COMP6237 Data Mining:
Introduction to Data Mining

Jo Houghton and
Markus Brede

J.Houghton@soton.ac.uk
Brede.Markus@gmail.com

Teaching Staff

- Credit goes to Jon Hare who developed a large part of the module

- Jo Houghton – VLC
  - J.Houghton@soton.ac.uk
  - 32/4031

- Markus Brede – AIC
  - Markus.Brede@soton.ac.uk
  - 32/4033

Module Overview

- Fairly new module, run for the 4th time
  - See feedback from last year
- Created to fill a gap
  - Data mining is almost synonymous with advanced machine learning
    - Inevitably some overlaps with COMP3206/COMP6208
      - Should be complementary and offer different views
    - Much more applied pragmatic focus
      - How do you work with real world data?
      - How do you solve real problems?

Module Structure

- Around 28 lectures + additional tutorials
  - Wide range of data mining topics

- Assessment
  - 50% 2 hour examination
  - 20% Individual coursework
  - 30% Group coursework

Module Timetable

- We have 4 slots timetabled for every week
  - Will not use all slots every week (some weeks we'll use all of them, in other weeks only 2 of them)
  - Have a look at the course webpage!
  - This may sometimes also change – we'll update you by email (check ECS module page)
- Roughly the plan is:

  Markus – Jo – Markus – Revisions

Coursework Timetable

- Group coursework
  - Set next week; report submission at the end of the term (May 17)
  - Will have presentation sessions at the end of the term
  - More in CW Q & A session Feb 8 in which we want you to have formed groups
- Individual coursework
  - Set week 4 (Feb 18)
  - Due one week before the Easter break (March 22)

Resources

- Course website [handouts, slides, interactive demos]
  - http://comp6237.ecs.soton.ac.uk
- ECS module pages [syllabus, announcements]
  - https://secure.ecs.soton.ac.uk:/module/comp6237
- Reading material
  - Toby Segaran. Programming Collective Intelligence: Building Smart Web 2.0 Applications. O'Reilly, 2007
  - Aurélien Géron. Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems. O'Reilly Media. March 2017

What is Data Mining?

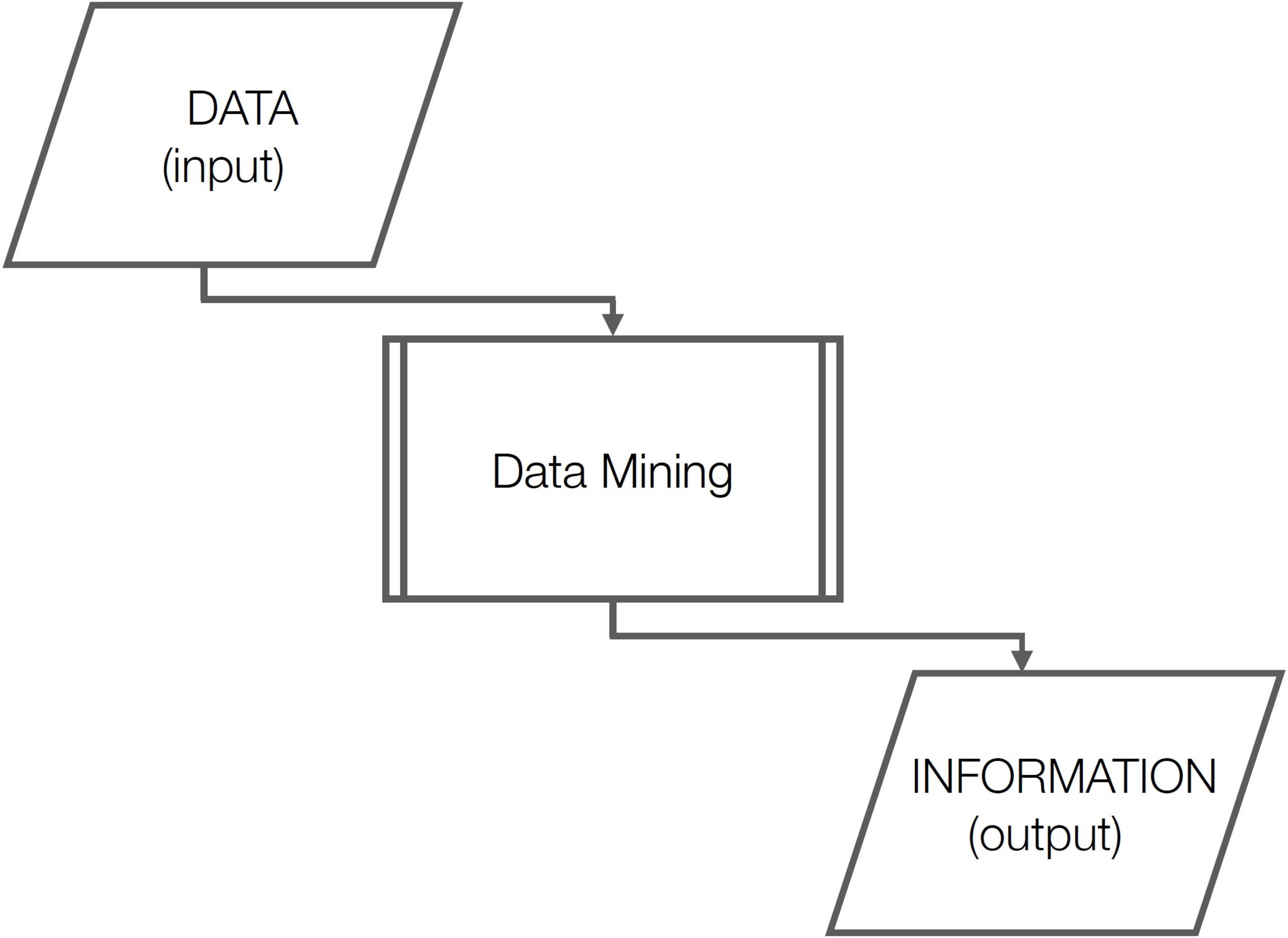
"Data mining is an interdisciplinary subfield of computer science. It is the computational process of discovering patterns in large data sets involving methods at the intersection of artificial intelligence, machine learning, statistics, and database systems. The overall goal of the data mining process is to <u>extract information from a data set and transform it into an understandable</u> structure for further use."

– wikipedia

What is Data Mining?

“Generally, data mining (sometimes called data or knowledge discovery) is the process of analyzing data from different perspectives and summarizing it into useful information - information that can be used to increase revenue, cuts costs, or both.”

