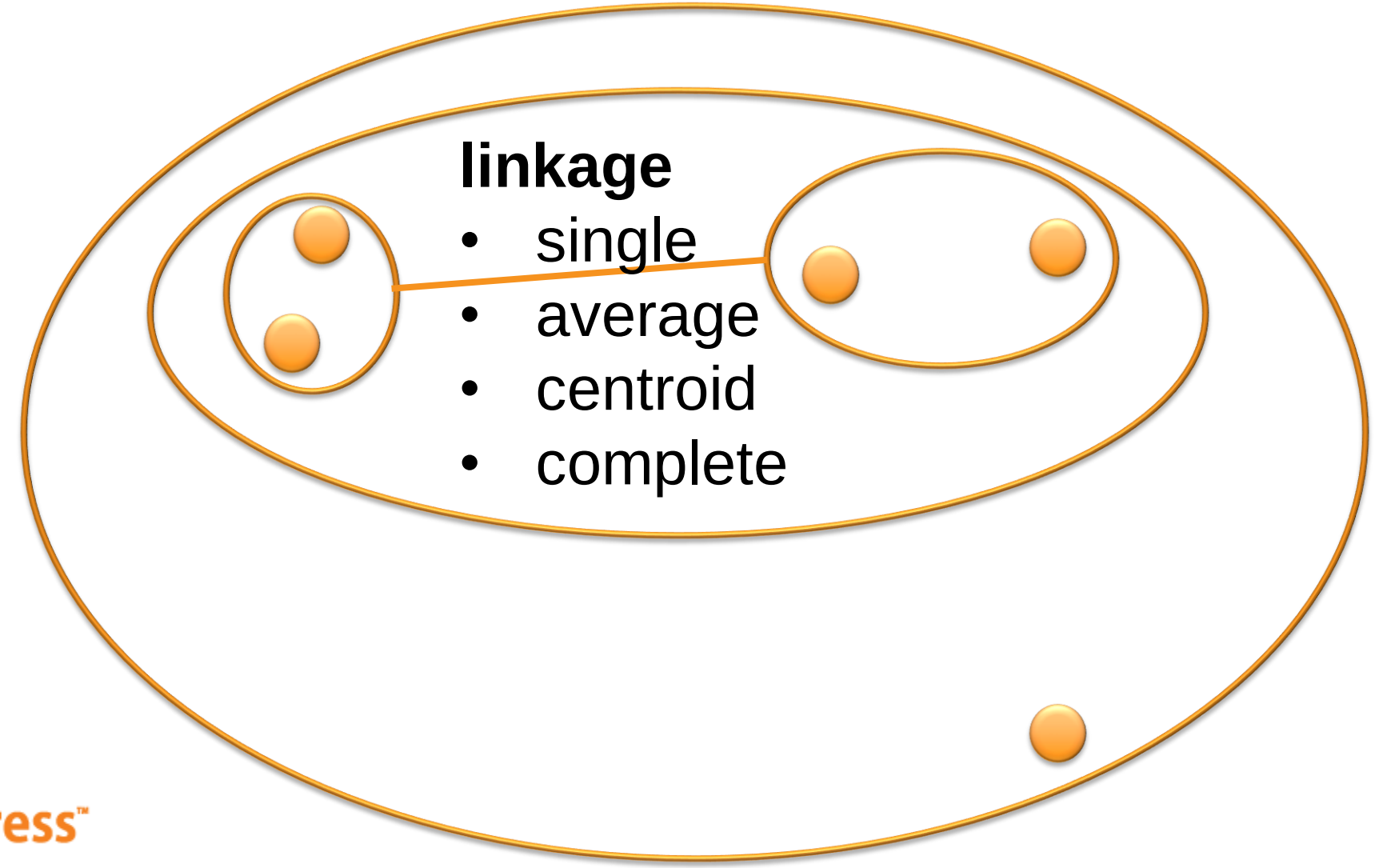
SIMILARITY

other ways of measuring similarity

HIERARCHICAL CLUSTERING

models

clustering



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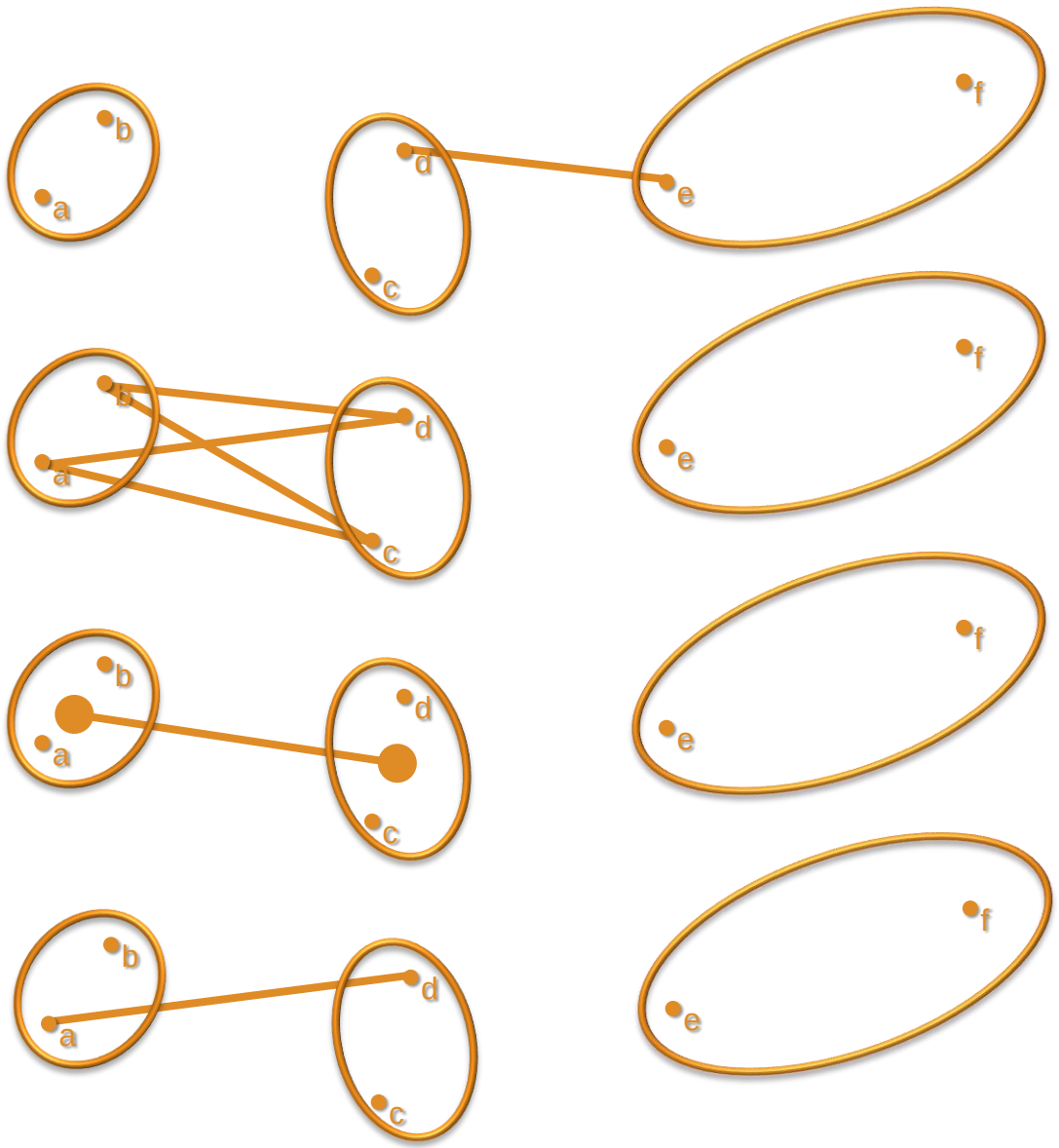
linkage

- single
- average
- centroid
- complete



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DEMONSTRATION

hierarchical clustering

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ANOMALY DETECTION

brainstorm / motivation

anomaly detection

- how could we use KMeans to detect anomalies?
  - step 1: get last **n** things and convert them to vectors (matrix)
  - step 2: get thing in question and add it to the bunch
  - step 3: run KMeans
  - step 4: measure distance of [new thing] from all centers
  - step 5: return min/avg/mode – whatever
  - step 6: tune (what is an acceptable threshold?)

anomaly detection

- how could we use Hierarchical Clustering to detect anomalies?

