

DATA CLEANING & DATA MANIPULATION

PETRA ISENBERG

VISUAL ANALYTICS

WHAT IS “DIRTY DATA”?

BEFORE WE CAN TALK ABOUT CLEANING, WE NEED TO KNOW ABOUT TYPES OF ERROR AND WHERE THEY COME FROM

SOURCES OF ERROR

DATA ENTRY ERRORS

MEASUREMENT ERRORS

DISTILLATION ERRORS

DATA INTEGRATION ERRORS

DATA ENTRY ERROR

LOTS OF DATA IS
ENTERED BY HAND

TYPOGRAPHIC ERRORS

MISUNDERSTANDING
DATA OR CONVENTIONS

“SPURIOUS INTEGRITY”

“SPURIOUS INTEGRITY”

ENTERING BAD DATA IN RESPONSE TO (OFTEN WELL-INTENTIONED) INTERFACE CONSTRAINTS

“SPURIOUS INTEGRITY”

Step 1: Activity/Equipment Type

Step 2: Add a Map

Step 3: Additional Details

Date of Activity:

Duration:

September 2014

Su	M	Tu	We	Th	Fr	Sa
7						
14						
21	22	23	24	25	26	27
28	29	30				

00 : 00 : 00



Oops! You forgot to enter a duration for this activity.

5.62 mi

Training Plan:

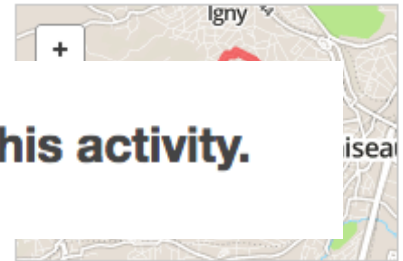
None

Average Heart Rate (optional):

bpm

Add An Activity

Activity Details



Activity Type:	Running
Equipment Type:	None
Route:	None
Distance:	5.62 mi.
Duration:	--:--

MEASUREMENT ERRORS

SENSOR ISSUES

MALFUNCTIONS

PLACEMENT

INTERFERENCE

MISCALIBRATION



DISTILLATION ERRORS

SOME DATA MAY BE LOST OR COMPRESSED
BEFORE IT ENTERS
THE DATABASE

0.345413 → 0.35

National Price Index → NPI

1985, \$2, Apples
1985, \$2, Oranges → 1985, \$2, "Apples, Oranges, Cucumbers"
1985, \$2, Cucumbers

DATA INTEGRATION ERRORS

DATA OFTEN COMES FROM MULTIPLE SOURCES

SCHEMAS CHANGE OVER TIME

DATA IS OFTEN COERCED FROM
ONE TYPE TO ANOTHER

**CAN LEAD TO DATA LOSS,
DUPLICATION, AND OTHER**

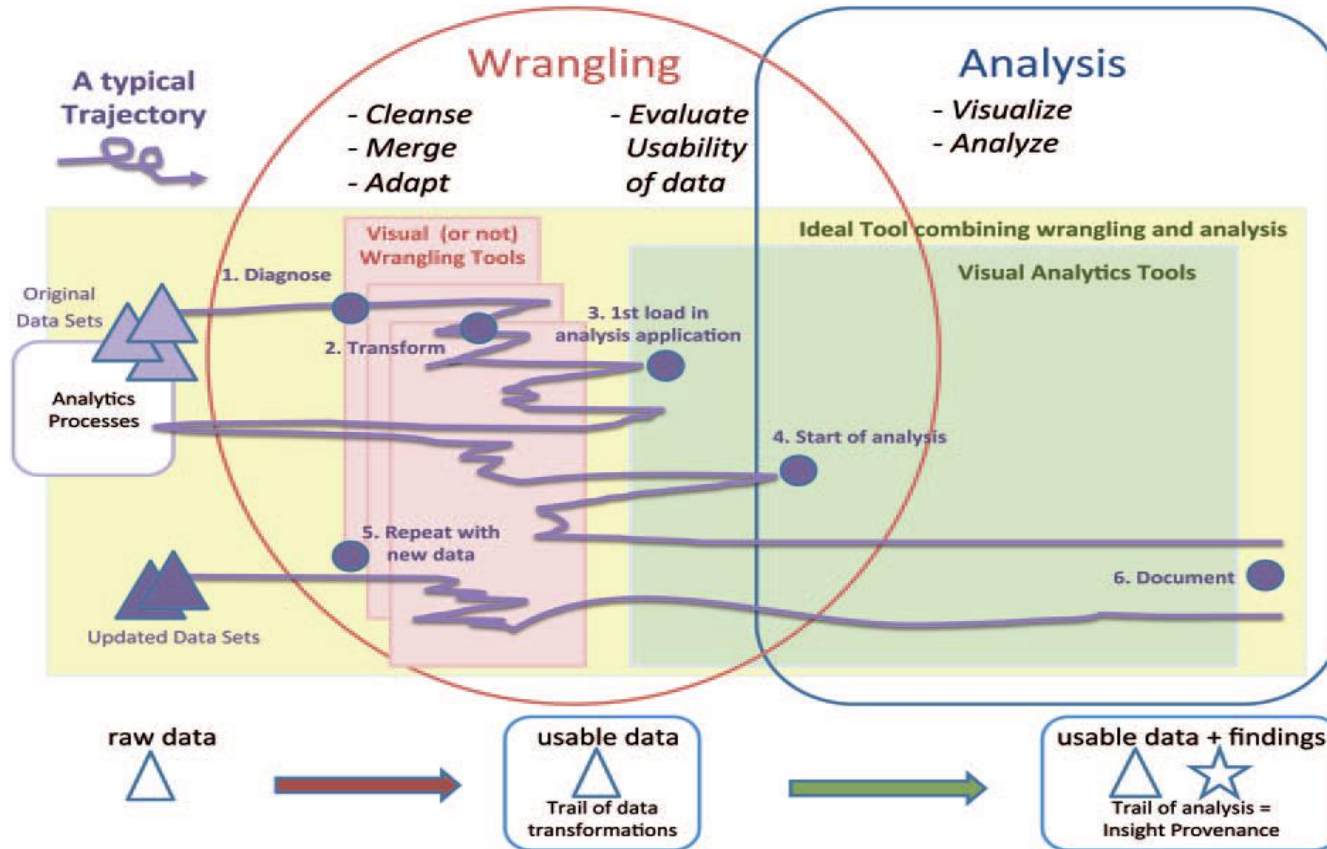
WHY IS THIS IMPORTANT?

**MOST OF THE TIME IN THE DATA
ANALYSIS PROCESS IS ACTUALLY
SPENT HERE!**

“I spend more than half my time integrating, cleansing, and transforming data without doing any actual analysis. Most of the time I’m lucky if I get to do any ‘analysis’ at all.”

[Kandel 2012]

ANALYSIS TRAJECTORIES



SOME DATA QUALITY ISSUES

MISSING DATA

MISSED MEASUREMENTS, REDACTED ITEMS, INCOMPLETE FORMS, ETC.

ERRONEOUS VALUES

MISPELLINGS, OUTLIERS, "SPURIOUS INTEGRITY", ETC.

ENTITY RESOLUTION

DIFFERENT VALUES, ABBREVS., 2+ ENTRIES FOR THE SAME THING?

TYPE CONVERSION

E.G., ZIP CODE OR PLACE NAME TO LAT-LON

DATA INTEGRATION

MISMATCHES AND INCONSISTENCIES WHEN COMBINING DATA

**SOME APPROACHES FOR
IMPROVING DATA QUALITY**

**TOOLS FOR MANIPULATING
AND CLEANING DATA**

SOME APPROACHES FOR IMPROVING DATA QUALITY

**TOOLS FOR MANIPULATING
AND CLEANING DATA**

PREVENTING ERROR ERROR

CATCHING DIRTY DATA AT THE SOURCE

MINIMIZING SENSOR ERROR

CALIBRATE AND VERIFY SENSORS



CHECK SENSORS BEFORE DEPLOYMENT (AND
PERIODICALLY REVALIDATE THEM)

USE REDUNDANT SENSORS

CHECK DATA AGAINST HISTORICAL
LOGS OR COMPUTED MODELS



TRADE-OFFS BETWEEN
(RE)CALIBRATION AND
REDUNDANCY



REDUCING ERROR DURING DATA ENTRY

DOUBLE DATA ENTRY

PERFORM ALL DATA ENTRY TWICE

(IDEALLY BY SEPARATE PEOPLE)

IDENTIFY MISMATCHES AND DISCARD OR REPAIR

(VIA VOTING OR RE-ENTRY)

INTEGRITY CONSTRAINTS

This field is required.

TEMPERATURE

xx

°C

INTEGRITY CONSTRAINTS

Temperatures must be between
-50°C and 50°C.

TEMPERATURE -60 °C

INTEGRITY CONSTRAINTS

TEMPERATURE °C

INTEGRITY CONSTRAINTS DO NOT PREVENT BAD
DATA

ENFORCING CONSTRAINTS LEADS TO FRUSTRATION

FRICTION AND PREDICTION

USE DATA QUALITY MEASURES TO **PREDICT**
HOW LIKELY A VALUE IS TO BE CORRECT.

ADJUST THE INTERFACE TO **ADD FRICTION**
WHEN ENTERING UNLIKELY RESPONSES.

FRICION AND PREDICTION

PRINCIPLE 1

DATA QUALITY SHOULD BE CONTROLLED VIA FEEDBACK, NOT ENFORCEMENT.

PRINCIPLE 2

FRICION MERITS EXPLANATION.

PRINCIPLE 3

ANNOTATION SHOULD BE EASIER THAN OMISSION OR SUBVERSION.

FRICTION AND PREDICTION



FRICTION AND PREDICTION

This value seems low.
Are you sure?

TEMPERATURE

-60 °C

Sensor disabled.

USHER

[Chen et al. 2010]

The screenshot displays the 'Patient Registration' window of the National Aids Control Programme CTC2 Database. The window title is 'Patient Registration'. At the top, there is a header with the national emblem of Tanzania on the left, the text 'National Aids Control Programme CTC2 Database' in the center, and a logo on the right. Below the header, there are four buttons: 'Register new patient', 'Search patients', 'Show all patients', and 'Delete patient'. The main form area contains various input fields and dropdown menus for patient information, including Patient ID, File Reference, First Name(s), Surname, Sex, Date of Birth (with an 'or Age' option), Age, Marital Status, Phone/contact details, Date of first positive HIV test, Date confirmed HIV positive, Referred from, Region, District (Wilaya), Division (Tarafa), Ward (Kata), Village / Mtaa (Mtaa au Kijiji), Chairperson (Mwenyekiti wa Kijiji), Ten Cell Leader (Mjumba/Balazi), Ten Cell LeaderContact, Household Head (Mkuu wa Kaya), Household Head contact details, Helper / treatment supporter (Jina la Msaidizi wa karibu), Helper / treatment supporter contact details, Community Support Organisation / Group, Drug Allergies, Prior Exposure, and Notes. There are also buttons for 'Add / Edit Village or chairperson', 'Patient classification', and 'Family information'. A 'Return' button and a search icon are located at the bottom right.