– Bill Palace, Anderson Graduate School of Management at UCLA, 1996


DATA
(input)
Data Mining
INFORMATION
(output)

What is Data?

- Data is any sequence of one or more symbols given meaning by specific act(s) of interpretation.
- Data (or datum - a single unit of data) is not information.
  - Data requires interpretation to become information.
  - To translate data to information, there must be several known factors considered. The factors involved are determined by the creator of the data and the desired information.

What is Information?

- There is a formal definition → Information theory … will have a bit of a look at this later.

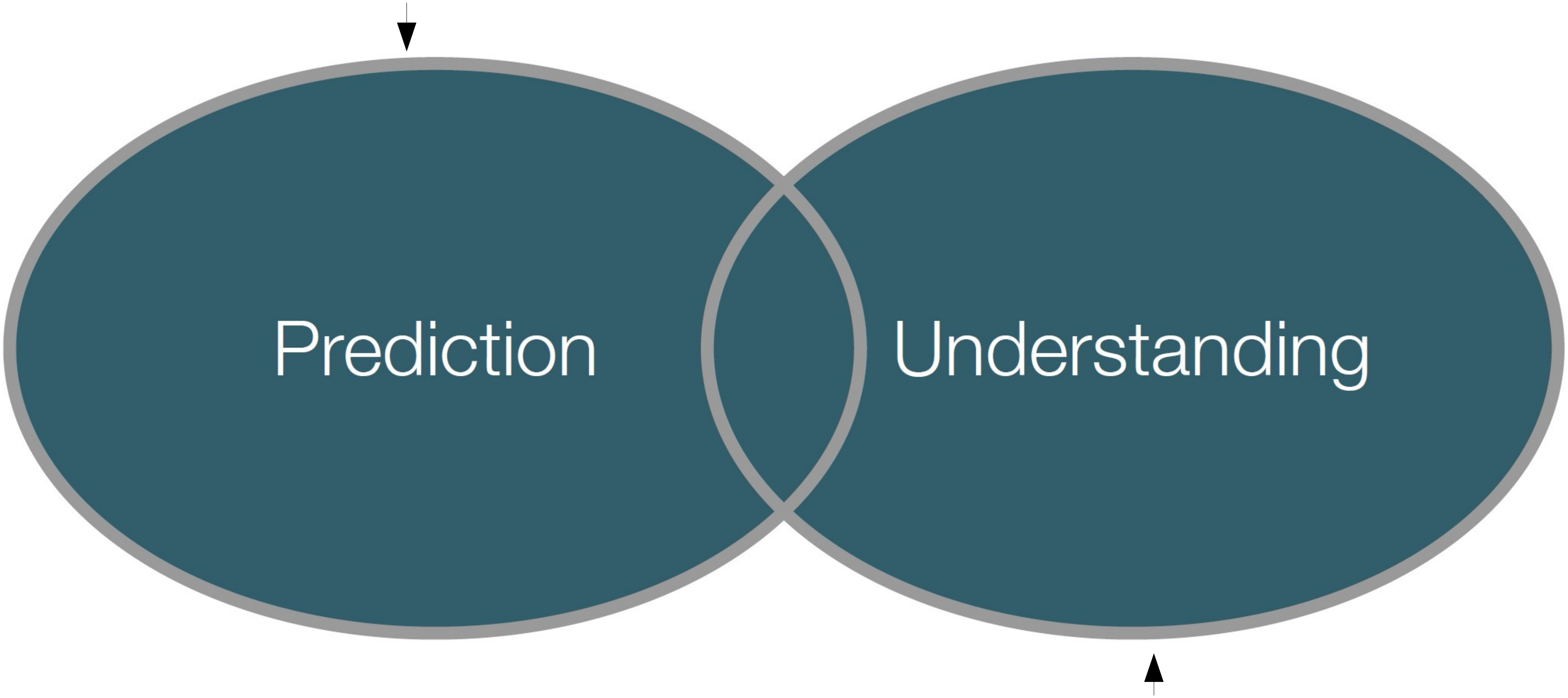
- “Actionable knowledge”
  - **Prediction**
    - Christoph Adami (Michigan State) defines information as: ‘the ability to make predictions with a likelihood better than chance’.
    - **Understanding**
      - Making sense of the data

What is Data Mining?

- Given lots of data …
- **Discover patterns and models** that are:
  - **Valid**: hold on new data with some certainty
  - **Useful**: should be possible to act on the item
  - **Unexpected**: non-obvious to the system
  - **Understandable**: humans should be able to interpret the pattern

Two Complementary Goals of Data Mining

Use some variables to predict unknown or future values of other variables

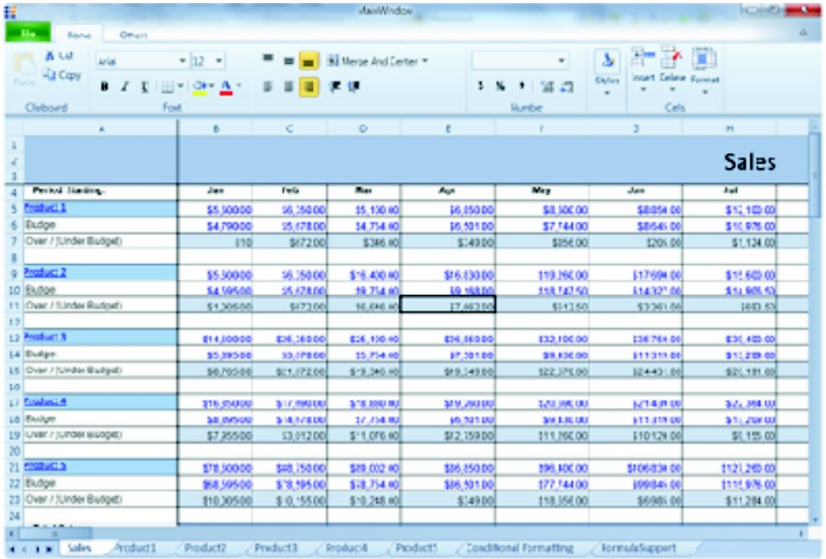


Prediction

Understanding

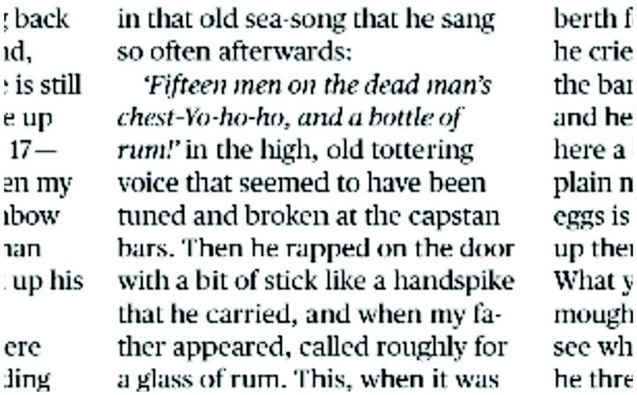
Find human-interpretable patterns that describe the data

What kinds of data are we interested in mining?