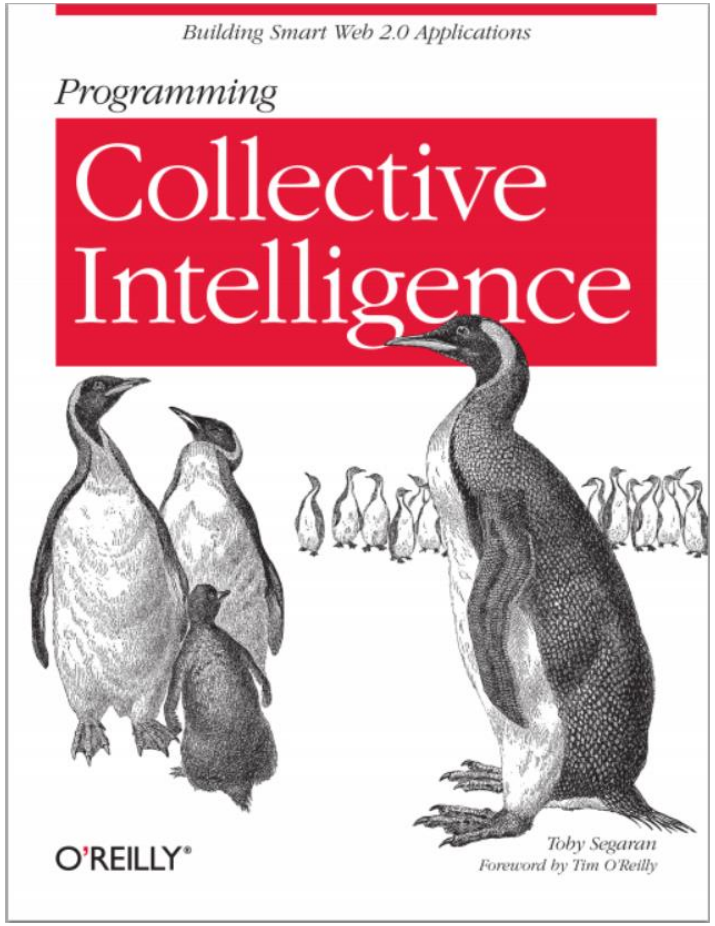
recap

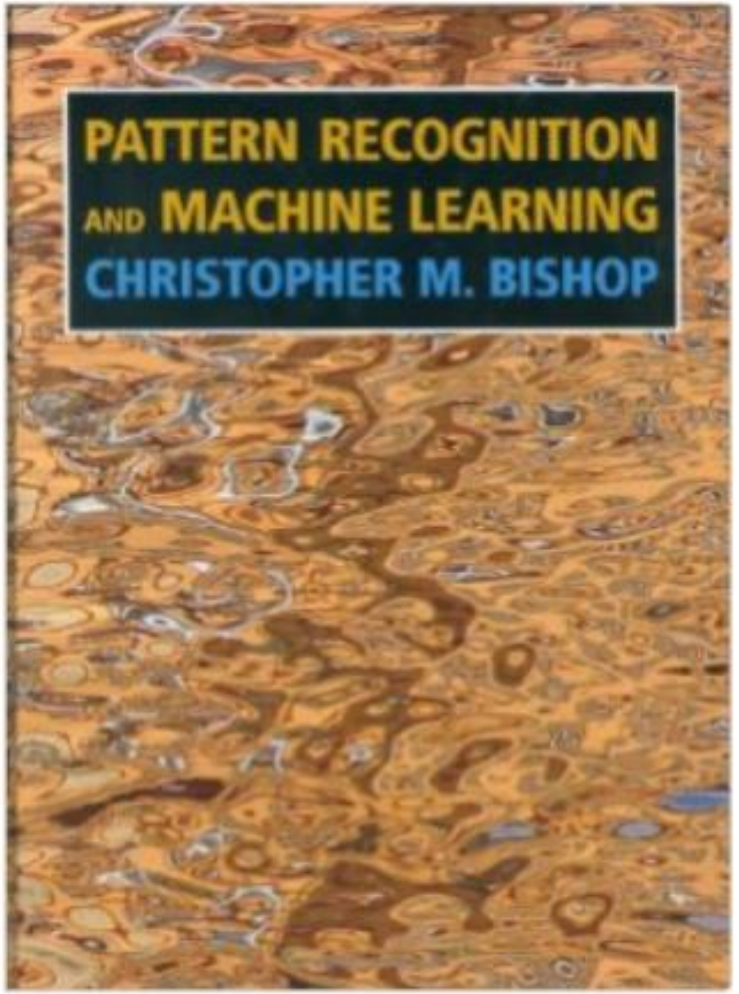
- a word about data science
- what is machine learning?
  - supervised
  - unsupervised
- recommender systems, anomaly detection
- k-means, hierarchical clustering
- nuML – http://numl.net

planned

- unsupervised learning:
  - gaussian mixture models
  - latent semantic analysis (better pca for text)
  - self organizing maps
  - smarter interfaces (API to deal with reduction chaining)
  - multi-processor, gpgpu

some reading





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QUESTIONS?

Seth Juarez

sethj@devexpress.com
@sethjuarez
Analytics Program Manager
DevExpress