**National Aids Control Programme
CTC2 Database**

Patient Registration

Register new patient Search patients Show all patients Delete patient

Home
Log off
Exit Database

The United Republic of Tanzania

Patient ID: Region:

File Reference: District: Household Head:
(Mkuu wa Kaya)

First Name(s): Division: Household Head contact details:

Surname: Ward: Helper / treatment supporter:
(Jina la Msaidizi wa karibu)

Sex: Village / Mtaa: Helper / treatment supporter contact details:
(Mtaa au Kijiji)

Date of Birth: or Age: Chairperson: Community Support Organisation / Group:
(Mwenyekiti wa Kijiji)

Age: Ten Cell Leader: Drug Allergies:

Marital Status: Ten Cell LeaderContact: Prior Exposure:

Phone/contact details: Notes:

Date of first positive HIV test:

Date confirmed HIV positive:

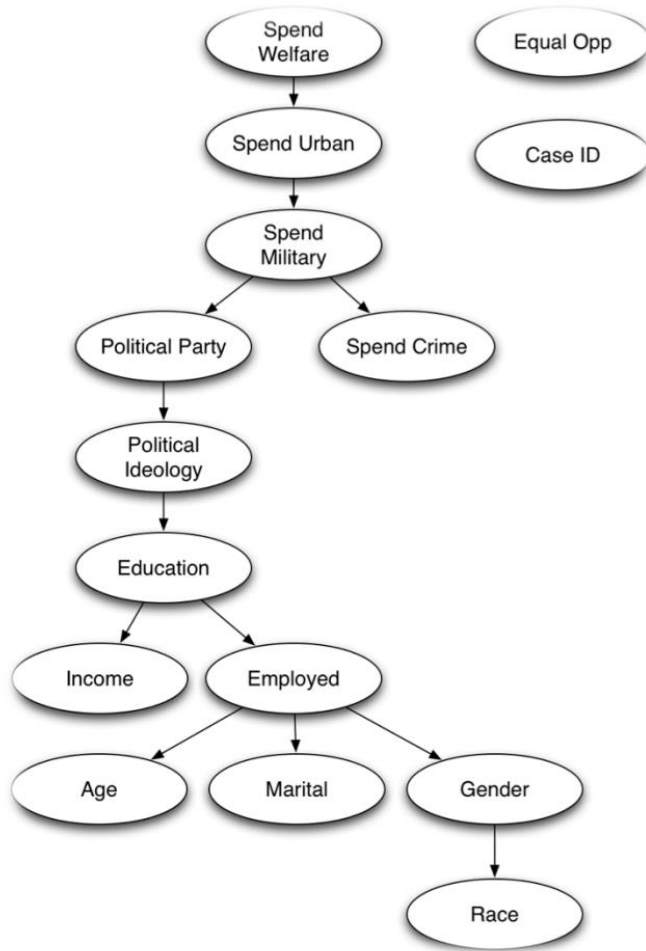
Referred from:

Add / Edit Village or chairperson

Patient classification
Family information

Return

MS Access data entry forms for Tanzanian HIV/AIDS monitoring

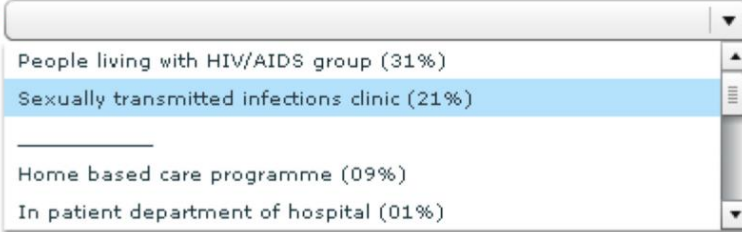


BUILD A MODEL to predict dependencies and relationships between questions.

DYNAMIC ORDERING

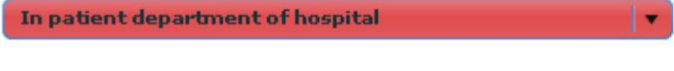
ALWAYS ASK THE MOST
APPROPRIATE NEXT
QUESTION

Select the referring organization *



- People living with HIV/AIDS group (31%)
- Sexually transmitted infections clinic (21%)**
- Home based care programme (09%)
- In patient department of hospital (01%)


Select the referring organization *



In patient department of hospital

SUGGEST THE MOST
LIKELY ANSWERS

Select the district code *



d

- Dodoma Rural**
- Dodoma Urban

Choose the patient's gender *

Male (40%)

Female (59%)

[Chen et al. 2010]

SMART RE-ASKING AND SUGGESTIONS

1. Given * 1234
name

WARNING! CHECK YOUR ANSWER!

FRICION

AUTOMATING ~~CONSTRAINTS~~

--NA--

Birere

Kabuyanda

Kikagati

Mwizi

Nyakitunda

DETECTING ERRORS

LOOK FOR OUTLIERS / ANOMALIES

EXAMINE DATA TYPES

SCHEMA CHECKING

VALIDATE WITH OTHER DATA

OTHER HEURISTICS

HISTORICALLY – MORE FOCUS ON AUTOMATED APPROACHES

“PROFILING” DATA

UNDERSTANDING WHAT ASSUMPTIONS YOU CAN
MAKE ABOUT DATA

INTERACTIVELY IDENTIFYING
DATA QUALITY ISSUES

AN EXAMPLE

FROM THE SNOW

Find Movies, TV shows, Celebrities and more

Movies TV News Videos

Rotten Tomatoes by Flixster

Search movies, actors, critics

MOVIES

AVAILABLE NOW DIGITAL

Now Playing
In 6 theaters near San Francisco, CA. [Change location](#)



The Hunger Games

MPAA Rating: PG-13
142 min - Action | [D](#)

Your rating: 7.6
Ratings: 7.6/10 from 1,170 reviews

Set in a future where the twelve districts to fight Katniss Everdeen volunteered place for the latest match

Director: Gary Ross
Writers: Gary Ross (screenplay), and 2 more
Stars: Jennifer Lawrence, Hemsworth

[Watch Trailer](#) + [W](#)



98 photos | 23 videos | 9081 news articles | full cast & crew

7 nominations [See more awards](#) >

Related Videos



[See all 23](#) >

People who liked this also liked...



The Hunger Games (2012)

TOMATOMETER: 84%
All Critics | Top

Average Rating: 7.2/10
Reviews Counted: 257
Fresh: 217 | Rotten: 40

Thinking and superbly acted, The Hunger Games captures the dire violence, raw emotion, and ardent scope of its source novel.

MY RATING

WANT TO SEE IT? | NOT INTERESTED

Add a Review (Optional)

POST

MOVIE INFO

Every year in the ruins of what was once North America, 1 Panem forces each of its twelve districts to send a teenage Hunger Games. A twisted punishment for a past uprising, it is a national television spectacle. The Hunger Games are a nationally televised fight with one another until one survivor remains. Pitted against each other, the districts have prepared for these Games their entire lives.

PG-13, 2 hr, 22 min
In Theaters
Drama, Mystery & Suspense, Science Fiction, Box Office & Fantasy
Lionsgate

Directed by: Gary Ross
Written by: Suzanne Collins, Gary Ross, Billy Ray

Friend Ratings

5 stars | 4 stars | 3 stars | 2 stars | 1 star

March 27, 2012

Jon Whetstone

The Hunger Games Trailer & Photos



Cast



THE NUMBERS

BOX OFFICE DATA, MOVIE STARS, IDLE SPECULATION

Learn About Our Research and Data Services

Search [GO](#)

News: Latest News, Coming Soon, Trailers, Theater Counts, Oscars

The Movies: Daily Chart, Blu-ray Sales Chart, Weekend Chart, Archive, Records, Top Rated, Popular, Budgets, Franchises, Keywords

Home Market: DVD Sales Chart, Blu-ray Sales Chart, 2012 DVD Chart, 2011 DVD Chart, 2010 DVD Chart, Coming Soon, Archive

Market Analysis: Overview, 2012, 2011, 2010, Distributors, Genres, MPAA Ratings, Sources, Prod'n Methods, Creative Types

International: World Chart, News, Records

The People: Star Archive, Records, Directors, Popular

The Speculation: HSX Analysis

The Site: Forums, Site Map, About Us, The Crunch, Data Feeds, Home Page

amazon.com
Movies & TV on DVD and Blu-ray Save up to 40% on Bestsellers

Play slots and casino online at Casinoplayers, we also have the best

save May in sales event! It's going on now!

Great deals available at your Toyota dealer.

TOYOTA moving forward

Ready to Buy

The Hunger Games

The Numbers Rating: 6.88 (24 votes) [Rate It](#) - [Rating Details](#)
Rotten Tomatoes Rating: 84% - [Fresh!](#)

Theatrical Performance	
Domestic Box Office	\$387,007,048
International Box Office	\$131,600,000
Worldwide Box Office	\$518,607,048

[For full financial breakdown, please contact our research team.](#)

Released: March 23, 2012 (Wide)
Production Budget: \$80,000,000
MPAA Rating: PG-13 for intense violent thematic material and disturbing images - all involving teens.
Domestic Marketing Budget Source: \$45 million (N.Y. Times)
Highest Combined Star Gross: 139 (see full chart)
Keywords: Lionsgate
Distributed by Source: Based on Book/Short Story
Major Genre: Thriller/Suspense
Production Method: Live Action
Creative Type: Science Fiction

THE 2012 Mazda3

starting at \$15,200*

IF IT'S NOT WORTH DRIVING, IT'S NOT WORTH BUILDING.

EXPLORE NOW

News (See All...)