	A	B	C	D	E	F	G	H
1								
2								Sales
3								
4	Period Ending	Jan	Feb	Mar	Apr	May	Jun	Jul
5	Product 1	$5,300.00	$6,250.00	$5,100.00	$6,850.00	$8,300.00	$8054.00	$12,100.00
6	Budge	$4,790.00	$5,678.00	$4,754.00	$6,501.00	$7,744.00	$8646.00	$10,976.00
7	Over / (Under Budget)	$10	$672.00	$346.00	$349.00	$856.00	$206.00	$1,124.00
8								
9	Product 2	$5,300.00	$6,250.00	$16,400.00	$16,830.00	$19,260.00	$17694.00	$15,600.00
10	Budge	$4,595.00	$5,678.00	$9,754.00	$9,168.00	$18,747.50	$14327.00	$14,906.50
11	Over / (Under Budget)	$1,305.00	$672.00	$6,646.00	$7,662.00	$513.50	$3361.00	$693.50
12								
13	Product 3	$14,000.00	$26,250.00	$26,100.00	$26,850.00	$32,100.00	$36764.00	$30,400.00
14	Budget	$5,295.00	$5,078.00	$5,754.00	$7,301.00	$9,830.00	$11311.00	$11,209.00
15	Over / (Under Budget)	$8,705.00	$21,172.00	$19,346.00	$19,549.00	$22,270.00	$24451.00	$20,191.00
16								
17	Product 4	$16,050.00	$17,690.00	$18,800.00	$19,250.00	$20,096.00	$21480.00	$22,384.00
18	Budget	$8,695.00	$14,678.00	$7,754.00	$6,501.00	$8,836.00	$11,419.00	$11,209.00
19	Over / (Under Budget)	$7,355.00	$3,012.00	$11,076.00	$12,359.00	$11,260.00	$10129.00	$9,155.00
20								
21	Product 5	$78,300.00	$88,750.00	$89,002.00	$86,850.00	$96,100.00	$106834.00	$121,260.00
22	Budge	$68,595.00	$78,595.00	$78,754.00	$86,501.00	$77,744.00	$99846.00	$111,976.00
23	Over / (Under Budget)	$10,305.00	$10,155.00	$10,248.00	$349.00	$18,356.00	$6986.00	$11,284.00
24								

Sales
Product1
Product2
Product3
Product4
Product5
Conditional Formatting
FormulaSupport



g back
id,
e is still
e up
17—
en my
ibow
ian
up his

ere
ding

in that old sea-song that he sang
so often afterwards:

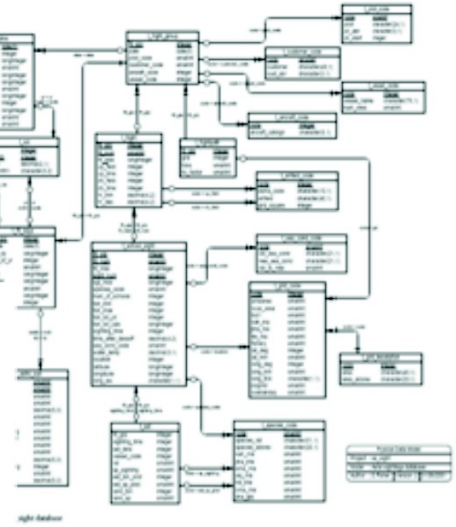
'Fifteen men on the dead man's chest-Yo-ho-ho, and a bottle of rum!' in the high, old tottering voice that seemed to have been tuned and broken at the capstan bars. Then he rapped on the door with a bit of stick like a handspike that he carried, and when my father appeared, called roughly for a glass of rum. This, when it was

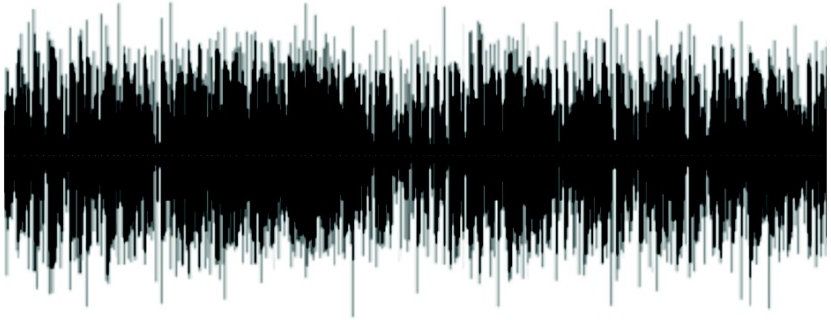
berth f
he crie
the bar
and he
here a
plain n
eggs is
up the
What y
mough
see wh
he thre

Twitter API @twitterapi 11 Jun
As part of the retirement plan today, we're also about to discontinue Basic Auth support for unelevated Streaming API roles. Use OAuth 1.0A.
Expand

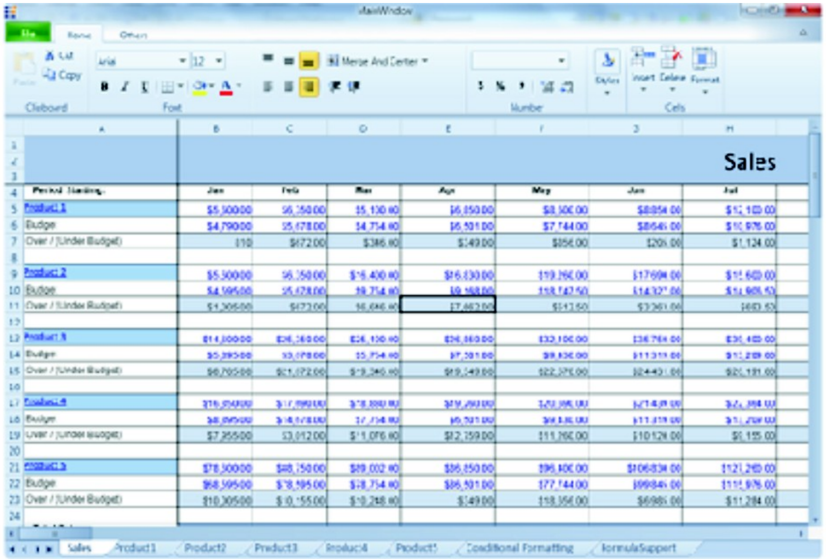
Twitter API @twitterapi 11 Jun
The retirement of API v1 continues. Most inbound requests should now see HTTP 410, including to the old Search API. dev.twitter.com/docs/faq#17750
Expand

