Converting Units Across Multiple Data Sources Using CSV Files

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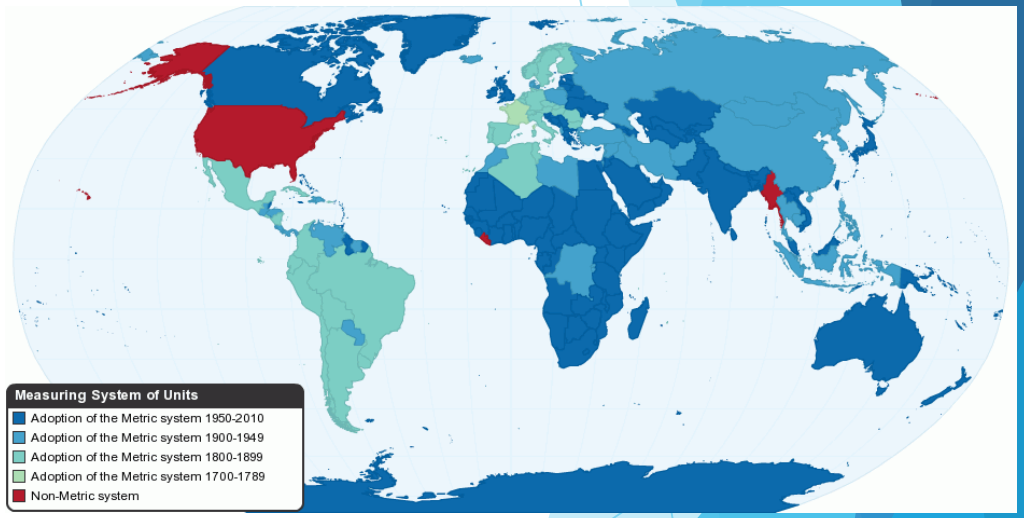
Link to presentation, code, dataset and data generator:

https://github.com/mihransimonian/Uva-Block3-Big_Data-Assignment

Introduction – What Are Measurement Units?

- Describe a measurement: Temperature / Distance / Weight etc.
- Different systems in the world, generally:
  - Metric system (SI)
    - Système international d'unites
    - 95% of the world
  - US customary system: USA
  - Burmese system: Burma
- Specific niches sometimes are applied, even today:
  - Imperial (UK)



Source image: http://chartsbin.com/view/d12

Motivation

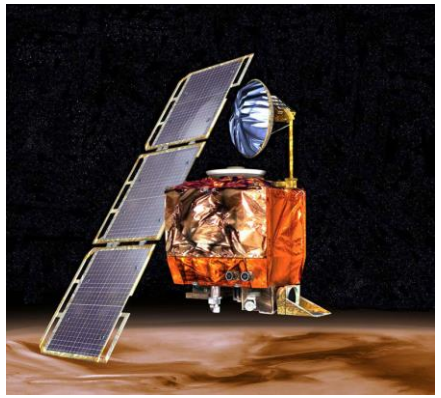
Motivation – Why Convert Units?

- Compare products
- Create a (technical) design
- Make decisions, e.g. procurement

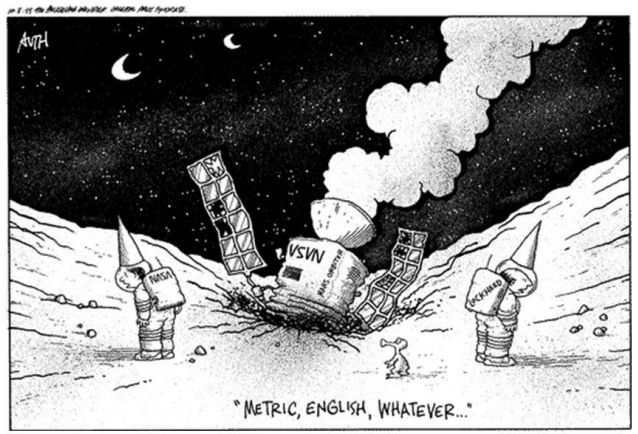
- Some niches require;
  - Oil & Gas:
    - Large pipes measured solely in inches US customary units, except sometimes not when European vendor
    - Small pipes measured sometimes in US customary and sometimes in SI metric
  - Engine horsepower: bhp (imperial) and hp (SI)
    - "British manufacturers often intermix metric horsepower and mechanical horsepower depending on the origin of the engine in question." (source: https://en.wikipedia.org/wiki/Horsepower)
  - Mechanical screwthread:
    - English (left-hand), Metric and US Customary (right-hand)

- In short; it's quite a mess still

Motivation – When Things Go Wrong



- NASA Mars climate orbiter, 1999
- Mix-up between US Customary and SI
- Orbiter crashed due to misinterpretation of units (wrong calculations)
- Damage:
  - USD 125 million in 1999
  - No mars climate orbiting!



