Data Cleaning

DATA 201: Thinking With Data
Winter 2022

Jonathan Hudson, Ph.D
Instructor
Department of Computer Science
University of Calgary

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What is Data Cleaning?

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Why Data Cleaning?

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“I spend more than half of 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.

Most of the time once you transform the data you just do an average… the insights can be scarily obvious.

It’s fun when you get to do something somewhat analytical.”

–Kandel et al. 2012

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Where does “dirty” data come from?

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Sources of Error

- What are some of your ideas on where errors in stored data comes from?

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Sources of Error

- Data entry
- Measurement
- Distillation
- Data integration

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Data Entry Errors

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Data Entry Errors

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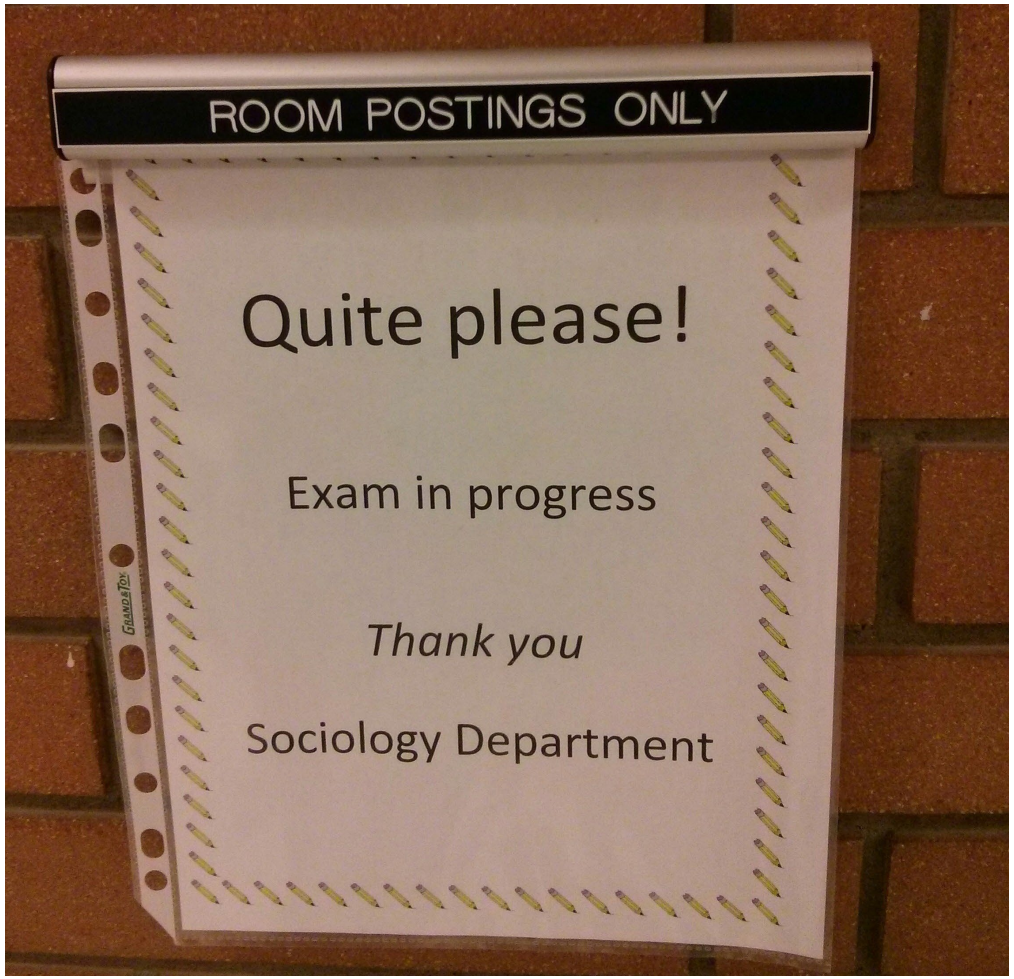
Data Entry Errors