2012-05-15 Weekend Wrap-Up: Avengers Begin New Century Club
2012-05-10 Weekend Predictions: Avengers Overshadows New Releases
2012-05-07 Weekend Wrap-up: Avengers Assemble a New Record Book
2012-05-03 Weekend Predictions: Will Box Office Records Be Avenged?
2012-05-03 International Box Office: Avengers are Marvelous
2012-04-30 Weekend Wrap-Up: The Box Office Will Be Avenged
2012-04-29 Weekend Estimates: Think Like a Man Rises Above the Pack
2012-04-26 Weekend Predictions: Seven-Day Engagement
2012-04-26 International Box Office: Battle on the High Seas
2012-04-23 Weekend Wrap-Up: Moviegoers were Very Thoughtful

[Submit news for this movie](#)

Trailer [More trailers...](#)

Title	Release Date	MPAA Rating	Distributor	Rotten Tomatoes Rating	IMDB Rating
The Land Girls	Jun 12, 1998	R	Gramercy		6.1
First Love, Last Rites	Aug 7, 1998	R	Strand		6.9
I Married a Strange Person	Aug 28, 1998		Lionsgate		6.8
Slam	Oct 9, 1998	R	Trimark	62	3.4
Mississippi Mermaid	Jan 15, 1999		MGM		
Following	Apr 4, 1999	R	Zeitgeist		7.7
Foolish	Apr 9, 1999	R	Artisan		3.8
Pirates	Jul 1, 1986	R		25	5.8
Duel in the Sun	Dec 31, 2046			86	7
Tom Jones	Oct 7, 1963			81	7
Oliver!	Dec 11, 1968		Sony Pictures	84	7.5
To Kill A Mockingbird	Dec 25, 1962		Universal	97	8.4
Tora, Tora, Tora	Sep 23, 1970				
Hollywood Shuffle	Mar 1, 1987			87	6.8
Over the Hill to the Poorhouse	Sep 17, 2020				
Wilson	Aug 1, 2044				7
Darling Lili	Jan 1, 1970				6.1
The Ten Commandments	Oct 5, 1956			90	2.5
12 Angry Men	Apr 13, 1957		United Artists		8.9
Twelve Monkeys	Dec 27, 1995	R	Universal		8.1
1776	Nov 9, 1972	PG	Sony/ Columbia	57	7

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Arnolds Park	Oct 19, 2007	PG-13	The Movie Partners
Sweet Sweetback's Baad Asssss Song	Jan 1, 1971		
And Then Came Love	Jun 1, 2007	Not Rated	Fox Meadow
Around the World in 80 Days	Oct 17, 1956	PG	United Artists
Barbarella	Oct 10, 1968		Paramount Pictures
Barry Lyndon	1975		Warner Bros.
Barbarians, The	March, 1987		
Babe	Aug 4, 1995	G	Universal
Boynton Beach Club	Mar 24, 2006	R	Wingate Distribution
Baby's Day Out	Jul 1, 1994	PG	20th Century

Bad Boys	Apr 7, 1995	6.6	53929
Body Double	Oct 26, 1984	6.4	9738
The Beast from 20,000 Fathoms	Jun 13, 1953		
Beastmaster 2: Through the Portal of Time	Aug 30, 1991	3.3	1327
The Beastmaster	Aug 20, 1982	5.7	5734
Ben-Hur	Dec 30, 2025	8.2	58510
Ben-Hur	Nov 18, 1959	8.2	58510
Benji	Nov 15, 1974	5.8	1801
Before Sunrise	Jan 27, 1995	8	39705

SOME DATA QUALITY ISSUES

MISSING DATA

MISSED MEASUREMENTS, REDACTED ITEMS, INCOMPLETE FORMS, ETC.

ERRONEOUS VALUES

MISPELLINGS, OUTLIERS, "SPURIOUS INTEGRITY", ETC.

ENTITY RESOLUTION

DIFFERENT VALUES, ABBREVS., 2+ ENTRIES FOR THE SAME THING?

TYPE CONVERSION

E.G., ZIP CODE OR PLACE NAME TO LAT-LON

DATA INTEGRATION

MISMATCHES AND INCONSISTENCIES WHEN COMBINING DATA

DETECTION METHODS

+ CAN IDENTIFY POTENTIAL ANOMALIES

- HARD TO KNOW IF THEY'RE REALLY ANOMALOUS OR HOW TO CORRECT THEM

Type	Issue	Detection Method(s)
Missing	Missing record	Outlier Detection Residuals then Moving Average w/ Hampel X84
		Frequency Outlier Detection Hampel X84
Inconsistent	Missing value	Find NULL/empty values
	Measurement units	Clustering Euclidean Distance
		Outlier Detection z-score, Hampel X84
	Misspelling	Clustering Levenshtein Distance
	Ordering	Clustering Atomic Strings
	Representation	Clustering Structure Extraction
	Special characters	Clustering Structure Extraction
Incorrect	Erroneous entry	Outlier Detection z-score, Hampel X84
	Extraneous data	Type Verification Function
	Misfielded	Type Verification Function
	Wrong physical data type	Type Verification Function
Extreme	Numeric outliers	Outlier Detection z-score, Hampel X84, Mahalanobis distance
	Time-series outliers	Outlier Detection Residuals vs. Moving Average then Hampel X84
Schema	Primary key violation	Frequency Outlier Detection Unique Value Ratio

MISSING AND IMPOSSIBLE VALUES

1. LOOK AT EMPTY/MISSING VALUES
2. LOOK AT IMPOSSIBLE VALUES

Gender = 3

Heart Rate = 0

Unlikely Dates (e.g. "01/01/0001")

JUST SORTING THE DATA CAN HELP HIGHLIGHT ISSUES LIKE THESE

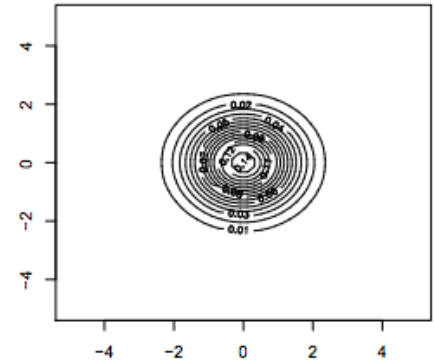
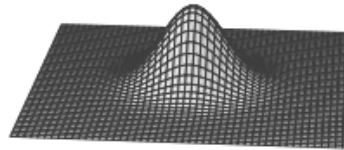
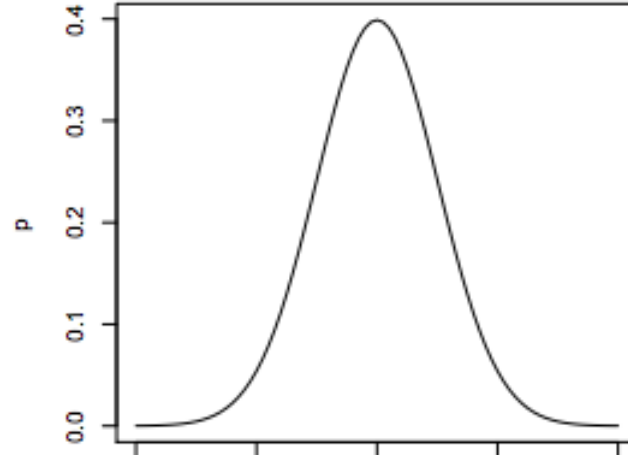
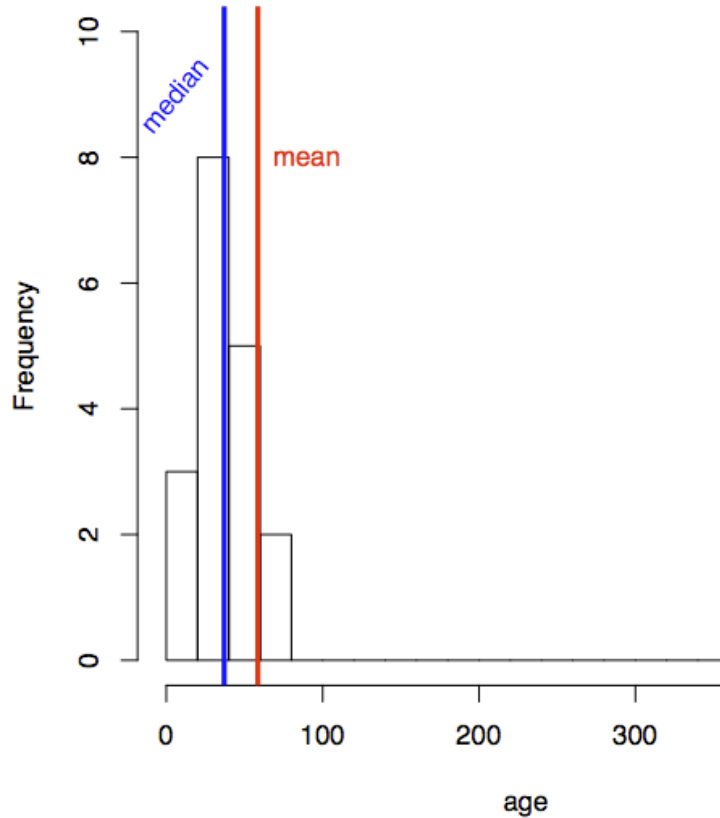
OUTLIER DETECTION

1. EXAMINE DISTRIBUTIONS
2. MODEL DATA AND LOOK FOR RESIDUALS
3. PARTITION DATA

FOR **ONE DATA DIMENSION** OR **MULTIPLE DIMENSIONS**

EXAMINE DISTRIBUTIONS

Histogram of age



DETECTING DUPLICATES

Title

Ben-Hur

Ben Hur

BEN-HUR

Ben-Hur (1959 film)

Name

Anand Vaskar

Anand Vaskkar

A. Vaskar

Vaskar, Anand

THESE MIGHT ALL BE THE SAME

SOME USEFUL DISTANCE METRICS

LEVENSHTEIN (“STRING-EDIT”) DISTANCE

How many edits do I need to change one value into another?

Ben-|Hur
Ben Hur

DISTANCE = 1

Anand Vaskar
Anand Vaskk|ar

DISTANCE = 1

SOME USEFUL DISTANCE METRICS

LEVENSHTEIN (“STRING-EDIT”) DISTANCE

How many edits do I need to change one value into another?

Ben-Hur

Ben-Hur (1959 film)

DISTANCE = 12

Anand Vaskar

Vaskar, Anand

DISTANCE = 12

SOME USEFUL DISTANCE METRICS

SOUNDEX / METAPHONE

How similar do they sound?

Ben-Hur

Ben-Hurr

Been Her

Anand Vaskar

Anand Vaskkar

Ahnund Vachkar

SOME USEFUL DISTANCE METRICS

“FINGERPRINTING” METHODS

Strip away unimportant details.

(e.g., remove punctuation, capitals, and sort)

Anand Vaskar → anand vaskar

Vaskar, Anand → anand vaskar

AND MANY MORE

STRING/KEY COMPARISONS

DISTANCE METRICS FOR NUMERIC DATA

e.g., HAMPEL X84 (UNIVARIATE), MAHALANOBIS (MULTIVARIATE)

“Quantitative Data Cleaning for Large Databases”

Hellerstein (2008)

Quantitative Data Cleaning for Large Databases

Joseph M. Hellerstein^{*}
EECS Computer Science Division
UC Berkeley
<http://db.cs.berkeley.edu/jmh>

February 27, 2008

1 Introduction

Data collection has become a ubiquitous function of large organizations – not only for record keeping, but to support a variety of data analysis tasks that are critical to the organizational mission. Data analysis typically drives decision-making processes and efficiency optimizations, and in an increasing number of settings is the reason *à* vive of entire agencies or firms.