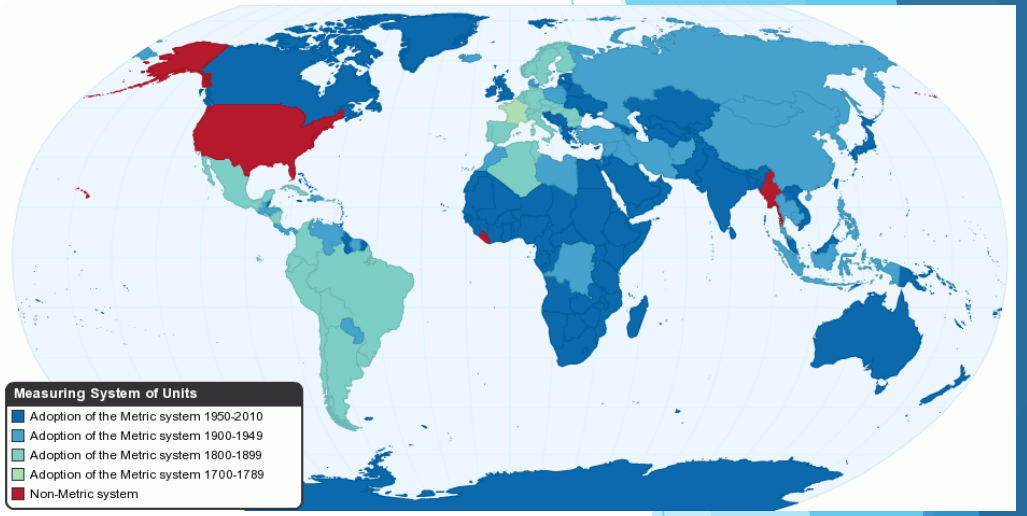
Remember the Mars Climate Orbiter incident from 1999?

Source costs: http://edition.cnn.com/TECH/space/9909/30/mars.metric/

Source image: https://solarsystem.nasa.gov/missions/mars-climate-orbiter/in-depth/
https://images.app.goo.gl/psJdWTtZb9C1uQkd7

Motivation - Situational Framework

- ERP system integration
  - Multiple vendors around the world
  - Use a single identifier for production identification
  - Have different units in place
- Want a single unit representation
- Each vendor should be able to design their own translation list as well for local utilization (instead of SI use US customary)
- Easy adjustment and verification of unit conversion



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Motivation – Focus On Big Data

- The famous eight V's
  - Some say there are too many V's
- Focus lays on variety
  - Data types:
    - Strings
    - Floats
  - File conversion
  - Using files for dictionaries and databases
- Touch fields of volume and speed superficially

Bullshit

Source image: Lecture 1, Block 3, University of Amsterdam, Big Data Class

Existing Methods

Existing Methods – Python Libraries

- Multiple libraries exist
- Either they are not sufficient, or they are too sufficient
  - Some abbreviations in measurement systems are used for multiple ‘subjects’, e.g. : R
    - Rockwell surface hardness / Radius / Rankine temperature
  - Some packages require the special characters: ° in temperatures, not always accepted in your csv container
- Error codes frequently arose
- Main issue;
  - it requires the coder to know what he is doing
  - it requires coding experience to verify/adjust the operation

Proposed Method

Proposed Method – Requirement: Use Multiple Files

- Multiple files arrange the unit conversion
  - Unit conversion file - CSV
  - Input: database file – CSV
  - Output: cleaned database
  - Output storage:
    - Csv
    - Sql
    - Hdf
    - Parquet
    - Feather
- This allows non-programming users to verify and adjust the unit conversion
- CSV is easy to understand, works with nearly any system in the world (import/export) and is supported even by Windows Notepad

Implementation

Implementation – General Steps

- 1. Import
  - Database
  - Unit conversion list
- 2. Process
  - Convert to Pandas Dataframe
  - Clean each data entry (decimal points, strings, remove columns etc.)
  - Perform unit conversion
- 3. Output
  - Store Pandas dataframe in data container

Implementation – Back to Basics: How to Convert A Unit?

- 1. Apply formula:
  - E.g. Fahrenheit to Celsius:
    - $T_{(^\circ C)} = (T_{(^\circ F)} - 32) \times 5/9$
- 2. Multiply by static number
  - Inches to Centimeter:
    - $D_{(cm)} = d_{(\text{inches})} * 2.54$

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```
if callable(x):
     # applies the unit transform function as stated in dictionary
    return x(data_in)
else:
    # multiple with unit transform amount (e.g. conversion rate)
    return data_in * x
```

- 2. Multiply by static number
  - Inches to Centimeter:
    - $D_{(cm)} = d_{(\text{inches})} * 2.54$

Proposed Method – CSV Unit Conversion?

- Dictionary can contain both methods for unit conversion (static and formula)
- A conversion number
- Special case: a formula
  - Read a string to memory location
  - Update dictionary and create a pointer to the memory location

Proposed Method – CSV Unit Conversion?

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```
'distance_USCS_in':0.0254, # inch
'temperatures_USCS_F': lambda x : ((5/9) * (x - 32)), # Fahrenheit to C
```

```
for k, v in reader:
    # add key and value to dict
    dict_unit_csv[k] = v
```

```
if type(dict[item]) is str and dict[item].startswith(string_indicator):
    # updates value to a 'pointer' of the actual formula
    dict[item] = eval(dict[item])
```