Science B

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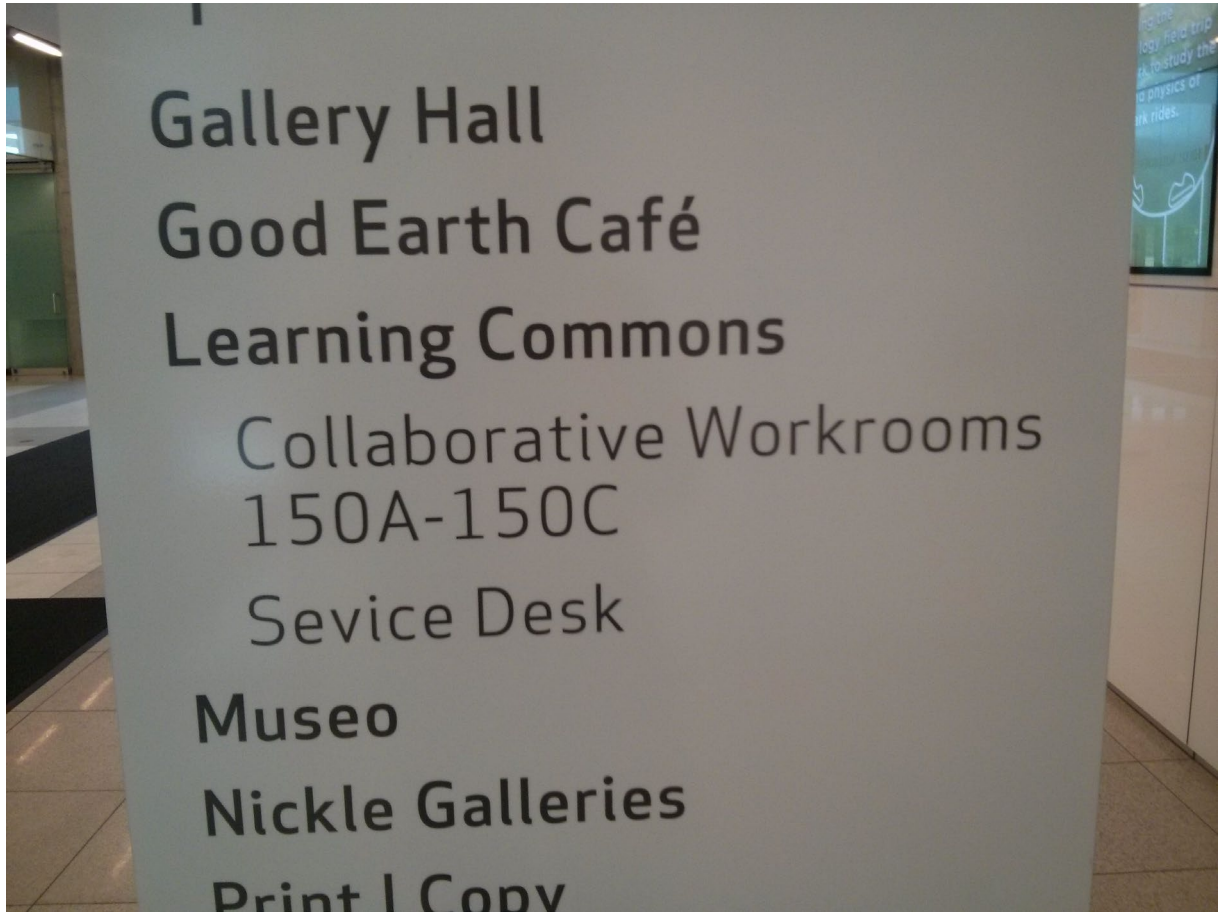
Data Entry Errors



Taylor Family
Digital Library

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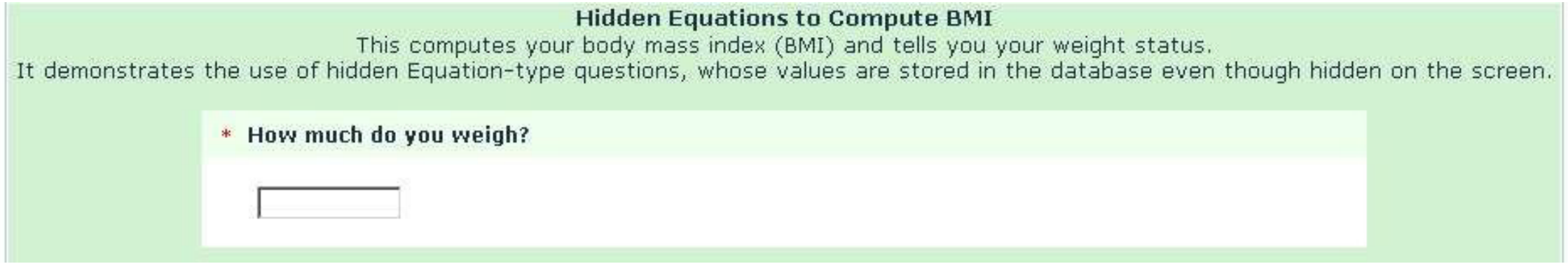
Data Entry Errors



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Data Entry Errors

Step 1: Activity/Equipment Type | Step 2: Add a Map | Step 3: Additional Details

Date of Activity:

September 2014

Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Average Heart Rate (optional):

bpm

Duration:

00 : 00 : 00

Start Time:

11 : 43 AM

Distance:

5.62 mi

Calories:

Training Plan:

None

Add An Activity

Activity Details

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

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Measurement Errors

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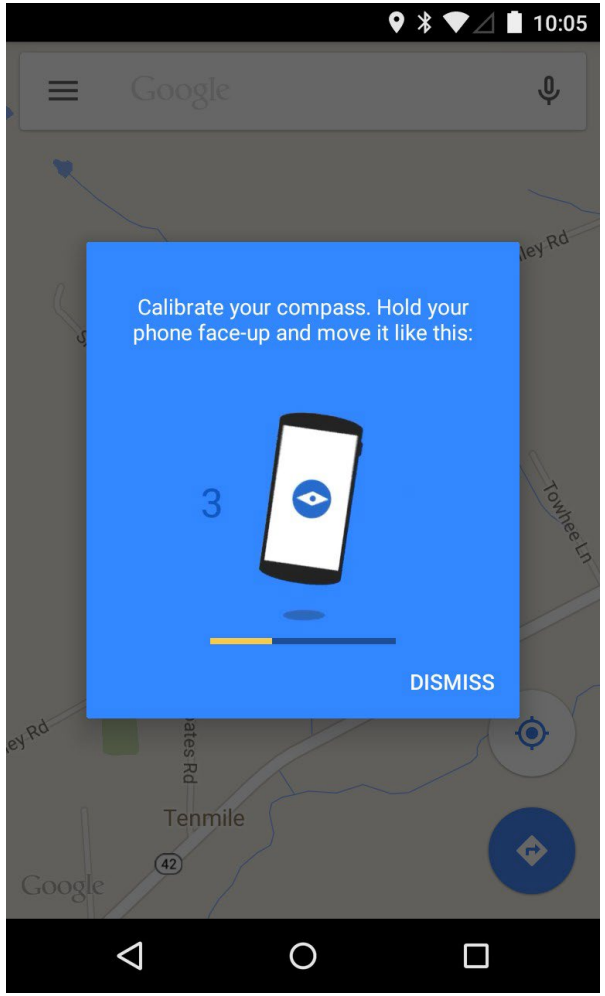
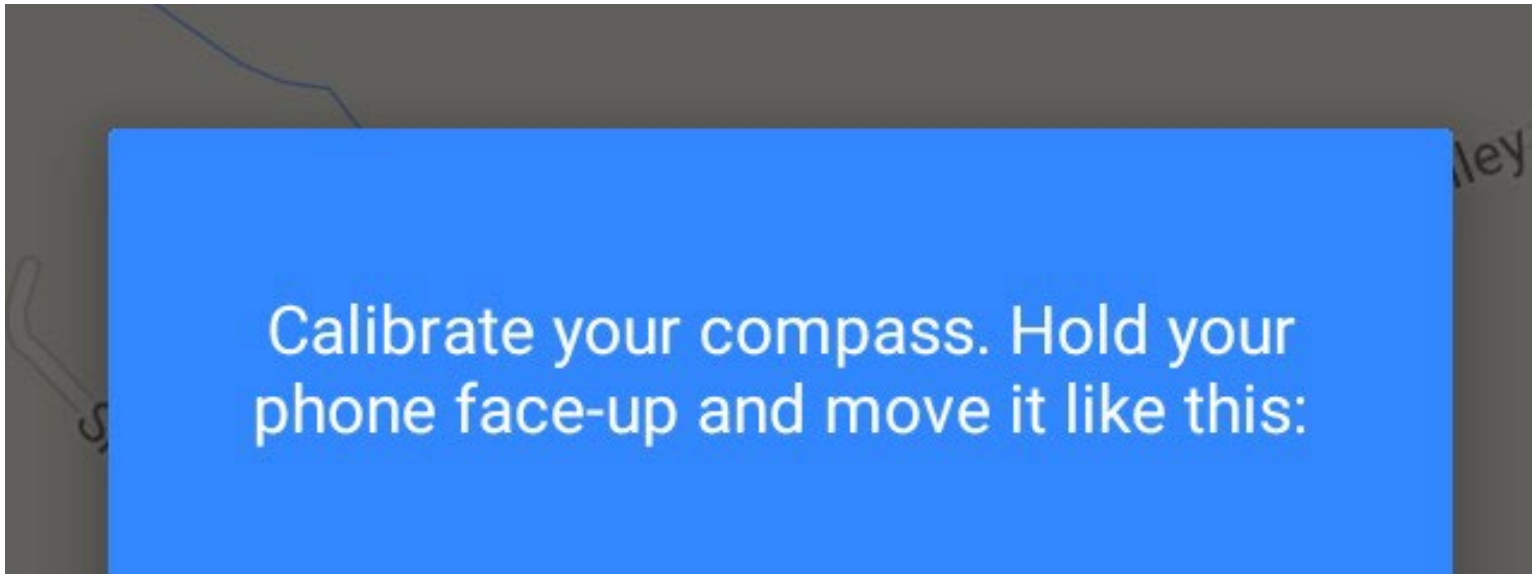
Measurement Errors