Twitter API @twitterapi 11 Jun
If you were using a legacy widget that no longer functions after API v1 retirement, we suggest using dev.twitter.com/docs/embedded-… instead.
Show Summary

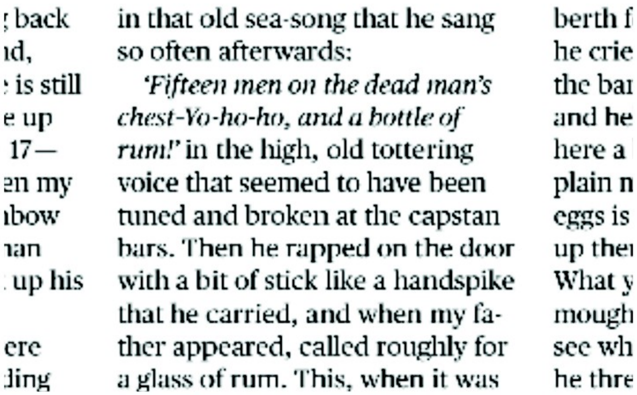




Categorizing data: Structured/ Unstructured



	A	B	C	D	E	F	G	H
1								Sales
2								
3								
4	Period Ending	Jan	Feb	Mar	Apr	May	Jun	Jul
5	Product 1	$5,500.00	$6,350.00	$5,130.40	$6,850.00	$8,500.00	$8054.00	$12,100.00
6	Budge	$4,790.00	$5,478.00	$4,754.40	$6,501.00	$7,744.00	$8646.00	$10,976.00
7	Over / (Under Budget)	$10	$872.00	$386.40	$349.00	$856.00	$206.00	$1,124.00
8								
9	Product 2	$5,500.00	$6,350.00	$16,400.40	$16,830.00	$19,260.00	$17698.00	$15,600.00
10	Budge	$4,595.00	$5,478.00	$9,754.40	$9,168.00	$18,747.50	$14,327.00	$14,905.50
11	Over / (Under Budget)	$1,305.00	$872.00	$6,646.40	$7,662.00	$513.50	$3,361.00	$683.50
12								
13	Product 3	$14,300.00	$26,350.00	$26,130.40	$26,860.00	$33,100.00	$36,764.00	$30,400.00
14	Budge	$5,395.00	$5,078.00	$5,754.40	$7,501.00	$9,836.00	$11311.00	$11,209.00
15	Over / (Under Budget)	$8,705.00	$21,272.00	$19,346.40	$19,349.00	$22,376.00	$24431.00	$20,191.00
16								
17	Product 4	$16,050.00	$17,090.00	$18,800.40	$19,260.00	$20,396.00	$21489.00	$22,364.00
18	Budge	$8,695.00	$14,078.00	$7,754.40	$6,501.00	$9,536.00	$11,419.00	$11,209.00
19	Over / (Under Budget)	$7,355.00	$3,012.00	$11,076.40	$12,759.00	$11,260.00	$10124.00	$11,155.00
20								
21	Product 5	$78,300.00	$88,750.00	$89,002.40	$86,850.00	$96,400.00	$106834.00	$121,260.00
22	Budge	$68,595.00	$78,595.00	$78,754.40	$86,501.00	$77,744.00	$99846.00	$111,976.00
23	Over / (Under Budget)	$10,305.00	$10,155.00	$10,248.40	$349.00	$18,356.00	$6986.00	$11,284.00
24								



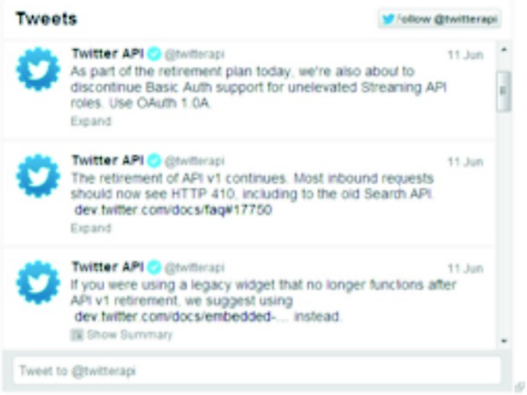
back
nd,
is still
e up
17—
en my
ibow
nan
up his

ere
ding

in that old sea-song that he sang
so often afterwards:

*'Fifteen men on the dead man's
chest-Yo-ho-ho, and a bottle of
rum!'* in the high, old tottering
voice that seemed to have been
tuned and broken at the capstan
bars. Then he rapped on the door
with a bit of stick like a handspike
that he carried, and when my father appeared, called roughly for
a glass of rum. This, when it was

berth f
he crie
the bar
and he
here a
plain n
eggs is
up the
What y
mough
see wh
he thre

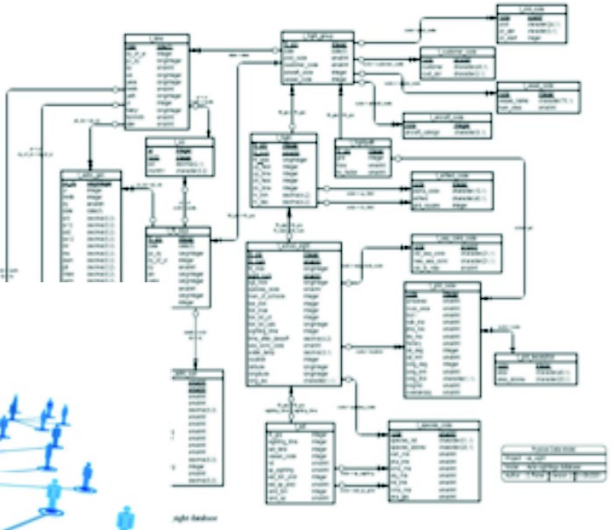


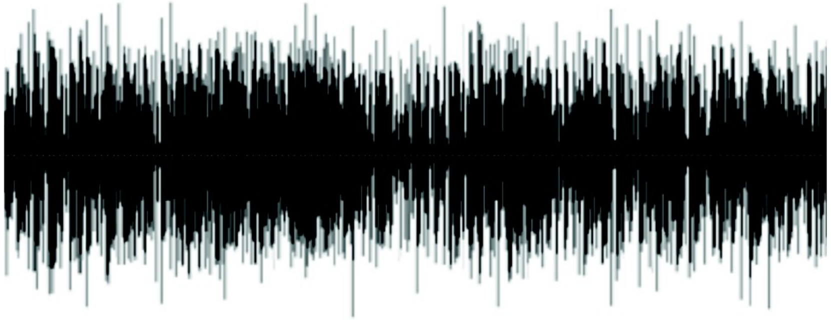
Twitter API @twitterapi 11 Jun
As part of the retirement plan today, we're also about to discontinue Basic Auth support for unelevated Streaming API roles. Use OAuth 1.0A.
Expand