Proposed Method – Dots, Decimal Points and Thousand Separators

- Countries use different systems
  - Choose to use decimal point
- Software can create thousand separators
  - Excel
    - US: commas
    - Netherlands: dots
- Sometimes your values are stored in strings
  - Try: float(number_which_is_now_in_string)
- Error handling included

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```
if type(data_in) is str:
    # assure all commas become dots
    data_in = data_in.replace(',','.')
    # assure we only remain with the most right dot
    if data_in.count('.') > 1:
        data_in = data_in.replace('.','', data_in.count('.') - 1)
```

Proposed Method – Error Handling

- Error handling included in functions
- Main case: the variable is not the correct datatype
  - String is delivered expect a float
  - Boolean delivered expect a float
- Solution:
  - Return string
  - Raise RuntimeError with datatype given and custom message (included in each function
- Using Booleans to determine whether to use error handling or not

Proposed Method – Error Handling

- Def function(input, return_error_message=False, return_runtimeerror=False):

- If input is not what I expect:
  - Try:
    - Fix It if possible
  - Except:
    - if return_runtimeerror:
      - **Raise** runtimerror(error message)
    - If return_error_message:
      - **Return** errormessage
  - Return function performed on input # everything is okay and we can return the input

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```
# errorhandling
if on_error_return_runtimerror:
    if type(data_in) is bool:
        # this will stop the program!
        raise RuntimeError("Boolean " + message_error_string)
    if type(data_in) is str:
        # this will stop the program!
        raise RuntimeError("String " + message_error_string)
elif on_wrong_datatype_return_errormessage_string:
    # return a string that can be used for storage in database or identification purposes
    return str(type(data_in)) + message_error_string
```

Proposed Method – Error Handling

- Return string:
  - Can be stored in the database for error tracking
- Return runtimeerror:
  - Will stop running the program, so much more useable for programmers
- Runtime error has been included as it provides better tracking of error (as you can see the codelines)

Proposed Method – Perform Conversions

- Import -> Dataframe
- Perform map & lambda operation on the columns in the dataframe

```
        if col != column_with_product_id:
            # if not column with product_id info it must be convertable information
            df_import_supplier[col] = df_import_supplier[col].map(lambda x : cleanup_data_values_return_float(x, on_error_return_runtimerror=False))
            df_import_supplier[col] = df_import_supplier[col].map(lambda x : convert_units_from_dict(dict_to_use, unit_subject, unit_system, unit_specs, x,
on_error_return_runtimerror=True, on_wrong_datatype_return_string=False))
        else:
            df_import_supplier[col] = df_import_supplier[col].map(lambda x: remove_character_from_string(x, character_to_remove=product_id_seperator_to_be_removed,
on_wrong_datatype_return_errormessage_string=True))
```

Proposed Method – Store To Container

- Use built-in pandas dataframe solutions
- Generally only a few hyperparameters
- Easily iterateable, so we can upscale to automate our conversion method

```
# hyperparameters, located here for easy adjustment
filepath_of_csv_unit_conversion_list = '.\conversion_of_units.csv'
filepath_of_csv_unit_of_database = '.\DataA.csv'
filepath_for_storing_the_cleaned_database = r'.\converted_db_of_supplier'
system_name_for_product_id = '12NC'
supplier_name = 'Company_A'
storing_filesystem = 'csv' # options: csv, sql, hdf, parquet and feather
```

Upscaling To Big Data

Upscaling To Big Data - Storage

- Pandas Dataframe offers storage to popular formats:
  - CSV
  - SQL
  - Hdf
  - Parquet
  - Feather
- CSV: ~11 MB
- Parquet (compression: 5): ~3 MB
- Further compression (zip, gzip etc.) possible

Upscaling To Big Data - Processing

- Using variable translation lists and databases, only functions need to be copied to individual nodes
- Relatively simple and self contained functions
- Parallelization is therefore easily possible, even without the need of using advanced techniques
- The whole import and transformation process can run on a single node
- A network of nodes can process multiple new supplier databases
- Merging to an existing database depends on the applied techniques

Conclusion

Conclusion – A Very Unique System

- Combine loose files with specific software
- By making software as generic as possible, this can be used for many instances
- A relative quick system
- Universally deployable
- Requires little to no additional libraries (depends on storage output, code provides for installation of libraries)

Discussion

Discussion – Humans Remain Involved

- Humans are able to adjust csv files, potentially ruining the system
- We will always need a human verification
- System was specifically designed to tailor the human side of the conversion; being able to use human's capabilities in interpretating information and thus assign a new measurement unit system

Discussion – Computer Imprecision

- Computer bits allow only 1 or 0 to be stored
- Due to bit size, we will always remain with an imprecision
  - IEEE 754 standard

- For simple calculations not an issue
- For the more advanced conversions much more important

- For most cases not important
- For NASA very important

- With each conversion
  - loose a bit of information
  - Create misinformation

```
x = 0.1 + 0.2
print(x)
# Output:
0.30000000000000004
```

End

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