Measurement Errors





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Measurement Errors

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Distillation Errors

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Distillation Errors

0.345413 => 0.35

Goods and Services Tax => GST

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Distillation Errors

2017, $2, Apples
2017, $2, Oranges => 2017, $2, “Apples, Oranges, Bananas”
2017, $2, Bananas

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Data Integration Errors

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Data Integration Errors

- Data often comes from multiple sources

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Data Integration Errors

- Data often comes from multiple sources
- Schemas change over time

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Data Integration Errors

- Data often comes from multiple sources
- Schemas change over time
- Same data may have different format from different sources

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Preventing Errors

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Integrity Constraints

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Integrity Constraints

Temperature _____

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Integrity Constraints

Temperature _____ °C

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Integrity Constraints

*Temperature _____ °C

*required

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Integrity Constraints

*Temperature _____ °C (-50 °C to 50 °C)

*required

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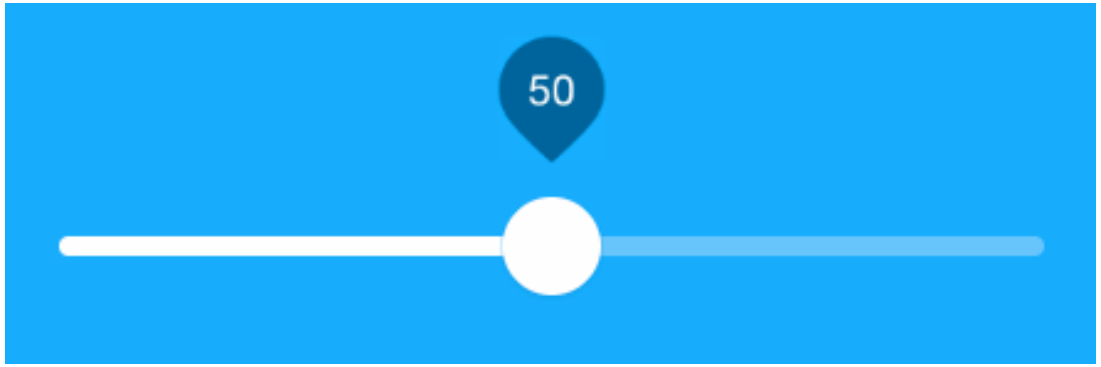
Integrity Constraints

Temperature



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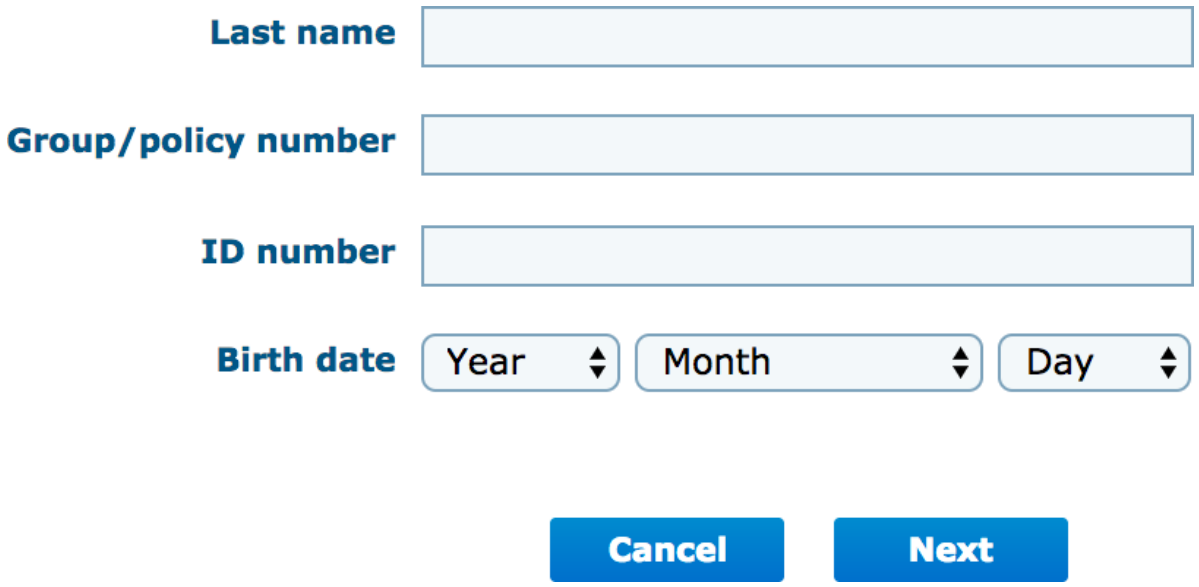
Integrity Constraints