Twitter API @twitterapi 11 Jun
The retirement of API v1 continues. Most inbound requests should now see HTTP 410, including to the old Search API. dev.twitter.com/docs/faq#17750
Expand

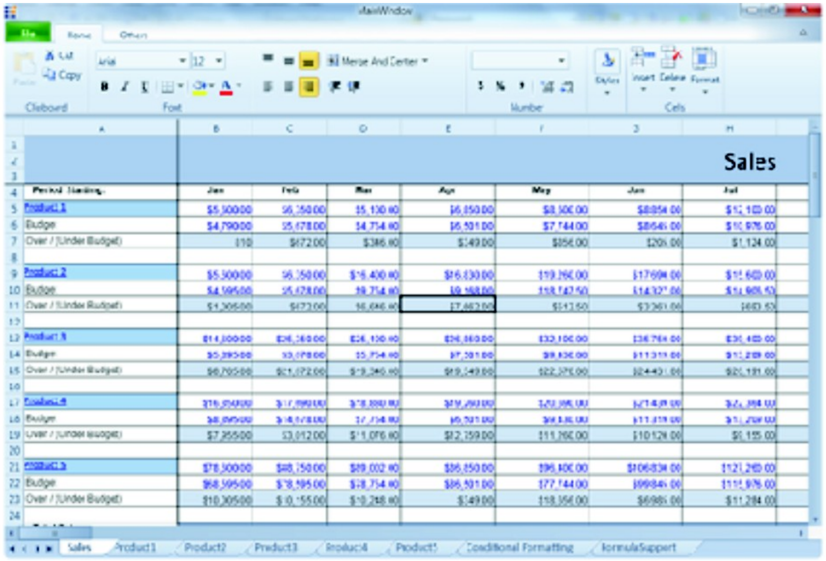
Twitter API @twitterapi 11 Jun
If you were using a legacy widget that no longer functions after API v1 retirement, we suggest using dev.twitter.com/docs/embedded-… instead.
Show Summary

Tweet to @twitterapi



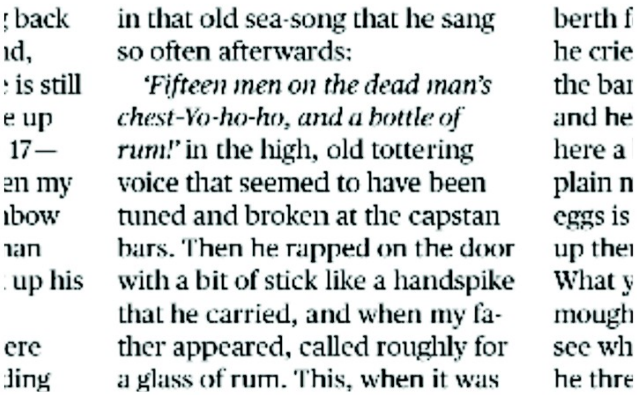


Categorizing data: Dynamic/static



	A	B	C	D	E	F	G	H
1								
2								Sales
3								
4	Period Ending	Jan	Feb	Mar	Apr	May	Jun	Jul
5	Product 1	$5,500.00	$6,250.00	$5,130.00	$6,850.00	$8,500.00	$8854.00	$12,100.00
6	Budge	$4,790.00	$5,478.00	$4,754.00	$6,501.00	$7,744.00	$8646.00	$10,976.00
7	Over / (Under Budget)	$10	$672.00	$386.00	$349.00	$856.00	$208.00	$1,124.00
8								
9	Product 2	$5,500.00	$6,250.00	$16,400.00	$16,630.00	$19,296.00	$17694.00	$15,600.00
10	Budge	$4,595.00	$5,478.00	$9,754.00	$9,168.00	$18,747.50	$14327.00	$14,905.50
11	Over / (Under Budget)	$1,305.00	$672.00	$6,646.00	$7,462.00	$513.50	$3361.00	$683.50
12								
13	Product 3	$14,000.00	$26,260.00	$26,100.00	$26,860.00	$32,100.00	$36,764.00	$30,400.00
14	Budget	$5,295.00	$5,478.00	$5,754.00	$7,501.00	$9,830.00	$11311.00	$11,209.00
15	Over / (Under Budget)	$8,705.00	$21,772.00	$19,346.00	$19,349.00	$22,270.00	$24451.00	$20,191.00
16								
17	Product 4	$16,050.00	$17,490.00	$18,830.00	$19,260.00	[illegible]	[illegible]	[illegible]
18	Budget	$8,695.00	$14,478.00	$7,754.00	$6,501.00	[illegible]	$11,319.00	$11,209.00
19	Over / (Under Budget)	$7,355.00	$3,012.00	$11,076.00	$12,759.00	$11,166.00	$10128.00	$8,155.00
20								
21	Product 5	$78,500.00	$88,750.00	$89,002.00	$86,850.00	$96,100.00	$106834.00	$121,260.00
22	Budge	$68,595.00	$78,595.00	$78,754.00	$86,501.00	$77,744.00	$99846.00	$111,976.00
23	Over / (Under Budget)	$10,305.00	$10,155.00	$10,248.00	$349.00	$18,356.00	$6988.00	$11,284.00
24								

Sales
Product1
Product2
Product3
Product4
Product5
Conditional Formatting
FormulaSupport



g back
nd,
e is still
e up
17—
en my
nbow
nan
up his

ere
ding

in that old sea-song that he sang so often afterwards:

'Fifteen men on the dead man's chest-Yo-ho-ho, and a bottle of rum!' in the high, old tottering voice that seemed to have been tuned and broken at the capstan bars. Then he rapped on the door with a bit of stick like a handspike that he carried, and when my father appeared, called roughly for a glass of rum. This, when it was

berth f
he crie
the bar
and he
here a
plain n
eggs is
up then
What y
mough
see wh
he thre