Despite the importance of data collection and analysis, data quality remains a pervasive and thorny problem in almost every large organization. The presence of incorrect or incomplete data can significantly distort the results of analyses, often negating the potential benefits of information-driven approaches. As a result, there has been a variety of research over the last decade on various aspects of data cleaning: computational procedures to automatically or semi-automatically identify – and, when possible, correct – errors in large data sets.

In this report, we survey data cleaning methods that focus on errors in quantitative attributes of large databases, though we also provide references to data cleaning methods for other types of attributes. The discussion is targeted at computer practitioners who manage large databases of quantitative information, and designers developing data entry and auditing tools for end users. Because of our focus on quantitative data, we take a statistical view of data quality, with an emphasis on intensive outlier detection and exploratory data analysis methods based in robust statistics (Hampel and Levy, 1987; Hampel et al., 1986; Huber, 1981). In addition, we stress algorithms and implementations that can be easily and efficiently implemented in very large databases, and which are easy to understand and visualize graphically. The discussion mixes statistical notations and methods, algorithmic building blocks, efficient relational database implementation strategies, and user interface considerations. Throughout the discussion, references are provided for deeper reading on all of these issues.

1.1 Sources of Error in Data

Before a data item ends up in a database, it typically passes through a number of steps involving both human interaction and computation. Data errors can creep in at every step of the process from initial data acquisition to archival storage. An understanding of the sources of data errors can be useful both in designing data collection and curation techniques that mitigate

^{*}This survey was written under contract to the United Nations Economic Commission for Europe (UNECE), which holds the copyright on this version.

DECIDING HOW TO FIX PROBLEMS

YOU CAN DO ALMOST ALL OF
THIS IN **SQL** ... BUT IT'S A LOT OF WORK

DECIDING HOW TO FIX PROBLEMS

WHICH DUPLICATE TO KEEP?

OUTLIERS: KEEP, REMOVE, OR REPAIR?

BADLY-STORED DATES, ADDRESSES, OR KEYS MAY
NEED TO BE PARSED MANUALLY

DECIDING HOW TO FIX PROBLEMS

FUZZY MATCHING SYSTEMS

MACHINE LEARNING TO DETECT/RESOLVE ERRORS

**USUALLY REQUIRES HUMAN JUDGMENT
(ESPECIALLY FOR NEW DATA)**

INTERACTIVE PROFILING

Schema Browser

- Creative Type
- Distributor
- IMDB Rating
- IMDB Votes
- MPAA Rating
- Major Genre
- Production Budget

Related Views:

Anomalies

Anomaly Browser

Missing (6)

- MPAA Rating
- Creative Type
- Source
- Major Genre
- Distributor

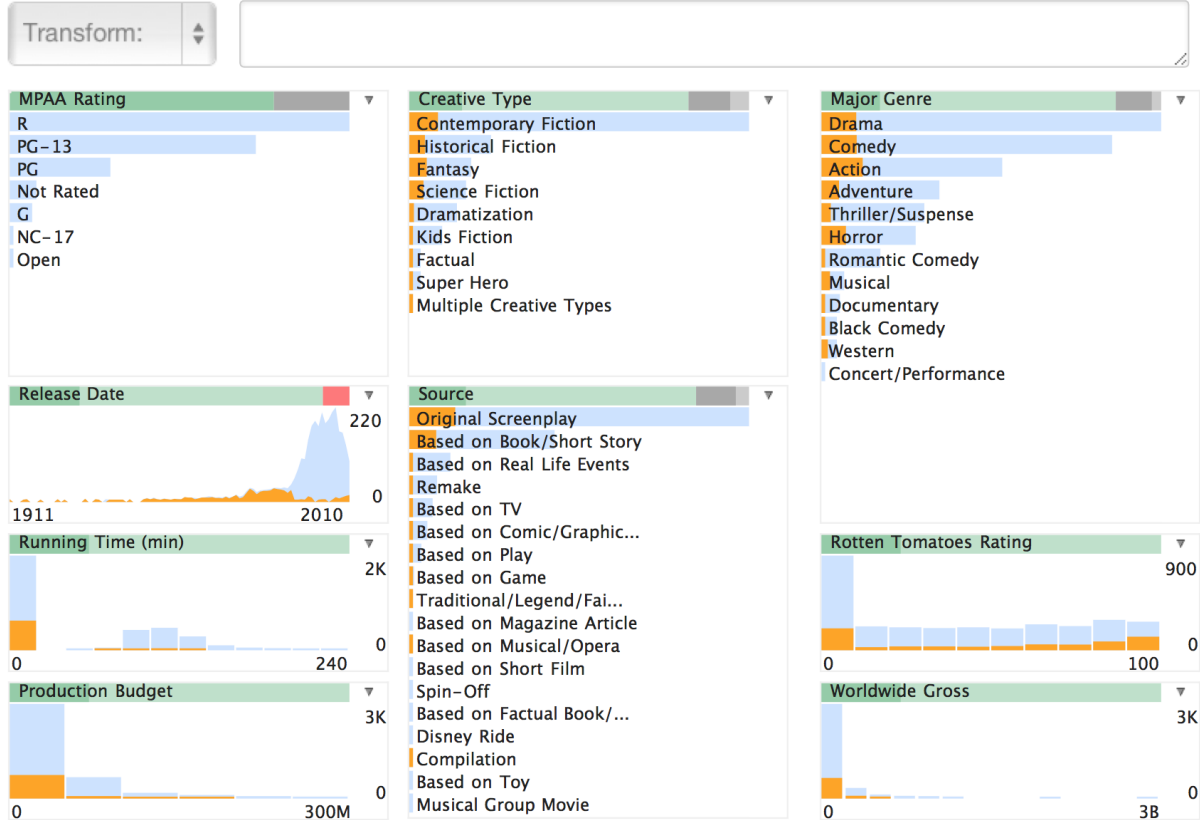
Release Location

Error (2)

Extreme (7)

Inconsistent (3)

- Distributor (Levenshtein)
- Source (Levenshtein)



PROFILING IN OPEN REFINE

Movies Analysis - Google Refine

127.0.0.1:3333/project?project=1615121211153

Google refine Movies Analysis Permalink

Open... Export Help

Facet / Filter Undo / Redo 7


Refresh Reset All Remove All

69 matching records (2448 total) Extensions: Freebase

Show as: rows records Show: 5 10 25 50 records « first < previous 1 - 10 next > last »

All	Title	ReleaseDate	USGross	MPAARating	WorldwideGross	USI
6.	Doogal	2006-02-24T00:00:00Z	7578946	G	26942802	
116.	Beauty and the Beast	1991-11-13T00:00:00Z	171340294	G	403476931	
142.	Aladdin	1992-11-11T00:00:00Z	217350219	G	504050219	
200.	The Lion King	1994-06-15T00:00:00Z	328539505	G	783839505	
255.	Pocahontas	1995-06-10T00:00:00Z	141579773	G	347100000	
268.	Babe	1995-08-04T00:00:00Z	63658910	G	246100000	
273.	The	1995-08-	669276	G	669276	

USGross change reset

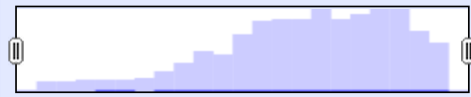


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Numeric Non-numeric Blank Error

69 0 0 0

ReleaseDate change reset



1987-02-20 00:00:00 — 00:00:00

**SOME APPROACHES FOR
IMPROVING DATA QUALITY**

**TOOLS FOR MANIPULATING
AND CLEANING DATA**

“WRANGLING” DATA

CLEANING AND TRANSFORMING DATASETS TO MAKE IT POSSIBLE TO ANALYZE AND VISUALIZE THEM

COMMON OPERATIONS

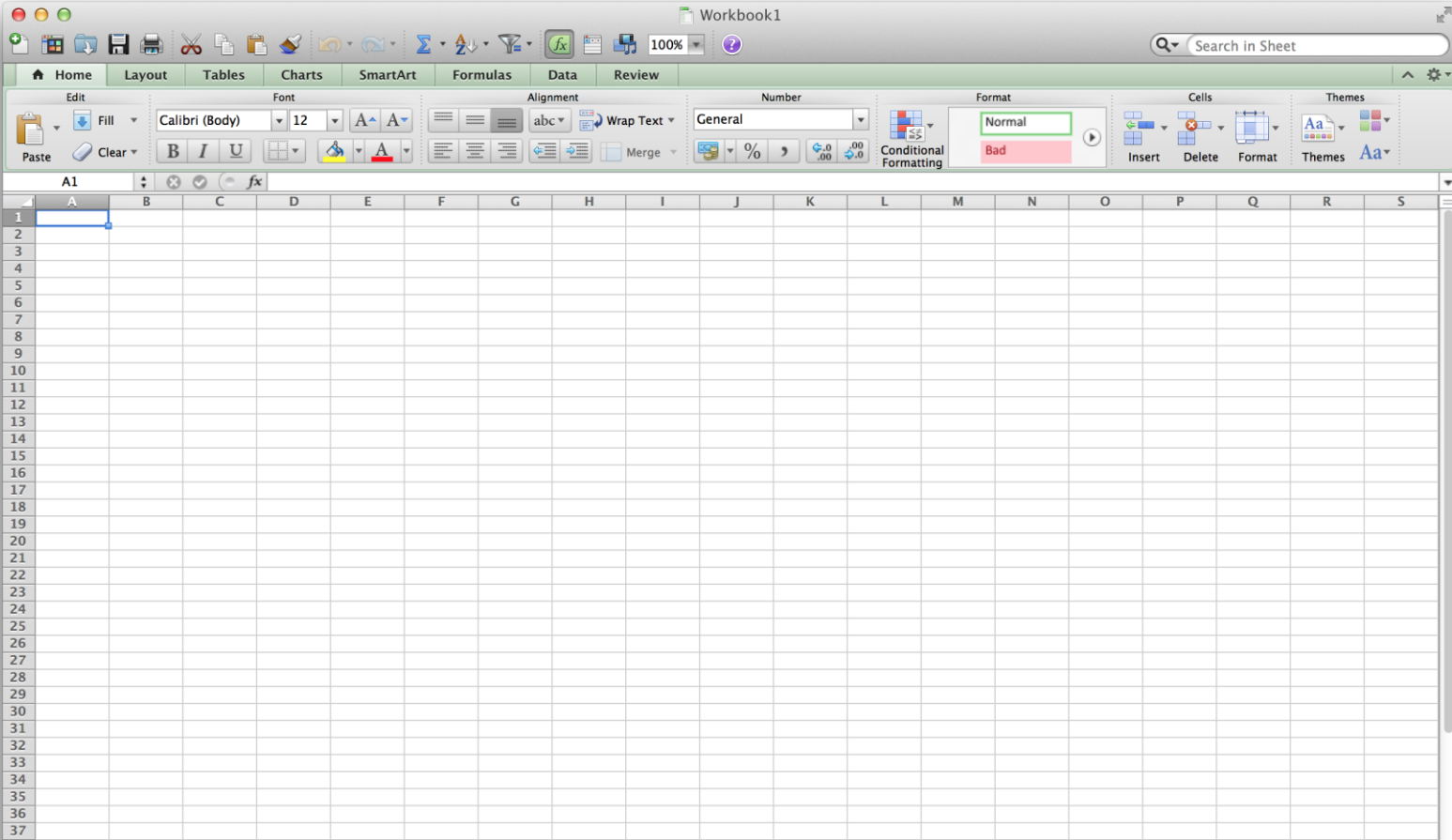
CORRECTING AND REMOVING ERRORS

CHANGING FORMATS

REMOVING FORMATTING

CONNECTING AND RESOLVING DATA

SPREADSHEETS



TRANSFORMATIONS ARE TIME-CONSUMING

“I spend more than half my time integrating, cleansing, and transforming data without doing any actual analysis. Most of the time I’m lucky if I get to do any ‘analysis’ at all.”