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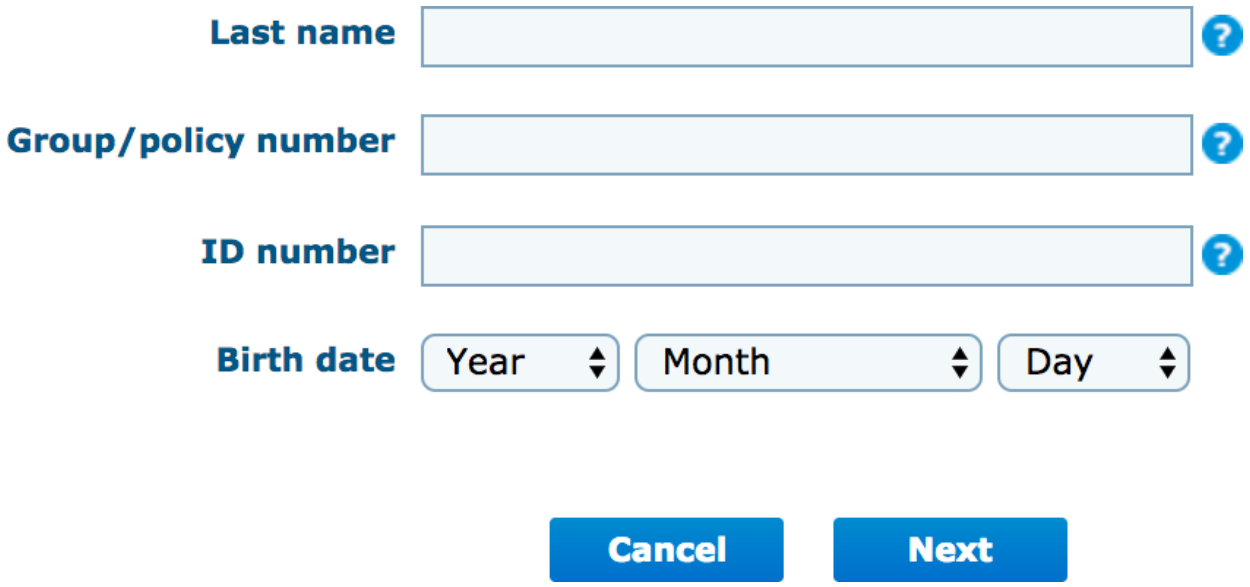
Integrity Constraints



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Integrity Constraints

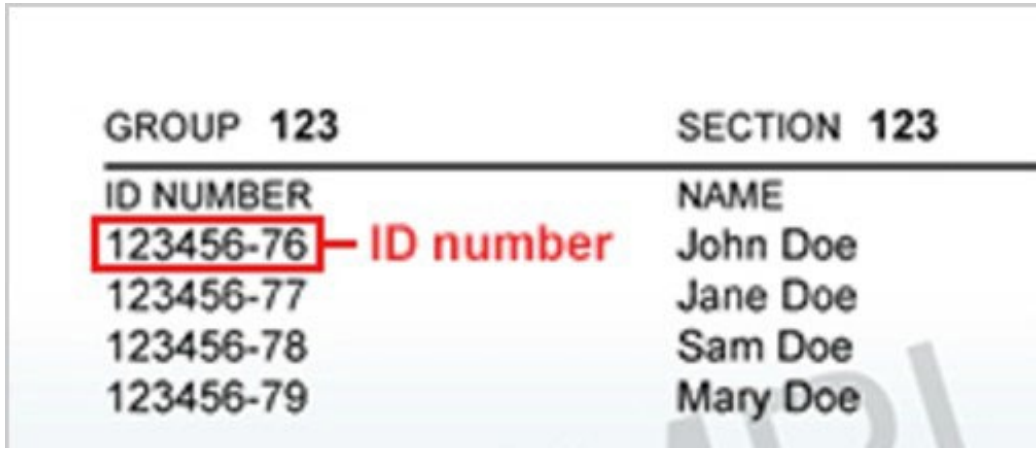
Last name

Group/policy number

ID number

Birth date Year Month Day

Cancel Next



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Prediction and Friction

- Use data quality measures to predict how likely a value is to be correct

- Adjust the interface to add friction when entering unlikely responses

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Integrity Constraints

- Integrity constraints do not prevent bad data
- Enforcing constraints may lead to frustration