Tweets

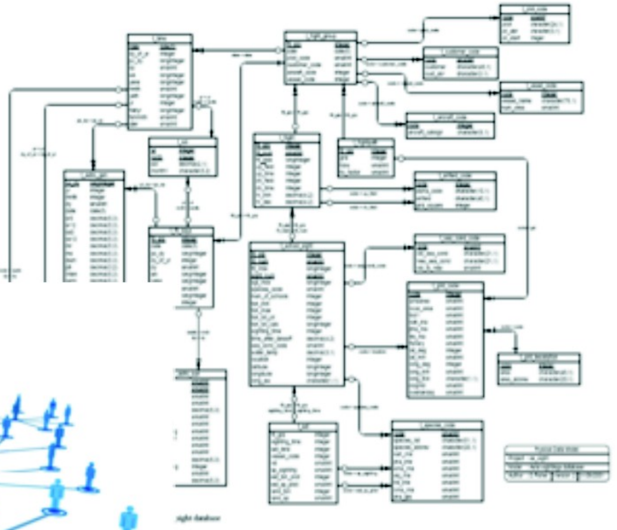
Follow @twitterapi

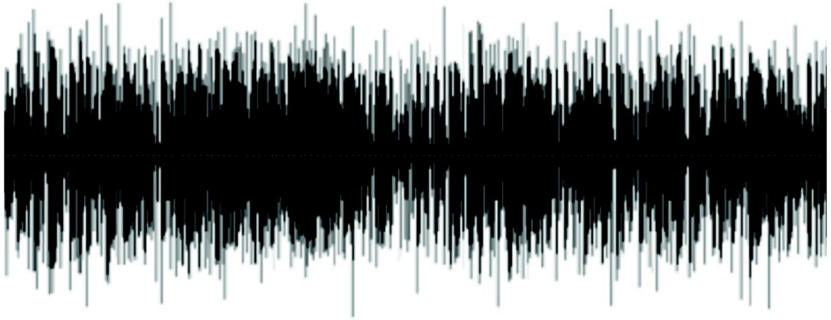
Twitter API @twitterapi 11 Jun
As part of the retirement plan today, we're also about to discontinue Basic Auth support for unelevated Streaming API roles. Use OAuth 1.0A.
Expand

Twitter API @twitterapi 11 Jun
The retirement of API v1 continues. Most inbound requests should now see HTTP 410, including to the old Search API dev.twitter.com/docs/faq#17750
Expand

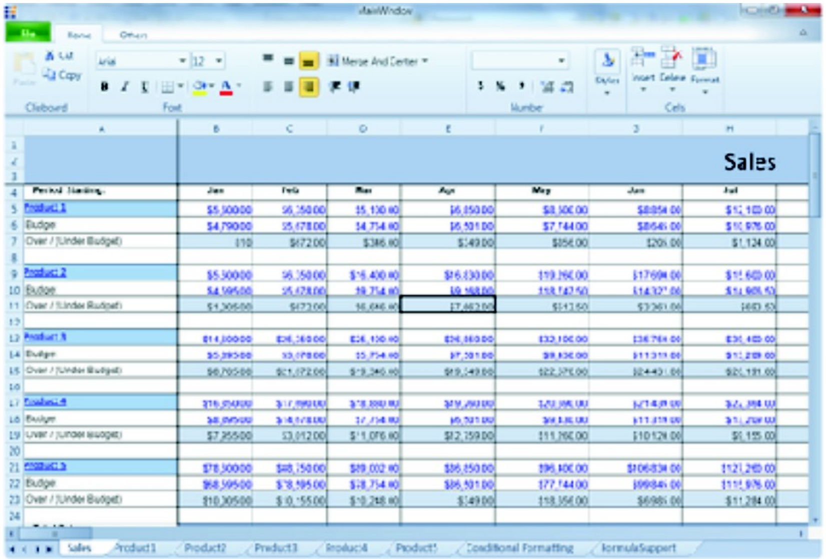
Twitter API @twitterapi 11 Jun
If you were using a legacy widget that no longer functions after API v1 retirement, we suggest using dev.twitter.com/docs/embedded-... instead.
Show Summary

Tweet to @twitterapi

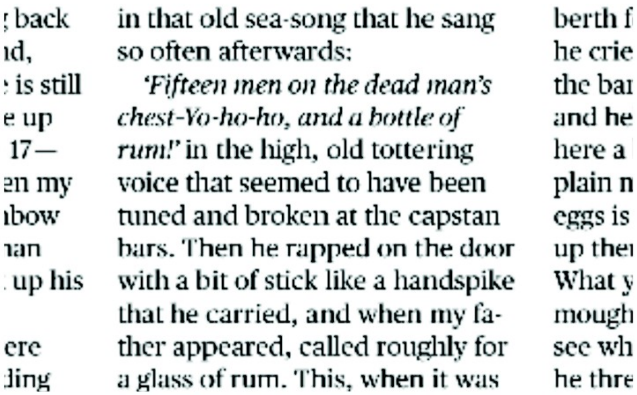




Categorizing data: Unimodal/multimodal



	A	B	C	D	E	F	G	H
1								
2								Sales
3								
4	Period Ending	Jan	Feb	Mar	Apr	May	Jun	Jul
5	Product 1	$5,500.00	$6,250.00	$5,130.00	$6,850.00	$8,500.00	$8854.00	$12,100.00
6	Budge	$4,790.00	$5,478.00	$4,754.00	$6,501.00	$7,744.00	$8646.00	$10,976.00
7	Over / (Under Budget)	$10	$672.00	$386.00	$349.00	$856.00	$208.00	$1,124.00
8								
9	Product 2	$5,500.00	$6,250.00	$16,400.00	$16,830.00	$19,266.00	$17694.00	$15,600.00
10	Budge	$4,595.00	$5,478.00	$9,754.00	$9,168.00	$18,742.50	$14327.00	$14,905.50
11	Over / (Under Budget)	$1,305.00	$672.00	$6,646.00	$7,662.00	$543.50	$3361.00	$693.50
12								
13	Product 3	$14,100.00	$26,250.00	$26,130.00	$26,860.00	$32,100.00	$36764.00	$36,400.00
14	Budge	$5,395.00	$5,078.00	$5,754.00	$7,501.00	$9,836.00	$11311.00	$11,209.00
15	Over / (Under Budget)	$8,705.00	$21,172.00	$19,346.00	$19,349.00	$22,276.00	$24451.00	$25,191.00
16								
17	Product 4	$16,050.00	$17,690.00	$18,880.00	$19,260.00	$20,986.00	$21469.00	$22,368.00
18	Budge	$8,695.00	$14,678.00	$7,754.00	$6,501.00	$9,836.00	$11319.00	$11,209.00
19	Over / (Under Budget)	$7,355.00	$3,012.00	$11,076.00	$12,759.00	$11,266.00	$10124.00	$8,155.00
20								
21	Product 5	$78,500.00	$88,250.00	$89,002.00	$86,850.00	$96,400.00	$106834.00	$121,240.00
22	Budge	$68,595.00	$78,595.00	$78,754.00	$86,501.00	$77,744.00	$99848.00	$111,976.00
23	Over / (Under Budget)	$10,305.00	$10,155.00	$10,248.00	$349.00	$18,356.00	$6986.00	$11,284.00
24								



g back
nd,
e is still
e up
17—
en my
nbow
nan
up his

ere
ding

in that old sea-song that he sang so often afterwards:

'Fifteen men on the dead man's chest-Yo-ho-ho, and a bottle of rum!' in the high, old tottering voice that seemed to have been tuned and broken at the capstan bars. Then he rapped on the door with a bit of stick like a handspike that he carried, and when my father appeared, called roughly for a glass of rum. This, when it was

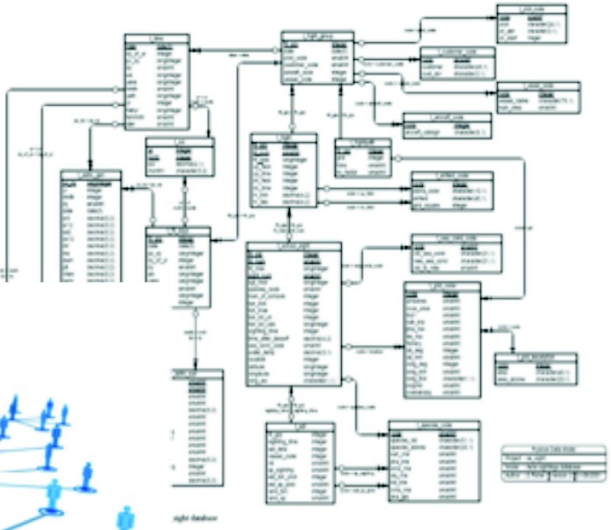
berth f
he crie
the bar
and he
here a
plain n
eggs is
up the
What y
mough
see wh
he thre

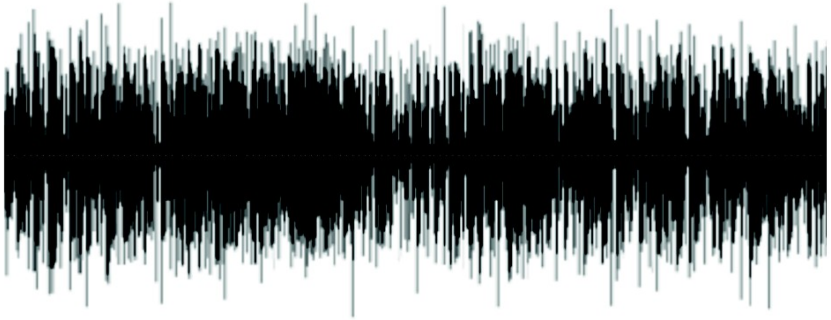
Twitter API @twitterapi 11 Jun
As part of the retirement plan today, we're also about to discontinue Basic Auth support for unelevated Streaming API roles. Use OAuth 1.0A.
Expand

Twitter API @twitterapi 11 Jun
The retirement of API v1 continues. Most inbound requests should now see HTTP 410, including to the old Search API dev.twitter.com/docs/faq#17750
Expand

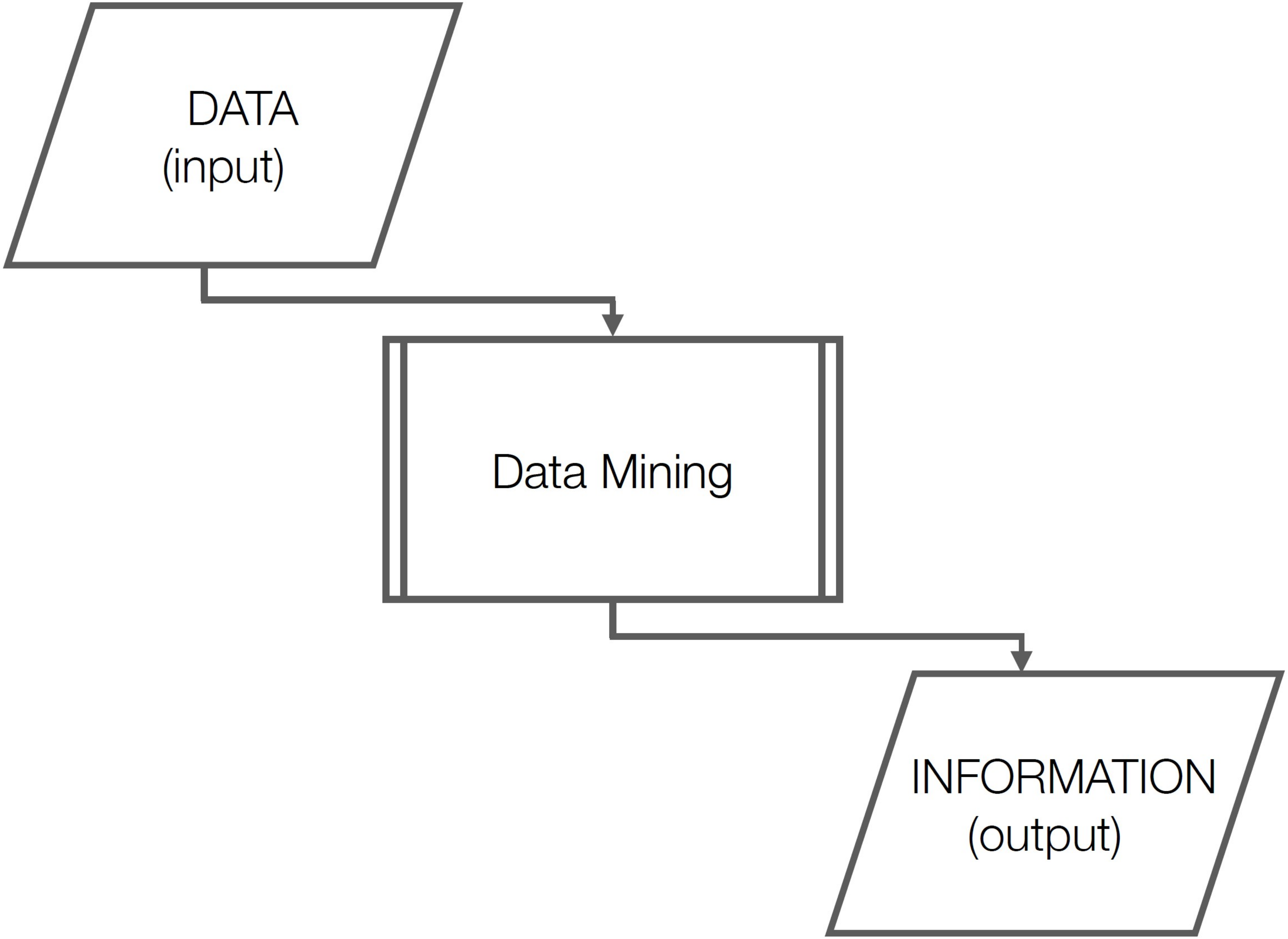
Twitter API @twitterapi 11 Jun
If you were using a legacy widget that no longer functions after API v1 retirement, we suggest using dev.twitter.com/docs/embedded-… instead.
Show Summary

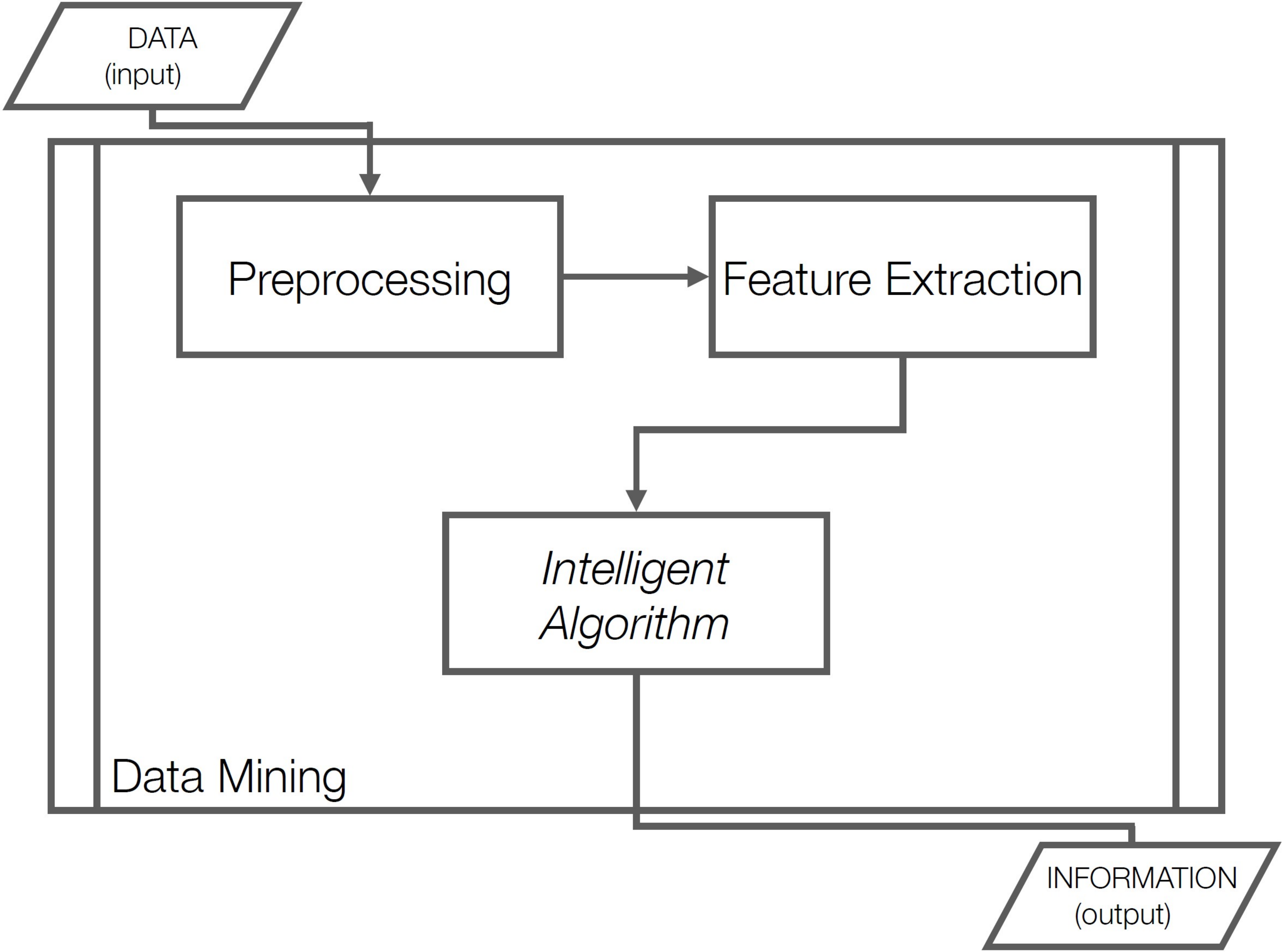
Tweet to @twitterapi





Typical Data Mining Pipeline




DATA
(input)
Preprocessing
Feature Extraction
Intelligent Algorithm
Data Mining
INFORMATION
(output)

Descriptive Techniques

PCA

ICA

MDS

Clustering

Anomaly Detection

. . .

Intelligent Algorithm

Predictive Techniques

Classification

Ranking

Regression

Matrix Completion

. . .

The Plan for the Next 12 Weeks

- You will learn to solve real-world problems – e.g.:
  - Recommender systems
  - Market Basket Analysis
  - Document filtering and spam detection
  - Duplicate document detection
- You will also learn various tools & techniques - e.g.:
  - Linear algebra (SVD, Eigendecomposition & PCA, NNMF, etc.
  - Optimisation (e.g. stochastic gradient descent)
  - Dynamic programming (frequent itemsets)
  - Hashing (LSH, Sketching, Bloom Filters)
- You will learn a bit of theory
  - Statistics of regression analysis
  - Information theory
  - Network theory

The Group Coursework

- You need to form groups
  - Target size is 6 (+/- 1)
  - As a group, you need to choose a **predictive** data mining problem to work on
    - (You’ll need to train and evaluate models and compare their performance [possibly against approaches from others])
- Come along to the Friday slot next week to discuss your ideas for problems to work on with us

Key Dates

- Each team needs to submit a 1-page project brief by the end of the day of the 15th of Feb.
- In week 9 must present their idea and approaches to the class.
  - Teams should be prepared to present in the first slot; to ensure fairness we will pick teams at random
- Teams must submit a conference paper by 4pm on May 17.