“Most of the time once you transform the data, the insights can be scarily obvious.”

[Kandel 2012]



- Publications & Products
- Key Facts
- Data Collections
- Funding
- Data Analysis Tools
- Terms & Definitions
- FAQs
- Related Links

- ▶ Corrections
- ▶ Courts
- ▶ Crime Type
- ▶ Criminal Justice Data Improvement Program
- ▶ Employment and Expenditure
- ▶ Federal
- ▶ Law Enforcement
- ▶ Victims

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-
-

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- [Workplace Violence, 1993-2009](#)
- [Punitive Damage Awards in State Courts, 2005](#)
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Other Releases

A Dialogue Between the Bureau of Justice Statistics and Key Criminal Justice Data Users

In 2008 the Bureau of Justice Statistics (BJS) convened a multidisciplinary workshop for professionals who use justice statistics. Participants and representatives from academia, court systems, victim advocacy, and law enforcement communities provided feedback about how they use BJS statistical information and recommended ways BJS could optimize the value of data it collects and publishes. A Dialogue Between BJS and Key Criminal Justice Data Users is now available.

Announcements

BJS Visiting Fellows

Lynn A. Addington, Ph.D., Janet L. Lauritsen, Ph.D., and Avinash Bhati, Ph.D., are Visiting Fellows at the Bureau of Justice Statistics (BJS). They will conduct research designed to enhance the analytical approach and usability of specific BJS data collections. Visit the [BJS Fellows page](#) for additional information about Professor Addington, Professor Lauritsen, Mr. Bhati, and the BJS Visiting Fellows Program.

Data Analysis Tools

Data Online

Dynamic interface that allows users to construct and download custom tables.

Crime and Justice Electronic Data Abstract spreadsheets

Aggregated data from a wide variety of published sources, intended for analytic use.

Federal Criminal Case Processing Statistics - FCCPS

The Federal Criminal Case Processing Statistics (FCCPS) tool permits an on-line analysis of suspects and defendants processed across stages of the Federal criminal justice system.

[▶ MORE DATA ANALYSIS TOOLS](#)

Special Topics

Deaths in Custody

- [Drugs and Crime](#)
- [Homicide Trends](#)
- [Intimate Partner Violence](#)
- [Reentry Trends](#)

[▶ MORE SPECIAL TOPICS](#)

BJS Partners

- [Federal Bureau of Investigation](#)

ANOTHER EXAMPLE

State	2004	2005	2006	2007	2008			
Alabama	4029.3	3900	3937	3974.9	4081.9			
Alaska	3370.9	3615	3582	3373.9	2928.3			
Arizona	5073.3	4827	4741.6	4502.6	4087.3			
Arkansas	4033.1	4068	4021.6	3945.5	3843.7			
California	3423.9	3321	3175.2	3032.6	2940.3			
Colorado	3918.5	4041	3441.8	2991.3	2856.7			
Connecticut	2684.9	2579	2575	2470.6	2490.8			
Delaware	3283.6	3118	3474.5	3427.1	3594.7			
District of Columbia	4852.8	4490	4653.9	4916.3	5104.6			
Florida	4182.5	4013	3986.2	4088.8	4140.6			
Georgia	4223.5	4145	3928.8	3893.1	3996.6			
Hawaii	4795.5	4800	4219.9	4119.3	3566.5			
Idaho	2781	2697	2386.9	2264.2	2116.5			
Illinois	3174.1	3092	3019.6	2935.8	2932.6			
Indiana	3403.6	3460	3464.3	3386.5	3339.6			
Iowa	2904.8	2845	2870.3	2648.6	2440.5			
Kansas	4015.5	3806	3858.5	3693.8	3397			
Kentucky	2540.2	2531	2621.9	2524.6	2677.1			
Louisiana	4419.1	3696	4088.5	4196.1	3880.2			
Maine	2413.7	2419	2546.1	2448.3	2463.7			
Maryland	3640.7	3551	3481.2	3431.5	3516			
Massachusetts	2468.2	2358	2396	2399.2	2402			
Michigan	3066.1	3098	3226	3057.8	2945.7			
Minnesota	3041.6	3088	3088.8	3045	2858.1			
Mississippi	3481.1	3274	3213	3137.8	2941.7			
Missouri	3900.1	3929	3828.4	3828.2	3663.6			
Montana	2936.1	3146	2863.4	2863.6	2720.9			
Nebraska	3519.6	3432	3364.9	3142.8	2878.3			
Nevada	4210	4246	4099.6	3785.1	3456.4			

Year	Property Crime Rate				
Reported crime in Alabama					
2004	4029.3				
2005	3900				
2006	3937				
2007	3974.9				
2008	4081.9				
Reported crime in Alaska					
2004	3370.9				
2005	3615				
2006	3582				
2007	3373.9				
2008	2928.3				
Reported crime in Arizona					
2004	5073.3				
2005	4827				
2006	4741.6				
2007	4502.6				
2008	4087.3				

Year	Property Crime Rate				
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2004	4029.3				
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2006	3937				
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2008	4081.9				
Reported crime in Alaska					
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2005	3615				
2006	3582				
2007	3373.9				
2008	2928.3				
Reported crime in Arizona					
2004	5073.3				
2005	4827				
2006	4741.6				
2007	4502.6				
2008	4087.3				

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2007	3974.9			
2008	4081.9			
Reported crime in Alaska				
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2005	3615			
2006	3582			
2007	3373.9			
2008	2928.3			
Reported crime in Arizona				
2004	5073.3			
2005	4827			
2006	4741.6			
2007	4502.6			
2008	4087.3			

Year	Property Crime Rate				
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2008	4081.9				
Reported crime in Alaska					
2004	3370.9				
2005	3615				
2006	3582				
2007	3373.9				
2008	2928.3				
Reported crime in Arizona					
2004	5073.3				
2005	4827				
2006	4741.6				
2007	4502.6				
2008	4087.3				

Year	Property Crime Rate				
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2005	3900				
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2008	4081.9				
Reported crime in Alaska					
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2005	3615				
2006	3582				
2007	3373.9				
2008	2928.3				
Reported crime in Arizona					
2004	5073.3				
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2006	4741.6				
2007	4502.6				
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Connecticut	2684.9	2579	2575	2470.6	2490.8			
Delaware	3283.6	3118	3474.5	3427.1	3594.7			
District of Columbia	4852.8	4490	4653.9	4916.3	5104.6			
Florida	4182.5	4013	3986.2	4088.8	4140.6			
Georgia	4223.5	4145	3928.8	3893.1	3996.6			
Hawaii	4795.5	4800	4219.9	4119.3	3566.5			
Idaho	2781	2697	2386.9	2264.2	2116.5			
Illinois	3174.1	3092	3019.6	2935.8	2932.6			
Indiana	3403.6	3460	3464.3	3386.5	3339.6			
Iowa	2904.8	2845	2870.3	2648.6	2440.5			
Kansas	4015.5	3806	3858.5	3693.8	3397			
Kentucky	2540.2	2531	2621.9	2524.6	2677.1			
Louisiana	4419.1	3696	4088.5	4196.1	3880.2			
Maine	2413.7	2419	2546.1	2448.3	2463.7			
Maryland	3640.7	3551	3481.2	3431.5	3516			
Massachusetts	2468.2	2358	2396	2399.2	2402			
Michigan	3066.1	3098	3226	3057.8	2945.7			
Minnesota	3041.6	3088	3088.8	3045	2858.1			
Mississippi	3481.1	3274	3213	3137.8	2941.7			
Missouri	3900.1	3929	3828.4	3828.2	3663.6			
Montana	2936.1	3146	2863.4	2863.6	2720.9			
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Reported crime in Alaska					
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2007	3373.9				
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Reported crime in Arizona					
2004	5073.3				
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2006	4741.6				
2007	4502.6				
2008	4087.3				

State	Year	Property Crime Rate
	Reported crime in Alabama	
	2004	4029.3
	2005	3900
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	2005	3615
	2006	3582
	2007	3373.9
	2008	2928.3
	Reported crime in Arizona	
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	2005	4827
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	2007	4502.6
	2008	4087.3

State	Year	Property Crime Rate
	Reported crime in Alabama	
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	2005	3615
	2006	3582
	2007	3373.9
	2008	2928.3
	Reported crime in Arizona	
	2004	5073.3
	2005	4827
	2006	4741.6
	2007	4502.6
	2008	4087.3

State	Year	Property Crime Rate
	Reported crime in Alabama	
	2004	4029.3
	2005	3900
	2006	3937
	2007	3974.9
	2008	4081.9
	Reported crime in Alaska	
	2004	3370.9
	2005	3615
	2006	3582
	2007	3373.9
	2008	2928.3
	Reported crime in Arizona	
	2004	5073.3
	2005	4827
	2006	4741.6
	2007	4502.6
	2008	4087.3
	Reported crime in Arkansas	

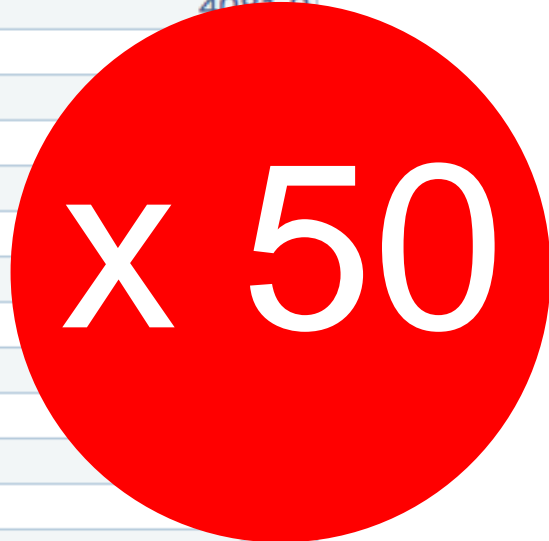
State	Year	Property Crime Rate
Alabama	Reported crime in Alabama	
	2004	4029.3
	2005	3900
	2006	3937
	2007	3974.9
	2008	4081.9
Alaska	Reported crime in Alaska	
	2004	3370.9
	2005	3615
	2006	3582
	2007	3373.9
	2008	2928.3
Arizona	Reported crime in Arizona	
	2004	5073.3
	2005	4827
	2006	4741.6
	2007	4502.6
	2008	4087.3
Arkansas	Reported crime in Arkansas	