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Minimize Sensor Errors

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Minimize Sensor Errors

- Check sensors before deployment

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Minimize Sensor Errors

- Check sensors before deployment
- Periodically revalidate equipment

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Minimize Sensor Errors

- Check sensors before deployment
- Periodically revalidate equipment
- Use redundant sensors

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Minimize Sensor Errors

- Check sensors before deployment
- Periodically revalidate equipment
- Use redundant sensors
- Check data against historical logs or computed models

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Minimize Sensor Errors

- Check sensors before deployment
- Periodically revalidate equipment
- Use redundant sensors
- Check data against historical logs or computed models
- Use common sense

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Double Data Entry

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Double Data Entry

- Perform all data entry twice

- Identify mismatches then discard or repair

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Detecting Errors

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Data Auditing & Error Detection

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Data Auditing & Error Detection

- Look for outliers / anomalies

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Data Auditing & Error Detection

- Look for outliers / anomalies
- Examine data types

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Data Auditing & Error Detection

- Look for outliers / anomalies
- Examine data types
- Schema checking

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Data Auditing & Error Detection

- Look for outliers / anomalies
- Examine data types
- Schema checking
- Validate with other data

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Data Auditing & Error Detection

- Look for outliers / anomalies
- Examine data types
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- Validate with other data
- Common Sense

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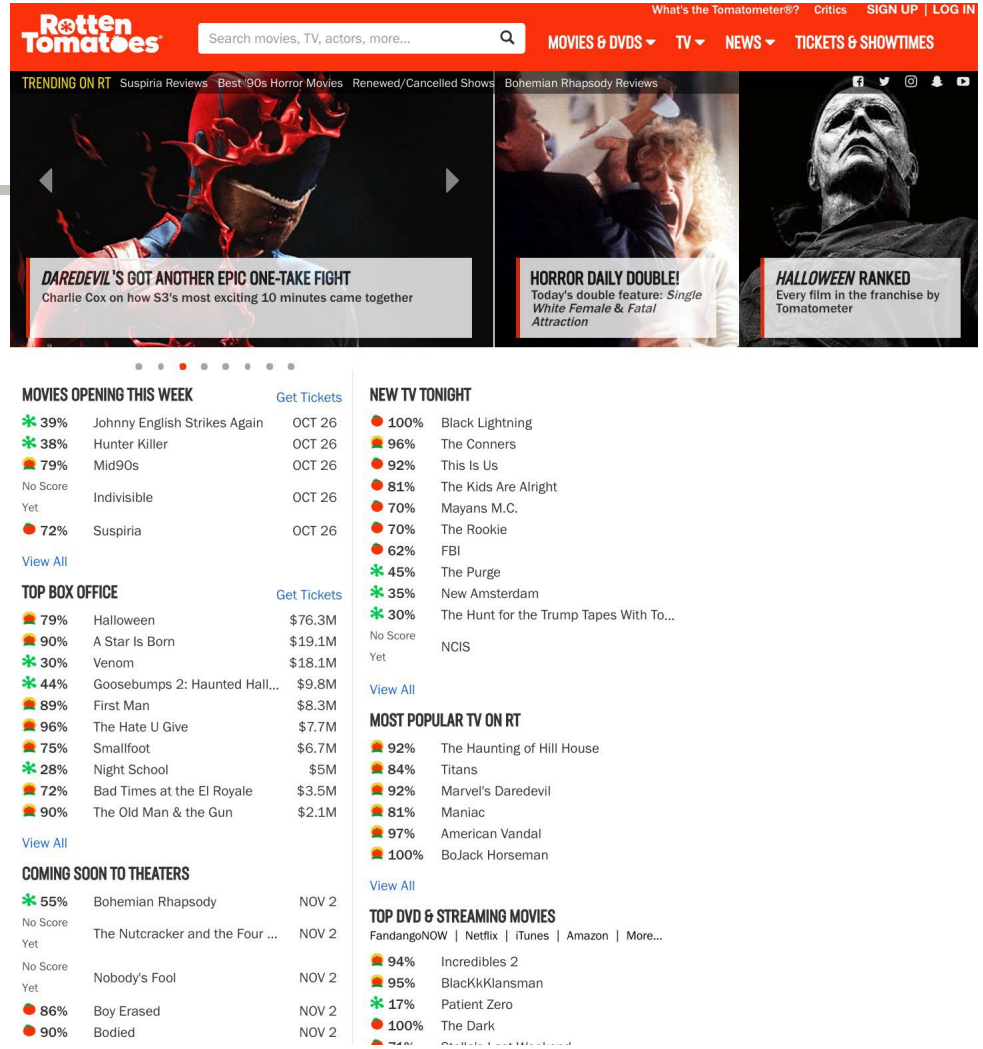

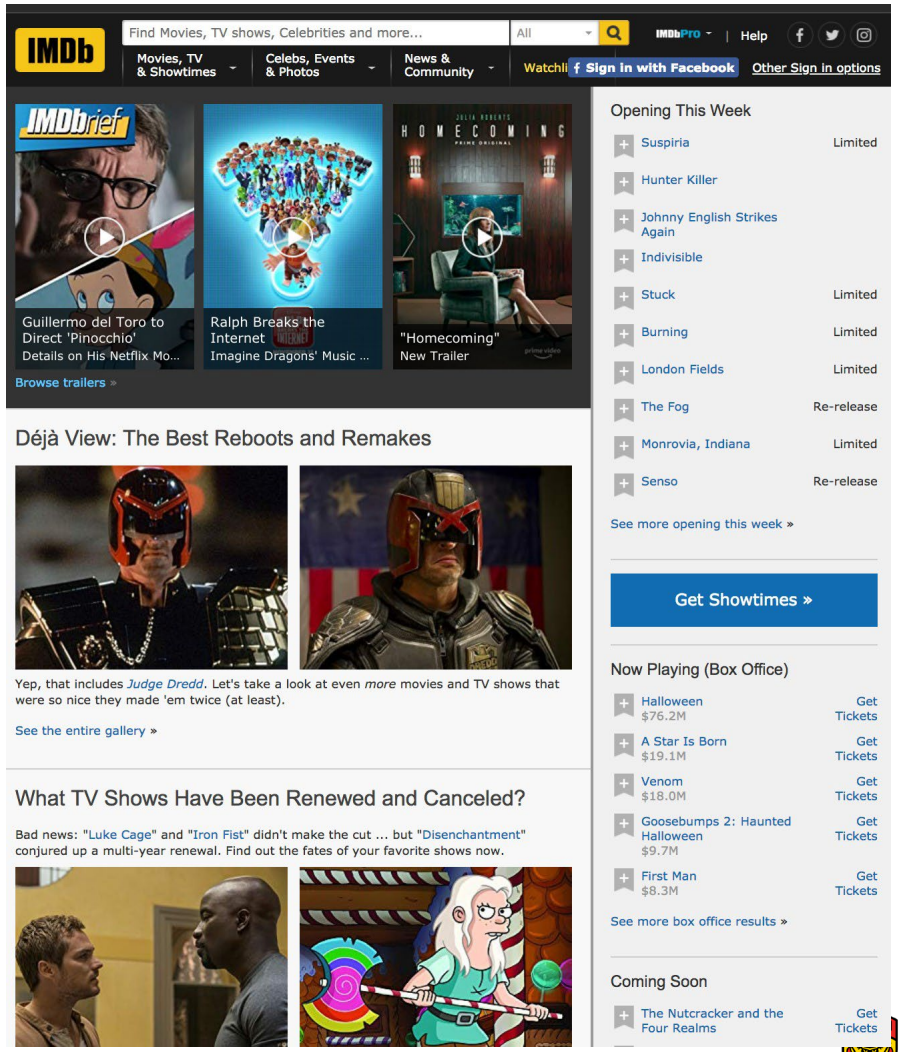

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Title	Release Date	MPAA Rating	Distributor	Rotten Tomatoes Rating	IMDB Rating
The Land Girls	Jun 12, 1998	R	Gramercy		6.1
First Love, Last Rites	Aug 7, 1998	R	Strand		6.9
I Married a Strange Person	Aug 28, 1998		Lionsgate		6.8
Slam	Oct 9, 1998	R	Trimark	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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Arn - Tempelriddaren	Dec 25, 2007	R		
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	17
Around the World in 80 Days	Oct 17, 1956	PG	United Artists	73
Barbarella	Oct 10, 1968		Paramount Pictures	74
Barry Lyndon	1975		Warner Bros.	94
Barbarians, The	March, 1987			
Babe	Aug 4, 1995	G	Universal	98
Boynton Beach Club	Mar 24, 2006	R	Wingate Distribution	
Baby's Day Out	Jul 1, 1994	PG	20th Century Fox	21

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Title	Release Date	IMDB Rating	IMDB Votes	MPAA Rating
Bad Boys	Apr 7, 1995	6.6	53929	R
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	R
Beauty and the Beast	Nov 13, 1991	3.4	354	G

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Common Data Quality Issues

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Common Data Quality Issues

- Missing Data —
- Erroneous Values —
- Entity Resolution —
- Type Conversion —
- Data Integration —

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Common Data Quality Issues

- Missing Data — Missed measurements, redacted items, incomplete forms, etc.
- Erroneous Values —
- Entity Resolution —
- Type Conversion —
- Data Integration —

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Common Data Quality Issues

- Missing Data — Missed measurements, redacted items, incomplete forms, etc.
- Erroneous Values — Misspellings, outliers, “spurious integrity”, etc.
- Entity Resolution —
- Type Conversion —
- Data Integration —

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Common Data Quality Issues

- Missing Data — Missed measurements, redacted items, incomplete forms, etc.
- Erroneous Values — Misspellings, outliers, “spurious integrity”, etc.
- Entity Resolution — Different values, abbrevs., 2+ entries for the same thing
- Type Conversion —
- Data Integration —

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Common Data Quality Issues

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- Data Integration —

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Common Data Quality Issues

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- Erroneous Values — Misspellings, outliers, “spurious integrity”, etc.
- Entity Resolution — Different values, abbrevs., 2+ entries for the same thing
- Type Conversion — e.g., postal code or place name to lat-lon
- Data Integration — Mismatches and inconsistencies when combining data

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Detect Duplicates

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Duplicates

TITLE	NAME
Ben-Hur	Anand Vaskar
Ben Hur	Anand Vaskkar
BEN-HUR	A. Vaskar
Ben-Hur (1959)	Vaskar, Anand

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Levenshtein Distance

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

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Levenshtein Distance

Ben-Hur
Ben Hur

Distance = 1

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Levenshtein Distance

Anand Vaskar
Anand Vaskkar

Distance = ?

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Levenshtein Distance

Ben-Hur
Ben Hur (1959 film)

Distance = ?

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Soundex / Metaphone

How similar do they sound?

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Soundex / Metaphone

Ben-Hur	Anana Vaskar
Ben-Hurr	Anand Vaskkar
Been Her	Ahnund Vachkar

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Fingerprinting

Strip away unimportant details (e.g., punctuation and capitals)

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Fingerprinting

Ben-Hur => ben hur

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Fingerprinting

Anand Vaskar => anand vaskar

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How to Fix Problems?

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Questions to Think About

- Which duplicate to keep?
- Outliers: keep, remove, or repair?
- How to deal with bad formats (e.g., dates and addresses)?

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Some Ways to Fix Problems

- Fuzzy matching systems
- Machine learning to detect/resolve errors
- Usually requires human judgement (especially for new data)

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Cleaning

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Common Operations

- Correct and remove errors
- Change formats
- Remove formatting

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Spreadsheets

+ Easily accessible

+ Visual

- Tedious

- Time-consuming

- Repetitive

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Scripts

+ Reusable

+ Scalable

- Difficult

- Tedious

- Time-consuming

```
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", on=",", max=0))

# Delete empty rows
w.add(dw.Filter(row=dw.Row(conditions=dw.Empty())))

# Extract from split after 'in '
w.add(dw.Extract(column="split", on=".*", after="in "))

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

# Delete  rows where split1 is null
```


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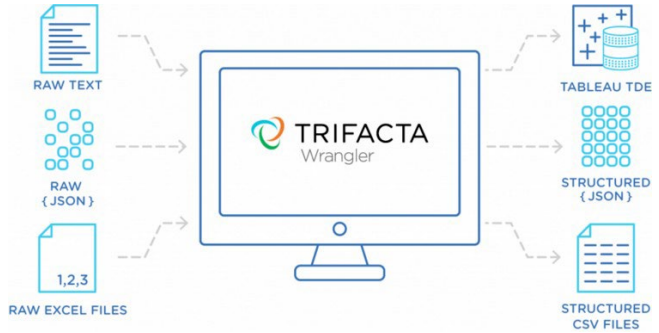
Interactive Data Cleaning

Trifacta Wrangler
https://www.trifacta.com



Wrangler (Stanford HCI Group)
http://vis.stanford.edu/wrangler

OpenRefine (formerly Google Refine)
http://openrefine.org

Onward to …
Charts

Jonathan Hudson
jwhudson@ucalgary.ca
https://pages.cpsc.ucalgary.ca/~jwhudson/

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