State	Year	Property Crime Rate
Alabama	Reported crime in Alabama	
Alabama	2004	4029.3
Alabama	2005	3900
Alabama	2006	3937
Alabama	2007	3974.9
Alabama	2008	4081.9
	Reported crime in Alaska	
	2004	3370.9
	2005	3615
	2006	3582
	2007	3373.9
	2008	2928.3
	Reported crime in Arizona	
	2004	5073.3
	2005	4827
	2006	4741.6
	2007	4502.6
	2008	4087.3
	Reported crime in Arkansas	

State	Year	Property Crime Rate
Alabama	Reported crime in Alabama	
Alabama	2004	4029.3
Alabama	2005	3900
Alabama	2006	3937
Alabama	2007	3974.9
Alabama	2008	4081.9
	Reported crime in Alaska	
	2004	3370.9
	2005	3615
	2006	3582
	2007	3373.9
	2008	2928.3
	Reported crime in Arizona	
	2004	5073.3
	2005	4827
	2006	4741.6
	2007	4502.6
	2008	4087.3
	Reported crime in Arkansas	

State	Year	Property Crime Rate
Alabama	2004	4029.3
Alabama	2005	3900
Alabama	2006	3937
Alabama	2007	3974.9
Alabama	2008	4084.9
Reported crime in Alaska		
	2004	
	2005	
	2006	
	2007	
	2008	
Reported crime in Arizona		
	2004	
	2005	4827
	2006	4741.6
	2007	4502.6
	2008	4087.3
Reported crime in Arkansas		

REPEAT



X 50

State	Year	Property Crime Rate
Alabama	2004	4029.3
Alabama	2005	3900
Alabama	2006	3937
Alabama	2007	3974.9
Alabama	2008	4081.9
Alaska	2004	3370.9
Alaska	2005	3615
Alaska	2006	3582
Alaska	2007	3373.9
Alaska	2008	2928.3
Arizona	2004	5073.3
Arizona	2005	4827
Arizona	2006	4741.6
Arizona	2007	4502.6
Arizona	2008	4087.3
Arkansas	2004	4033.1
Arkansas	2005	4068
Arkansas	2006	4021.6
Arkansas	2007	3945.5
Arkansas	2008	3843.7
California		
California		
California	2006	3175.2

RESHAPE ('PIVOT') THE TABLE

State	2004	2005	2006	2007	2008			
Alabama	4029.3	3900	3937	3974.9	4081.9			
Alaska	3370.9	3615	3582	3373.9	2928.3			
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Delaware	3283.6	3118	3474.5	3427.1	3594.7			
District of Columbia	4852.8	4490	4653.9	4916.3	5104.6			
Florida	4182.5	4013	3986.2	4088.8	4140.6			
Georgia	4223.5	4145	3928.8	3893.1	3996.6			
Hawaii	4795.5	4800	4219.9	4119.3	3566.5			
Idaho	2781	2697	2386.9	2264.2	2116.5			
Illinois	3174.1	3092	3019.6	2935.8	2932.6			
Indiana	3403.6	3460	3464.3	3386.5	3339.6			
Iowa	2904.8	2845	2870.3	2648.6	2440.5			
Kansas	4015.5	3806	3858.5	3693.8	3397			
Kentucky	2540.2	2531	2621.9	2524.6	2677.1			
Louisiana	4419.1	3696	4088.5	4196.1	3880.2			
Maine	2413.7	2419	2546.1	2448.3	2463.7			
Maryland	3640.7	3551	3481.2	3431.5	3516			
Massachusetts	2468.2	2358	2396	2399.2	2402			
Michigan	3066.1	3098	3226	3057.8	2945.7			
Minnesota	3041.6	3088	3088.8	3045	2858.1			
Mississippi	3481.1	3274	3213	3137.8	2941.7			
Missouri	3900.1	3900	3900	3900	3900			
Montana	2936.1	3100	3100	3100	3100			
Nebraska	3519.6	3400	3400	3400	3400			
Nevada	4210	4246	4099.6	3785.1	3456.4			

RESHAPE ('PIVOT') THE TABLE

State	2004	2005	2006	2007	2008			
Alabama	4029.3	3900	3937	3974.9	4081.9			
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Arkansas	4033.1	4068	4021.6	3945.5	3843.7			
California	3423.9	3321	3175.2	3032.6	2940.3			
Colorado	3911.5	4041	3911.8	4091.3	2851.1			
Connecticut	2671.9	2579	5171.5	4170.1	2411.1			
Delaware	3283.6	3118	3474.5	3427.1	3594.7			
District of Columbia	4852.8	4490	4653.9	4916.3	5104.6			
Florida	4182.5	4003	3986.2	4061.8	4110.6			
Georgia	4223.5	4115	3928	3891.1	3916.6			
Hawaii	4795.5	4800	4219.9	4119.3	3566.5			
Idaho	2781	2697	2386.9	2264.2	2116.5			
Illinois	3174.1	3092	3000.6	2935.8	2931.1			
Indiana	3403.6	3460	3414.9	3386.5	3331.5			
Iowa	2904.8	2845	2810.3	2448.6	2411.5			
Kansas	4015.5	3806	3858.5	3693.8	3397			
Kentucky	2540.2	2531	2621.9	2524.6	2677.1			
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ONLY NOW ARE WE
READY FOR
ANALYSIS

State	2004	2005	2006	2007	2008
Alabama	4029.3	3900	3937	3974.9	4081.9
Alaska	3370.9	3615	3582	3373.9	2928.3
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Idaho	2781	2697			
Illinois	3174.1	3092			
Indiana	3403.6	3460			
Iowa	2904.8	2845			
Kansas	4015.5	3806			
Kentucky	2540.2	2531	2621.9	2524.6	2677.1
Louisiana	4419.1	3696	4088.5	4196.1	3880.2
Maine	2413.7	2419	2546.1	2448.3	2463.7
Maryland	3640.7	3551	3481.2	3431.5	3516
Massachusetts	2468.2	2358	2396	2399.2	2402

SPREADSHEETS

+ FAMILIAR
+ VISUAL

- TEDIOUS
- TIME-CONSUMING
- REPETITIVE

```
from wrangler import dw
import sys
```

```
w = dw.DataWrangler()
```

```
# Split data repeatedly on newline into rows
w.add(dw.Split(column="data", result="row", on="\n", max=0))
```

```
# Split data repeatedly on ','
w.add(dw.Split(column="data", c
```

```
# Delete empty rows
w.add(dw.Filter(row=dw.Row(cond
```

```
# Extract from split after 'in'
w.add(dw.Extract(column="split"
```

```
# Fill extract with values from above
w.add(dw.Fill(column="extract", direction="down"))
```

```
# Delete rows where split1 is null
```

SCRIPTS

+ REUSABLE
+ SCALABLE

- HARD
- TEDIOUS
- TIME-CONSUMING

INTERACTIVE DATA CLEANING



Trifacta Wrangler

<https://www.trifacta.com/>



Wrangler (Stanford HCI Group)

<http://vis.stanford.edu/wrangler/>



OpenRefine (formerly Google Refine)

<http://openrefine.org/>

INTERACTIVE DATA CLEANING BY EXAMPLE

```
Reported crime in Alabama,  
,  
2004,4029.3  
2005,3900  
2006,3937  
2007,3974.9  
2008,4081.9  
,  
Reported crime in Alaska,  
,  
2004,3370.9  
2005,3615  
2006,3582  
2007,3373.9  
2008,2928.3  
,  
Reported crime in Arizona,  
,  
2004,5073.3  
2005,4827  
2006,4741.6  
2007,4502.6  
2008,4087.3  
,  
Reported crime in Arkansas,  
,  
2004,4033.1  
2005,4068  
2006,4021.6  
2007,3945.5  
2008,3843.7  
,  
Reported crime in California,  
,  
2004,3423.9  
2005,3321  
2006,3175.2
```

<http://vimeo.com/19185801>

WRANGLER [KANDEL ET AL. 2011]



	#	split	extract	#	split1
1	2004		Alabama	4029.3	
2	2005		Alabama	3900	
3	2006		Alabama	3937	
4	2007		Alabama	3974.9	
5	2008		Alabama	4081.9	
6	2004		Alaska	3370.9	
7	2005		Alaska	3615	
8	2006		Alaska	3582	
9	2007		Alaska	3373.9	
10	2008		Alaska	2928.3	
11	2004		Arizona	5073.3	
12	2005		Arizona	4827	
13	2006		Arizona	4741.6	
14	2007		Arizona	4502.6	
15	2008		Arizona	4087.3	
16	2004		Arkansas	4033.1	
17	2005		Arkansas	4068	
18	2006		Arkansas	4021.6	
19	2007		Arkansas	3945.5	
20	2008		Arkansas	3843.7	
21	2004		California	3423.9	
22	2005		California	3321	
23	2006		California	3175.2	
24	2007		California	3032.6	
25	2008		California	2940.3	

```
from wrangler import dw
import sys
```

```
if(len(sys.argv) < 3):
    sys.exit('Error: Please include an input and output file. Example python script.py
input.csv output.csv')
```

```
w = dw.DataWrangler()
```

```
# Split data repeatedly on newline into rows
```

```
w.add(dw.Split(column=["data"],
    table=0,
    status="active",
    drop=True,
    result="row",
    update=False,
    insert_position="right",
    row=None,
    on="\n",
    before=None,
    after=None,
    ignore_between=None,
    which=1,
    max=0,
    positions=None,
    quote_character=None))
```

RESEARCH → PRODUCTS

The image displays the Trifacta website and its data transformation interface. The top portion shows the website's header with the Trifacta logo, navigation links for PRODUCT, CUSTOMERS, COMPANY, RESOURCES, BLOG, NEWS, and EVENTS, and a prominent green button labeled "SCHEDULE A DEMO". Below the header, a text-based message states: "Trifacta helps you with **wrangling and transforming data**, enabling better, faster decision-making".

The bottom portion of the image shows a screenshot of the Trifacta data transformation interface. It features a "Mobile Campaign Project" window with a data table and several charts. The table has columns for Device_Manufacturer, Device_OS_Version, column#, #, Duration, Event_Type, Session_ID, and Center_Net. The charts show distributions for 8 Categories, 17 Categories, and 4 Categories. A "Job Results" window is also visible, displaying a progress bar with 95.0% valid, 3.8% mismatched, and 0.2% missing values. It shows 10 columns, 120 M rows, and 140 GB of data. The job status is "Complete" and the launch time is "Today at 11:47 AM". Below the job results, there are sample rows of data, including a row for "Farruh Kelly" with address "P.O. Box 698, 9221 Maurika, St. Baton Rouge, LA 70801" and phone number "(833) 275-7552".

DATA CLEANING IN GOOGLE REFINE

The screenshot displays the Google Refine interface for a 'Movies Analysis' project. The browser address bar shows '127.0.0.1:3333/project?'. The main header indicates '69 matching records' out of '448 total'. Two large yellow boxes with white text are overlaid on the interface: 'FILTER' on the left and 'TRANSFORM' on the right. Two large black curved arrows point from the 'FILTER' box to the 'TRANSFORM' box, indicating a workflow. The interface includes a 'Facet / Filter' section with a histogram for 'USC' (0.00 to 610,000,000.00) and a 'ReleaseDate' facet (1987-02-20 to 00:00:00 to 00:00:00). A table of data is visible, with columns for movie titles, release dates, and other attributes. A link for 'Google Refine Intro Video' is located at the bottom right.

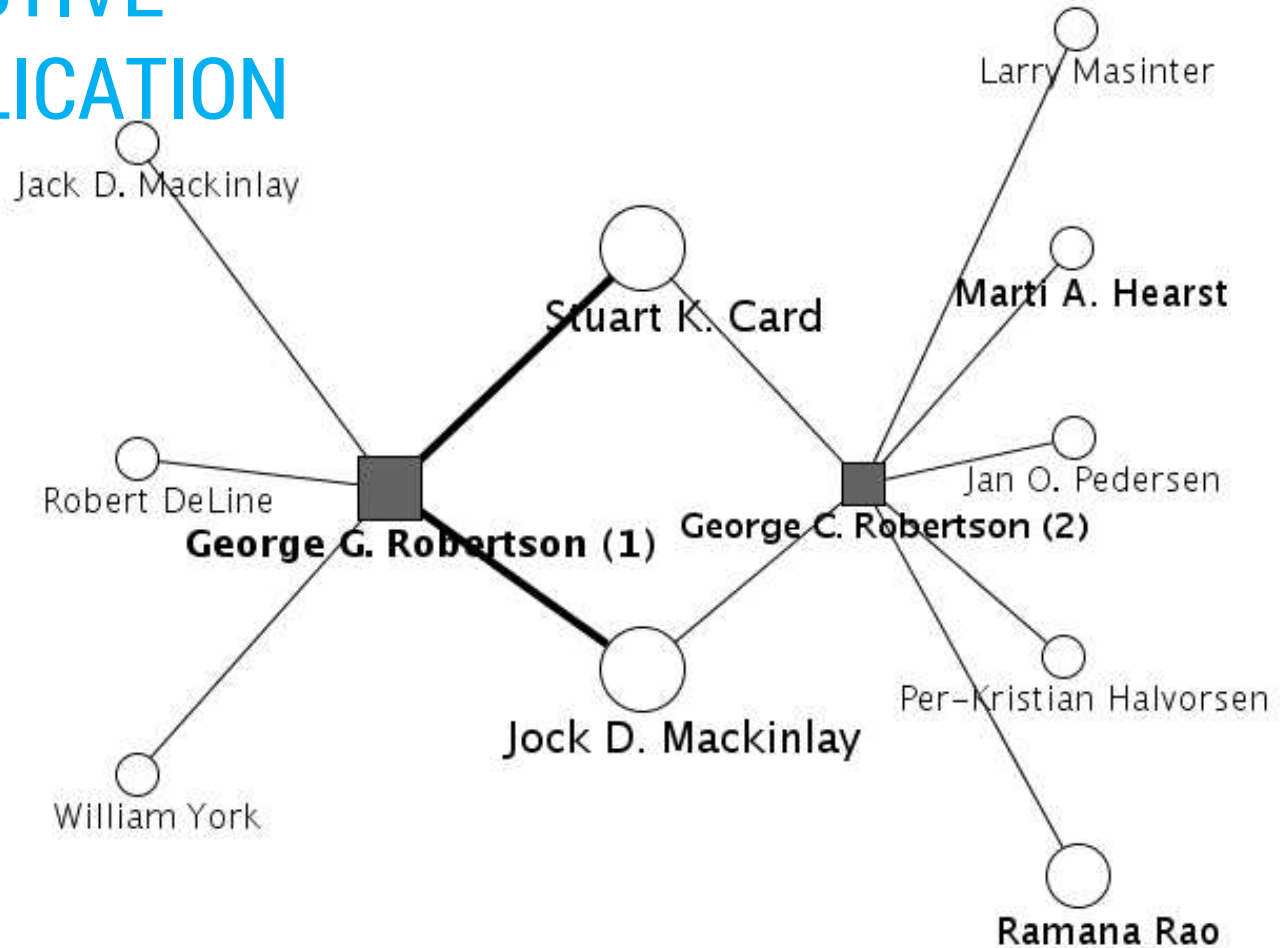
FILTER

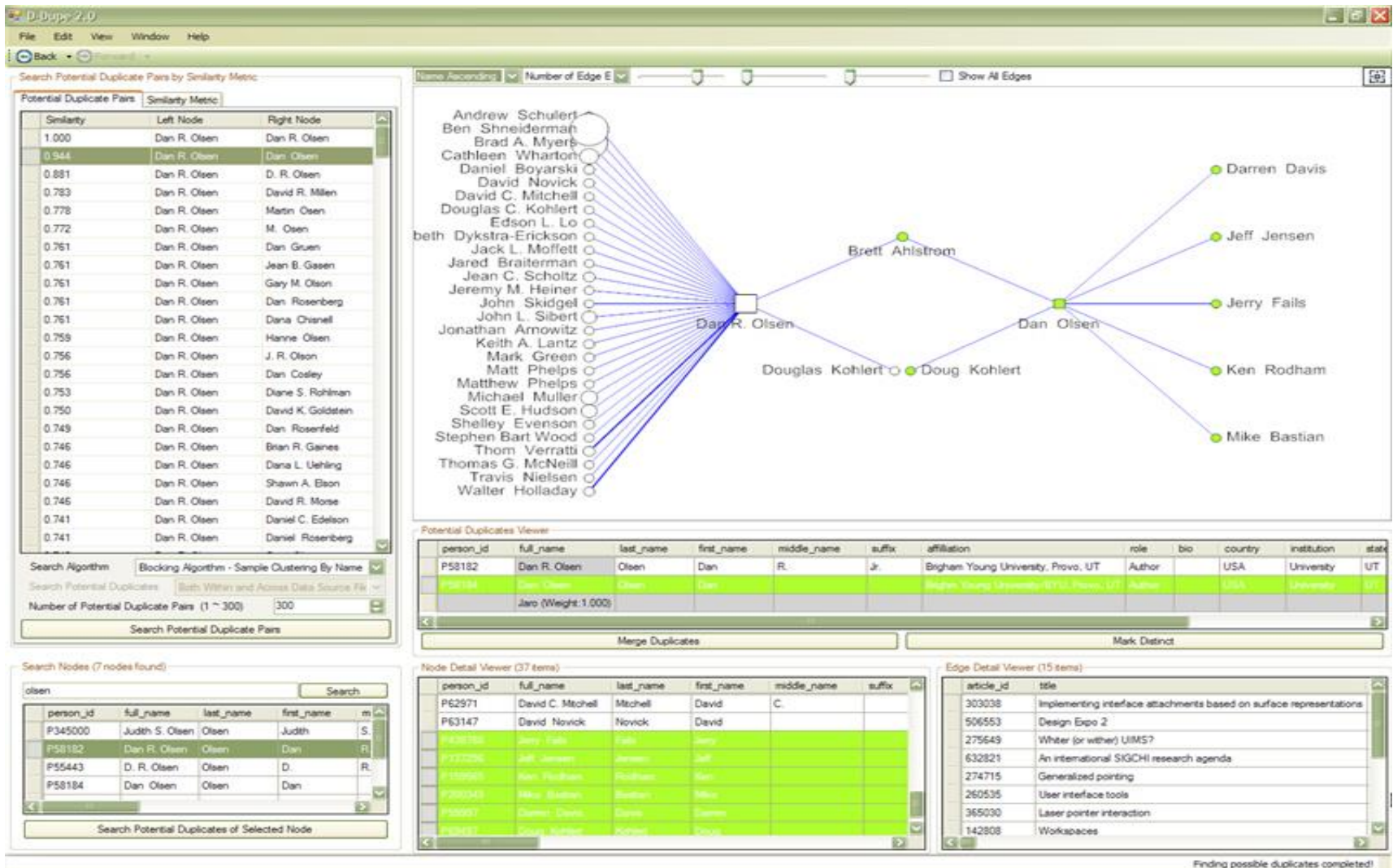
TRANSFORM

Google Refine Intro Video

**THERE ARE LOTS OF OTHER
SPECIALIZED TOOLS**

INTERACTIVE DE-DUPLICATION





REFERENCES

“Quantitative Data Cleaning for Large Databases”

Hellerstein (2008)

Quantitative Data Cleaning for Large Databases

Joseph M. Hellerstein*
EECS Computer Science Division
UC Berkeley
<http://db.cs.berkeley.edu/jmh>

February 27, 2008

1 Introduction

Data collection has become a ubiquitous function of large organizations – not only for record keeping, but to support a variety of data analysis tasks that are critical to the organizational mission. Data analysis typically drives decision-making processes and efficiency optimizations, and in an increasing number of settings is the *raison d'être* of entire agencies or firms.

Despite the importance of data collection and analysis, data *quality* remains a pervasive and thorny problem in almost every large organization. The presence of incorrect or inconsistent data can significantly distort the results of analyses, often negating the potential benefits of information-driven approaches. As a result, there has been a variety of research over the last decades on various aspects of *data cleaning*: computational procedures to automatically or semi-automatically identify – and, when possible, correct – errors in large data sets.

In this report, we survey data cleaning methods that focus on errors in *quantitative* attributes of large databases, though we also provide references to data cleaning methods for other types of attributes. The discussion is targeted at computer practitioners who manage large databases of quantitative information, and designers developing data entry and auditing tools for end users. Because of our focus on quantitative data, we take a statistical view of data quality, with an emphasis on intuitive outlier detection and exploratory data analysis methods based in *robust statistics* [Rousseeuw and Leroy, 1987, Hampel et al., 1986, Huber, 1981]. In addition, we stress algorithms and implementations that can be easily and efficiently implemented in very large databases, and which are easy to understand and visualize graphically. The discussion mixes statistical intuitions and methods, algorithmic building blocks, efficient relational database implementation strategies, and user interface considerations. Throughout the discussion, references are provided for deeper reading on all of these issues.

1.1 Sources of Error in Data

Before a data item ends up in a database, it typically passes through a number of steps involving both human interaction and computation. Data errors can creep in at every step of the process from initial data acquisition to archival storage. An understanding of the sources of data errors can be useful both in designing data collection and curation techniques that mitigate

*This survey was written under contract to the United Nations Economic Commission for Europe (UNECE), which holds the copyright on this version.

TIDY DATA PRINCIPLES

Tidy Data

Hadley Wickham

RStudio

Abstract

A huge amount of effort is spent cleaning data to get it ready for analysis, but there has been little research on how to make data cleaning as easy and effective as possible. This paper tackles a small, but important, component of data cleaning: data tidying. Tidy datasets are easy to manipulate, model and visualise, and have a specific structure: each variable is a column, each observation is a row, and each type of observational unit is a table. This framework makes it easy to tidy messy datasets because only a small set of tools are needed to deal with a wide range of un-tidy datasets. This structure also makes it easier to develop tidy tools for data analysis, tools that both input and output tidy datasets. The advantages of a consistent data structure and matching tools are demonstrated with a case study free from mundane data manipulation chores.

Keywords: data cleaning, data tidying, relational databases, R.

TIDY DATA

= data structured to facilitate analysis

labelled columns

	treatmenta	treatmentb
John Smith	—	2
Jane Doe	16	11
Mary Johnson	3	1

labelled rows

= data structure

TIDY DATA

Data semantics

variables
= column names



name	trt	result
John Smith	a	—
Jane Doe	a	16
Mary Johnson	a	3
John Smith	b	2
Jane Doe	b	11
Mary Johnson	b	1

observations
= rows



values

TIDY DATA

- Variables are columns
- Observations are rows
- Each observational unit in one table

In addition: put fixed variables first and then measured variables last

If you order, do so by the first variable

MESSY DATA - EXAMPLES

Column headers = values, not variables

religion	<\$10k	\$10-20k	\$20-30k	\$30-40k	\$40-50k	\$50-75k
Agnostic	27	34	60	81	76	137
Atheist	12	27	37	52	35	70
Buddhist	27	21	30	34	33	58
Catholic	418	617	732	670	638	1116
Don't know/refused	15	14	15	11	10	35
Evangelical Prot	575	869	1064	982	881	1486
Hindu	1	9	7	9	11	34
Historically Black Prot	228	244	236	238	197	223
Jehovah's Witness	20	27	24	24	21	30
Jewish	19	19	25	25	30	95

MESSY DATA - EXAMPLES

Better (most of the time)

Process to produce this
= melting

religion	income	freq
Agnostic	<\$10k	27
Agnostic	\$10-20k	34
Agnostic	\$20-30k	60
Agnostic	\$30-40k	81
Agnostic	\$40-50k	76
Agnostic	\$50-75k	137
Agnostic	\$75-100k	122
Agnostic	\$100-150k	109
Agnostic	>150k	84
Agnostic	Don't know/refused	96

YOU!

This table is good for data entry but not analysis.
How do we tidy it up?

year	artist	track	time	date.entered	wk1	wk2	wk3
2000	2 Pac	Baby Don't Cry	4:22	2000-02-26	87	82	72
2000	2Ge+her	The Hardest Part Of ...	3:15	2000-09-02	91	87	92
2000	3 Doors Down	Kryptonite	3:53	2000-04-08	81	70	68
2000	98~0	Give Me Just One Nig...	3:24	2000-08-19	51	39	34
2000	A*Teens	Dancing Queen	3:44	2000-07-08	97	97	96
2000	Aaliyah	I Don't Wanna	4:15	2000-01-29	84	62	51
2000	Aaliyah	Try Again	4:03	2000-03-18	59	53	38
2000	Adams, Yolanda	Open My Heart	5:30	2000-08-26	76	76	74

year	artist	time	track	date	week	rank
2000	2 Pac	4:22	Baby Don't Cry	2000-02-26	1	87
2000	2 Pac	4:22	Baby Don't Cry	2000-03-04	2	82
2000	2 Pac	4:22	Baby Don't Cry	2000-03-11	3	72
2000	2 Pac	4:22	Baby Don't Cry	2000-03-18	4	77
2000	2 Pac	4:22	Baby Don't Cry	2000-03-25	5	87
2000	2 Pac	4:22	Baby Don't Cry	2000-04-01	6	94
2000	2 Pac	4:22	Baby Don't Cry	2000-04-08	7	99
2000	2Ge+her	3:15	The Hardest Part Of ...	2000-09-02	1	91
2000	2Ge+her	3:15	The Hardest Part Of ...	2000-09-09	2	87
2000	2Ge+her	3:15	The Hardest Part Of ...	2000-09-16	3	92
2000	3 Doors Down	3:53	Kryptonite	2000-04-08	1	81
2000	3 Doors Down	3:53	Kryptonite	2000-04-15	2	70
2000	3 Doors Down	3:53	Kryptonite	2000-04-22	3	68
2000	3 Doors Down	3:53	Kryptonite	2000-04-29	4	67
2000	3 Doors Down	3:53	Kryptonite	2000-05-06	5	66

MESSY DATA - EXAMPLES

Multiple variables in one column

country	year	m014	m1524	m2534	m3544	m4554	m5564	m65	mu	f014
AD	2000	0	0	1	0	0	0	0	—	—
AE	2000	2	4	4	6	5	12	10	—	3
AF	2000	52	228	183	149	129	94	80	—	93
AG	2000	0	0	0	0	0	0	1	—	1
AL	2000	2	19	21	14	24	19	16	—	3
AM	2000	2	152	130	131	63	26	21	—	1
AN	2000	0	0	1	2	0	0	0	—	0
AO	2000	186	999	1003	912	482	312	194	—	247
AR	2000	97	278	594	402	419	368	330	—	121
AS	2000	—	—	—	—	1	1	—	—	—

FIRST WE MELT

How do we do this...?

country	year	m014	m1524	m2534	m3544	m4554	m5564	m65	mu	f014
AD	2000	0	0	1	0	0	0	0	—	—
AE	2000	2	4	4	6	5	12	10	—	3
AF	2000	52	228	183	149	129	94	80	—	93
AG	2000	0	0	0	0	0	0	1	—	1
AL	2000	2	19	21	14	24	19	16	—	3
AM	2000	2	152	130	131	63	26	21	—	1
AN	2000	0	0	1	2	0	0	0	—	0
AO	2000	186	999	1003	912	482	312	194	—	247
AR	2000	97	278	594	402	419	368	330	—	121
AS	2000	—	—	—	—	1	1	—	—	—

country	year	column	cases
AD	2000	m014	0
AD	2000	m1524	0
AD	2000	m2534	1
AD	2000	m3544	0
AD	2000	m4554	0
AD	2000	m5564	0
AD	2000	m65	0
AE	2000	m014	2
AE	2000	m1524	4
AE	2000	m2534	4
AE	2000	m3544	6
AE	2000	m4554	5
AE	2000	m5564	12
AE	2000	m65	10
AE	2000	f014	3

NEXT: SPLIT COLUMNS

country	year	sex	age	cases
AD	2000	m	0-14	0
AD	2000	m	15-24	0
AD	2000	m	25-34	1
AD	2000	m	35-44	0
AD	2000	m	45-54	0
AD	2000	m	55-64	0
AD	2000	m	65+	0
AE	2000	m	0-14	2
AE	2000	m	15-24	4
AE	2000	m	25-34	4
AE	2000	m	35-44	6
AE	2000	m	45-54	5
AE	2000	m	55-64	12
AE	2000	m	65+	10
AE	2000	f	0-14	3

MESSY DATA - EXAMPLES

Multi observational units in the same table

year	artist	track	time	date.entered	wk1	wk2	wk3
2000	2 Pac	Baby Don't Cry	4:22	2000-02-26	87	82	72
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2000	Adams, Yolanda	Open My Heart	5:30	2000-08-26	76	76	74

TIDYER & MORE SPACE EFFICIENT

id	artist	track	time	id	date	rank
1	2 Pac	Baby Don't Cry	4:22	1	2000-02-26	87
2	2Ge+her	The Hardest Part Of ...	3:15	1	2000-03-04	82
3	3 Doors Down	Kryptonite	3:53	1	2000-03-11	72
4	3 Doors Down	Loser	4:24	1	2000-03-18	77
5	504 Boyz	Wobble Wobble	3:35	1	2000-03-25	87
6	BUT not all tools work well across multiple tables					
7						
8	Aaliyah	I Don't Wanna	4:15	2	2000-09-02	91
9	Aaliyah	Try Again	4:03	2	2000-09-09	87
10	Adams, Yolanda	Open My Heart	5:30	2	2000-09-16	92
11	Adkins, Trace	More	3:05	3	2000-04-08	81
12	Aguilera, Christina	Come On Over Baby	3:38	3	2000-04-15	70
13	Aguilera, Christina	I Turn To You	4:00	3	2000-04-22	68
14	Aguilera, Christina	What A Girl Wants	3:18	3	2000-04-29	67
15	Alice DeeJay	Better Off Alone	6:50	3	2000-05-06	66

MORE EXAMPLES HERE

Tidy Data

Hadley Wickham

RStudio

Abstract

A huge amount of effort is spent cleaning data to get it ready for analysis, but there has been little research on how to make data cleaning as easy and effective as possible. This paper tackles a small, but important, component of data cleaning: data tidying. Tidy datasets are easy to manipulate, model and visualise, and have a specific structure: each variable is a column, each observation is a row, and each type of observational unit is a table. This framework makes it easy to tidy messy datasets because only a small set of tools are needed to deal with a wide range of un-tidy datasets. This structure also makes it easier to develop tidy tools for data analysis, tools that both input and output tidy datasets. The advantages of a consistent data structure and matching tools are demonstrated with a case study free from mundane data manipulation chores.

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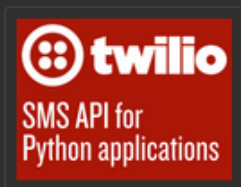
CSVKIT

🏠 csvkit

1.0.2

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Make and receive SMS messages in your applications with just a few lines of Python

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[Edit on GitHub](#)

csvkit 1.0.2

About

build **passing** dependencies **up-to-date** coverage **88%** downloads **no longer available** pypi **v1.0.2** license **MIT**

python **2.7, 3.3, 3.4, 3.5, 3.6**

csvkit is a suite of command-line tools for converting to and working with CSV, the king of tabular file formats.

It is inspired by pdftk, gdal and the original csvcut tool by Joe Germuska and Aaron Bycoffe.

If you need to do more complex data analysis than csvkit can handle, use [agate](#).

Important links: