

Comparing strings

CLEANING DATA IN PYTHON



Adel Nehme

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In this chapter

Chapter 4 - Record linkage

Minimum edit distance

I	N	T	E	N	T	I	O	N
---	---	---	---	---	---	---	---	---

E	X	E	C	U	T	I	O	N
---	---	---	---	---	---	---	---	---

Least possible amount of steps needed to transition from one string to another

Minimum edit distance

I	N	T	E	N	T	I	O	N
---	---	---	---	---	---	---	---	---

+ Insertion

- Deletion

↔ Substitution

↔ Transposition

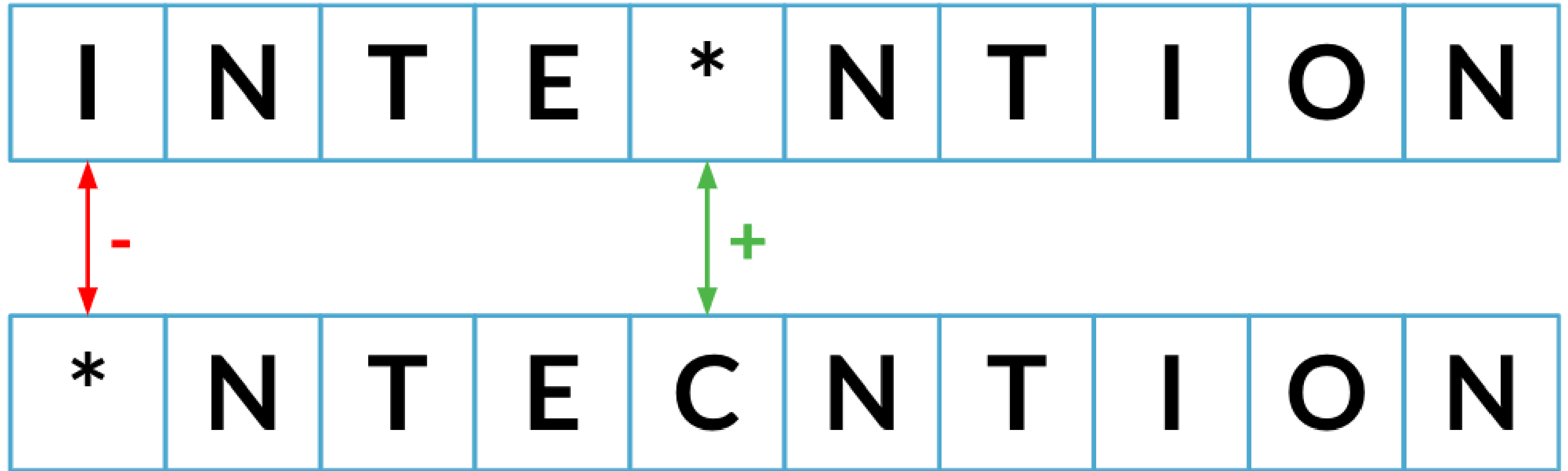
E	X	E	C	U	T	I	O	N
---	---	---	---	---	---	---	---	---

Least possible amount of steps needed to transition from one string to another

Minimum edit distance

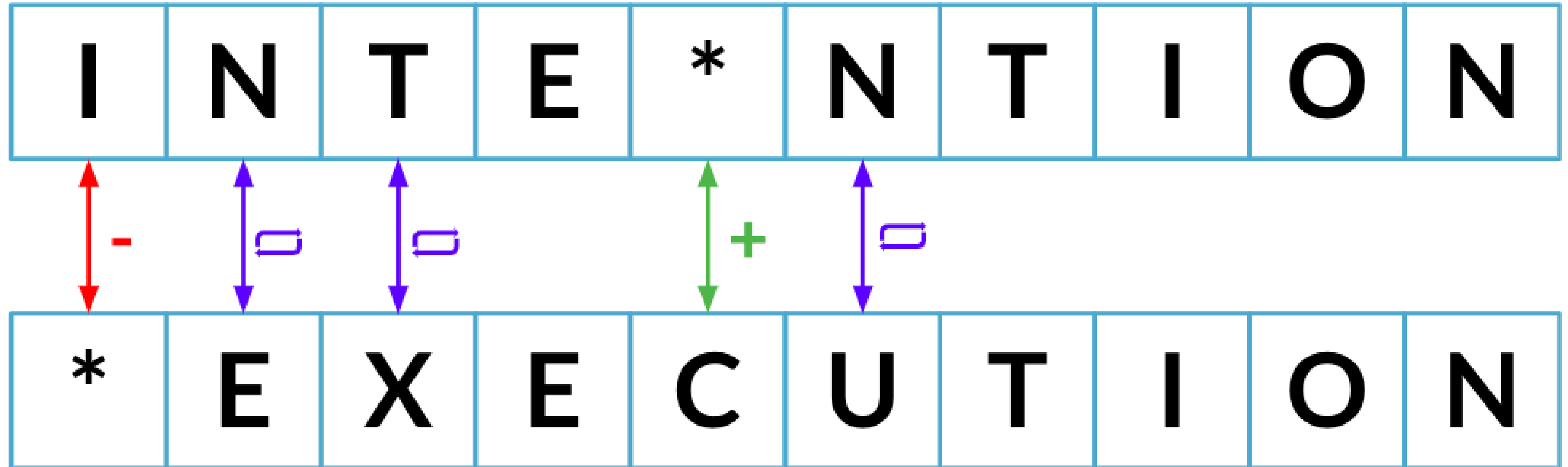
I	N	T	E	N	T	I	O	N
---	---	---	---	---	---	---	---	---

Minimum edit distance



Minimum edit distance so far: 2

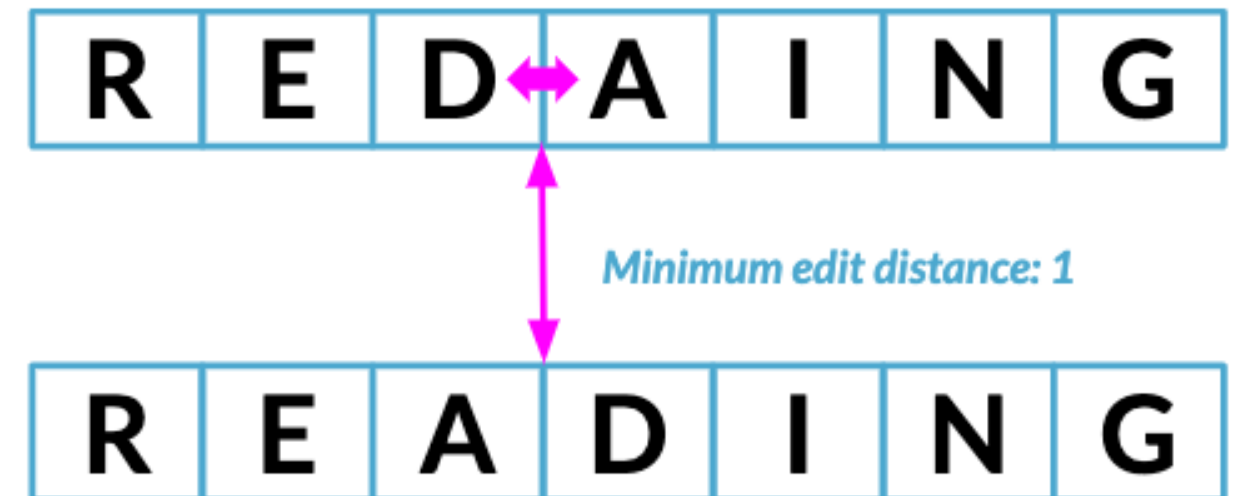
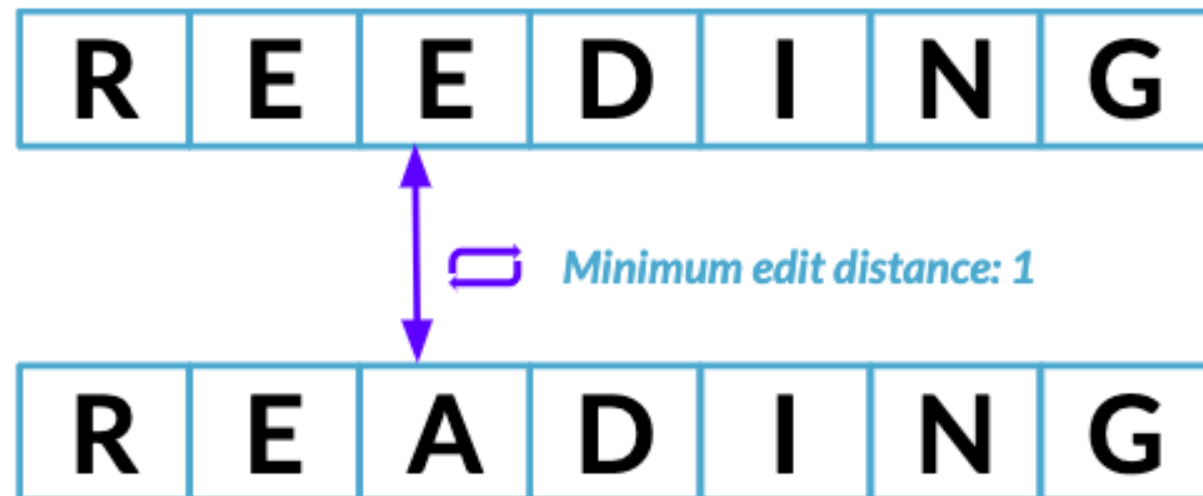
Minimum edit distance



Minimum edit distance: 5

Minimum edit distance

Typos for the word: READING



Minimum edit distance algorithms

Algorithm	Operations
Damerau-Levenshtein	insertion, substitution, deletion, transposition
Levenshtein	insertion, substitution, deletion
Hamming	substitution only
Jaro distance	transposition only
...	...

Possible packages: `nltk` , `fuzzywuzzy` , `textdistance` ..

Minimum edit distance algorithms

Algorithm	Operations
Damerau-Levenshtein	insertion, substitution, deletion, transposition
<i>Levenshtein</i>	<i>insertion, substitution, deletion</i>
Hamming	substitution only
Jaro distance	transposition only
...	...

Possible packages: `fuzzywuzzy`

Simple string comparison

```
# Lets us compare between two strings
from fuzzywuzzy import fuzz

# Compare reeding vs reading
fuzz.WRatio('Reeding', 'Reading')
```

86

Partial strings and different orderings

```
# Partial string comparison  
fuzz.WRatio('Houston Rockets', 'Rockets')
```

90

```
# Partial string comparison with different order  
fuzz.WRatio('Houston Rockets vs Los Angeles Lakers', 'Lakers vs Rockets')
```

86

Comparison with arrays

```
# Import process
from fuzzywuzzy import process

# Define string and array of possible matches
string = "Houston Rockets vs Los Angeles Lakers"
choices = pd.Series(['Rockets vs Lakers', 'Lakers vs Rockets',
                    'Houson vs Los Angeles', 'Heat vs Bulls'])

process.extract(string, choices, limit = 2)
```

```
[('Rockets vs Lakers', 86, 0), ('Lakers vs Rockets', 86, 1)]
```

Collapsing categories with string similarity

Chapter 2

Use `.replace()` to collapse `"eur"` into `"Europe"`

What if there are too many variations?

`"EU"` , `"eur"` , `"Europ"` , `"Europa"` , `"Erope"` , `"Evropa"` ...

String similarity!

Collapsing categories with string matching

```
print(survey['state'].unique())
```

```
categories
```

```
id      state
0    California
1         Cali
2    California
3    Californie
4    Californie
5    California
6    Calefernia
7     New York
8 New York City
...
```

```
state
0 California
1 New York
```

Collapsing all of the state

```
# For each correct category
for state in categories['state']:
    # Find potential matches in states with typos
    matches = process.extract(state, survey['state'], limit = survey.shape[0])
    # For each potential match match
    for potential_match in matches:
        # If high similarity score
        if potential_match[1] >= 80:
            # Replace typo with correct category
            survey.loc[survey['state'] == potential_match[0], 'state'] = state
```

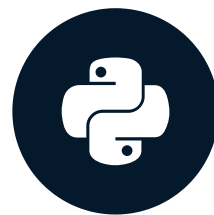

Record linkage

Event	Time	Event	Time
Houston Rockets vs Chicago Bulls	19:00	NBA: Nets vs Magic	8pm
Miami Heat vs Los Angeles Lakers	19:00	NBA: Bulls vs Rockets	9pm
Brooklyn Nets vs Orlando Magic	20:00	NBA: Heat vs Lakers	7pm
Denver Nuggets vs Miami Heat	21:00	NBA: Grizzlies vs Heat	10pm
San Antonio Spurs vs Atlanta Hawks	21:00	NBA: Heat vs Cavaliers	9pm

Let's practice!
CLEANING DATA IN PYTHON

Generating pairs

CLEANING DATA IN PYTHON



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Motivation

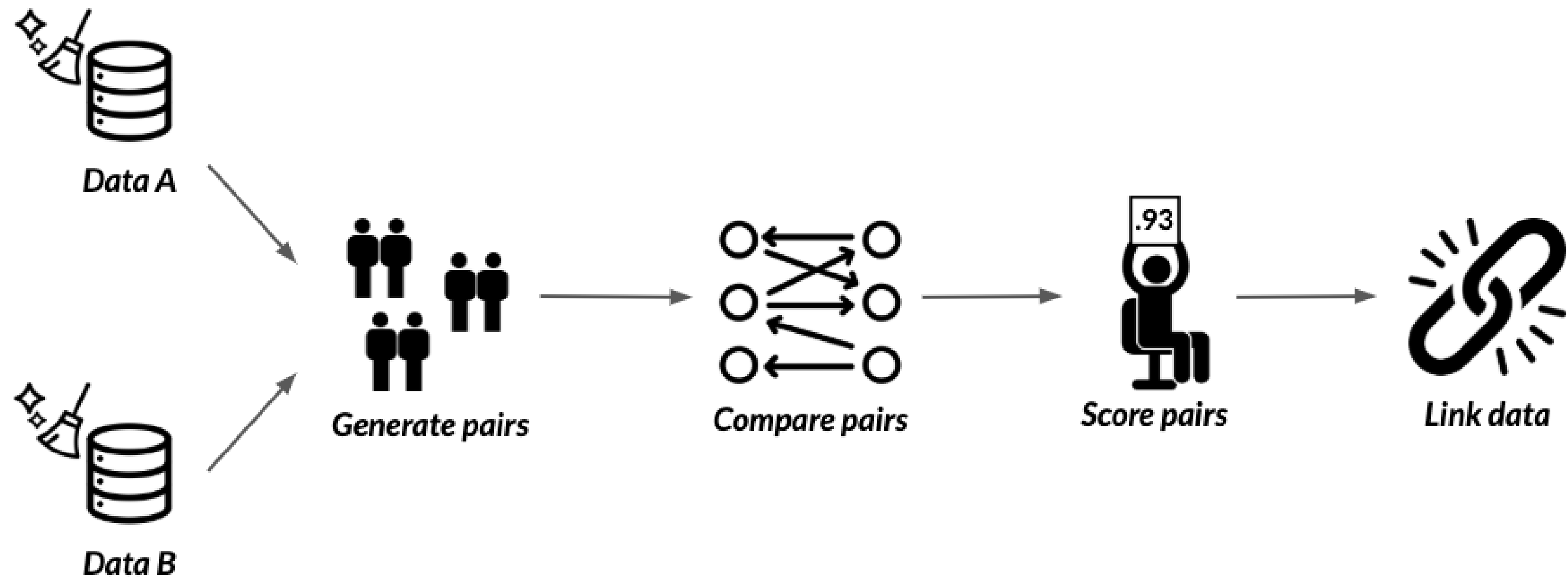
Event	Time
Houston Rockets vs Chicago Bulls	19:00
Miami Heat vs Los Angeles Lakers	19:00
Brooklyn Nets vs Orlando Magic	20:00
Denver Nuggets vs Miami Heat	21:00
San Antonio Spurs vs Atlanta Hawks	21:00

Event	Time
NBA: Nets vs Magic	8pm
NBA: Bulls vs Rockets	9pm
NBA: Heat vs Lakers	7pm
NBA: Grizzlies vs Heat	10pm
NBA: Heat vs Cavaliers	9pm

When joins won't work

Event	Time	Event	Time
Houston Rockets vs Chicago Bulls	19:00	NBA: Nets vs Magic	8pm
Miami Heat vs Los Angeles Lakers	19:00	NBA: Bulls vs Rockets	9pm
Brooklyn Nets vs Orlando Magic	20:00	NBA: Heat vs Lakers	7pm
Denver Nuggets vs Miami Heat	21:00	NBA: Grizzlies vs Heat	10pm
San Antonio Spurs vs Atlanta Hawks	21:00	NBA: Heat vs Cavaliers	9pm

Record linkage



The `recordlinkage` package

Our DataFrames

census_A

```
      given_name  surname date_of_birth      suburb state address_1
rec_id
rec-1070-org  michaela  neumann    19151111  winston hills    cal  stanley street
rec-1016-org  courtney  painter    19161214    richlands    txs  pinkerton circuit
...
```

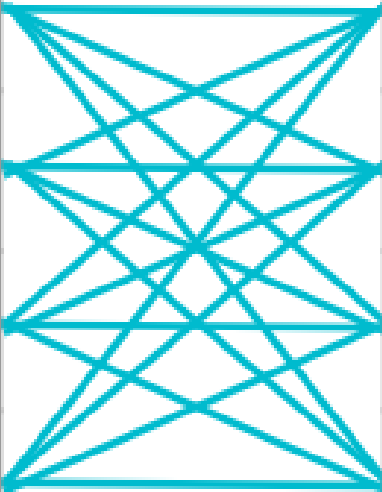
census_B

```
      given_name  surname date_of_birth      suburb state address_1
rec_id
rec-561-dup-0    elton    NaN    19651013  windermere    ny  light setreet
rec-2642-dup-0  mitchell  maxon    19390212  north ryde    cal  edkins street
...
```

Generating pairs

census_A

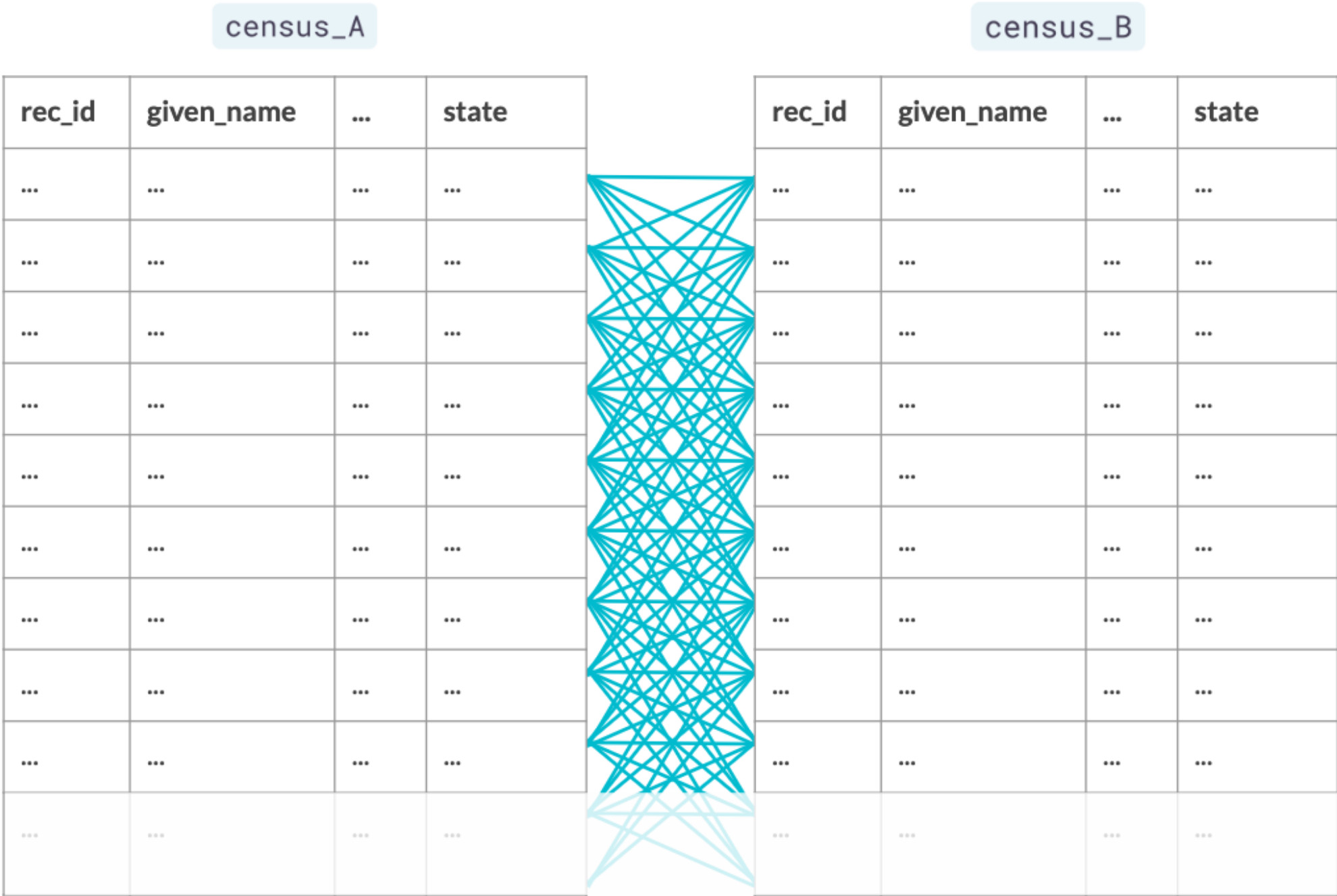
rec_id	given_name	...	state
...
...
...
...



census_B

rec_id	given_name	...	state
...
...
...
...

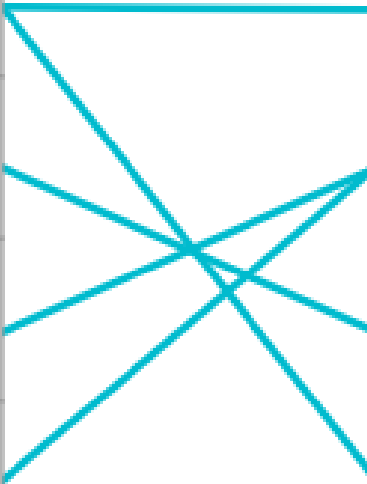
Generating pairs



Blocking

census_A

rec_id	given_name	...	state
...	cal
...	ny
...	txs
...	txs



census_A

rec_id	given_name	...	state
...	cal
...	txs
...	ny
...	cal

Generating pairs

```
# Import recordlinkage
import recordlinkage

# Create indexing object
indexer = recordlinkage.Index()

# Generate pairs blocked on state
indexer.block('state')
pairs = indexer.index(census_A, census_B)
```

Generating pairs

```
print(pairs)
```

```
MultiIndex(levels=[['rec-1007-org', 'rec-1016-org', 'rec-1054-org', 'rec-1066-org',  
'rec-1070-org', 'rec-1075-org', 'rec-1080-org', 'rec-110-org', 'rec-1146-org',  
'rec-1157-org', 'rec-1165-org', 'rec-1185-org', 'rec-1234-org', 'rec-1271-org',  
'rec-1280-org',.....  
66, 14, 13, 18, 34, 39, 0, 16, 80, 50, 20, 69, 28, 25, 49, 77, 51, 85, 52, 63, 74, 61,  
83, 91, 22, 26, 55, 84, 11, 81, 97, 56, 27, 48, 2, 64, 5, 17, 29, 60, 72, 47, 92, 12,  
95, 15, 19, 57, 37, 70, 94]], names=['rec_id_1', 'rec_id_2'])
```

Comparing the DataFrames

```
# Generate the pairs
pairs = indexer.index(census_A, census_B)

# Create a Compare object
compare_cl = recordlinkage.Compare()

# Find exact matches for pairs of date_of_birth and state
compare_cl.exact('date_of_birth', 'date_of_birth', label='date_of_birth')
compare_cl.exact('state', 'state', label='state')

# Find similar matches for pairs of surname and address_1 using string similarity
compare_cl.string('surname', 'surname', threshold=0.85, label='surname')
compare_cl.string('address_1', 'address_1', threshold=0.85, label='address_1')

# Find matches
potential_matches = compare_cl.compute(pairs, census_A, census_B)
```

Finding matching pairs

```
print(potential_matches)
```

rec_id_1	rec_id_2	date_of_birth	state	surname	address_1
rec-1070-org	rec-561-dup-0	0	1	0.0	0.0
	rec-2642-dup-0	0	1	0.0	0.0
	rec-608-dup-0	0	1	0.0	0.0
...					
rec-1631-org	rec-4070-dup-0	0	1	0.0	0.0
	rec-4862-dup-0	0	1	0.0	0.0
	rec-629-dup-0	0	1	0.0	0.0
...					

Finding the only pairs we want

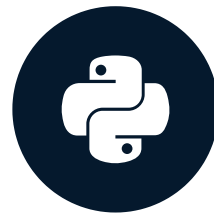
```
potential_matches[potential_matches.sum(axis = 1) == 2]
```

rec_id_1	rec_id_2	date_of_birth	state	surname	address_1
rec-4878-org	rec-4878-dup-0	1	1	1.0	0.0
rec-417-org	rec-2867-dup-0	0	1	0.0	1.0
rec-3964-org	rec-394-dup-0	0	1	1.0	0.0
rec-1373-org	rec-4051-dup-0	0	1	1.0	0.0
	rec-802-dup-0	0	1	1.0	0.0
rec-3540-org	rec-470-dup-0	0	1	1.0	0.0

Let's practice!
CLEANING DATA IN PYTHON

Linking DataFrames

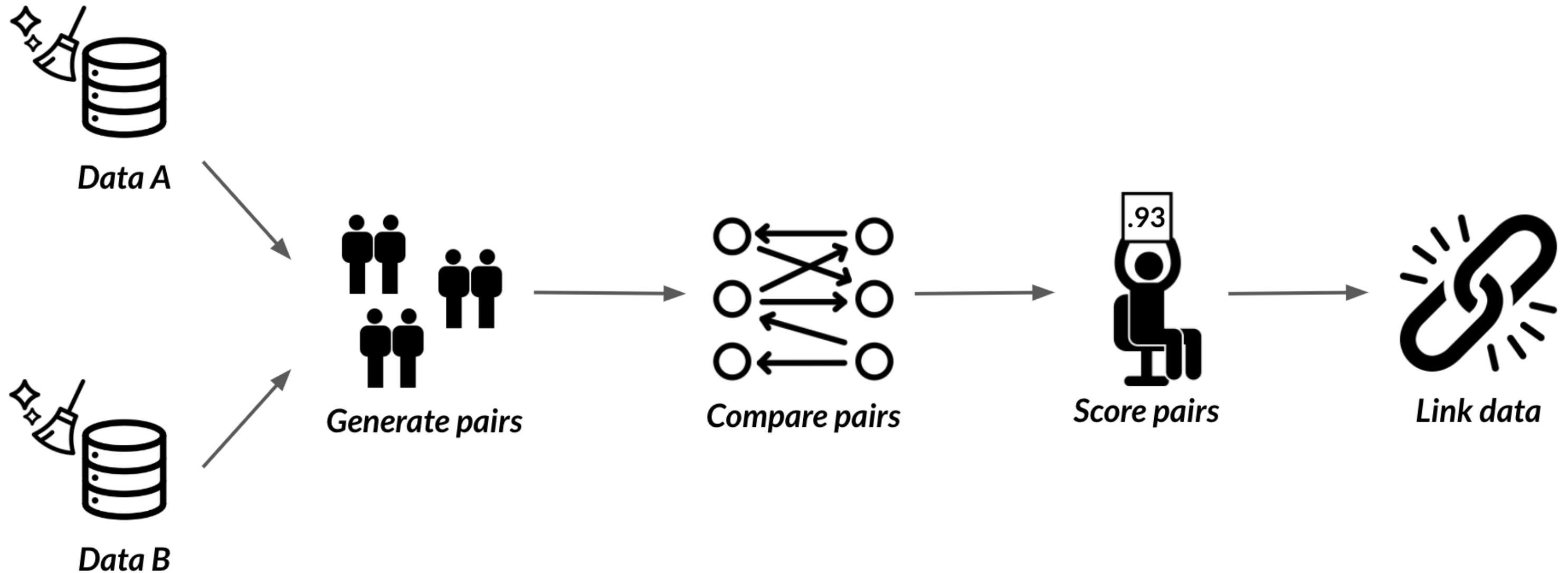
CLEANING DATA IN PYTHON



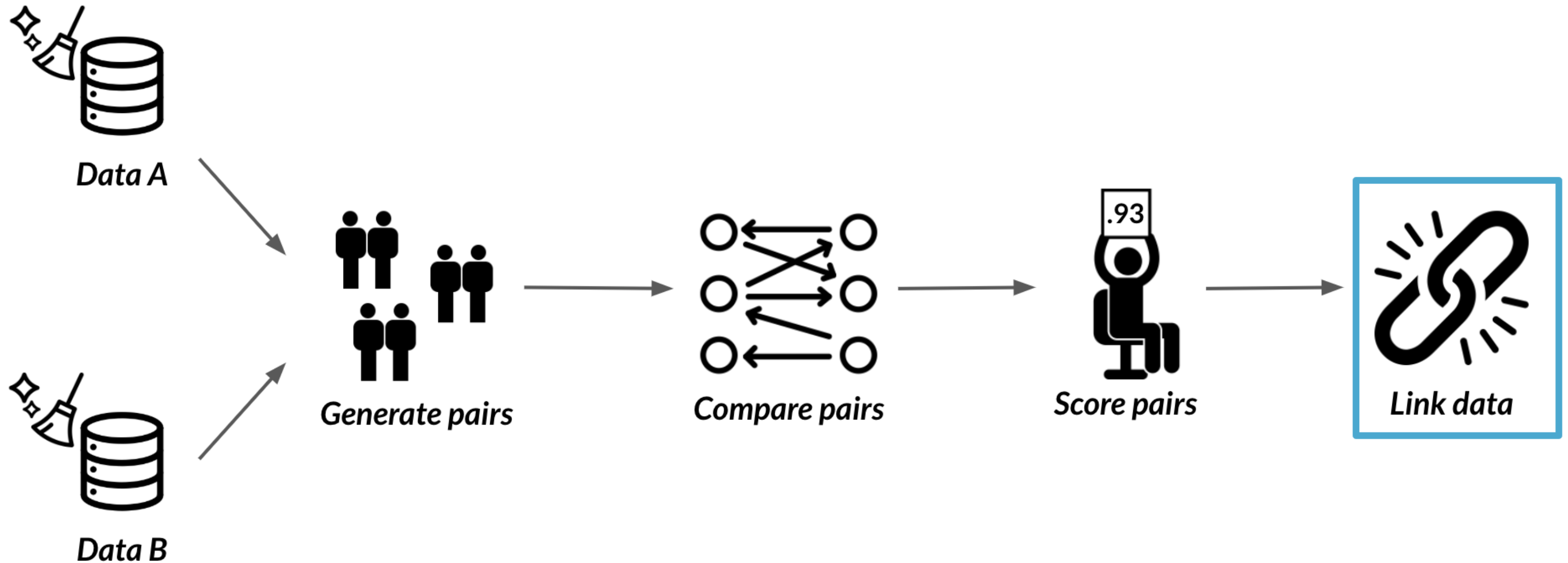
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Record linkage



Record linkage



Our DataFrames

census_A

```
      given_name  surname date_of_birth      suburb state address_1
rec_id
rec-1070-org    michaela  neumann    19151111  winston hills    nsw  stanley street
rec-1016-org    courtney  painter    19161214    richlands    vic  pinkerton circuit
...
```

census_B

```
      given_name  surname date_of_birth      suburb state address_1
rec_id
rec-561-dup-0      elton      NaN    19651013  windermere    vic  light setreet
rec-2642-dup-0  mitchell    maxon    19390212  north ryde    nsw  edkins street
...
```

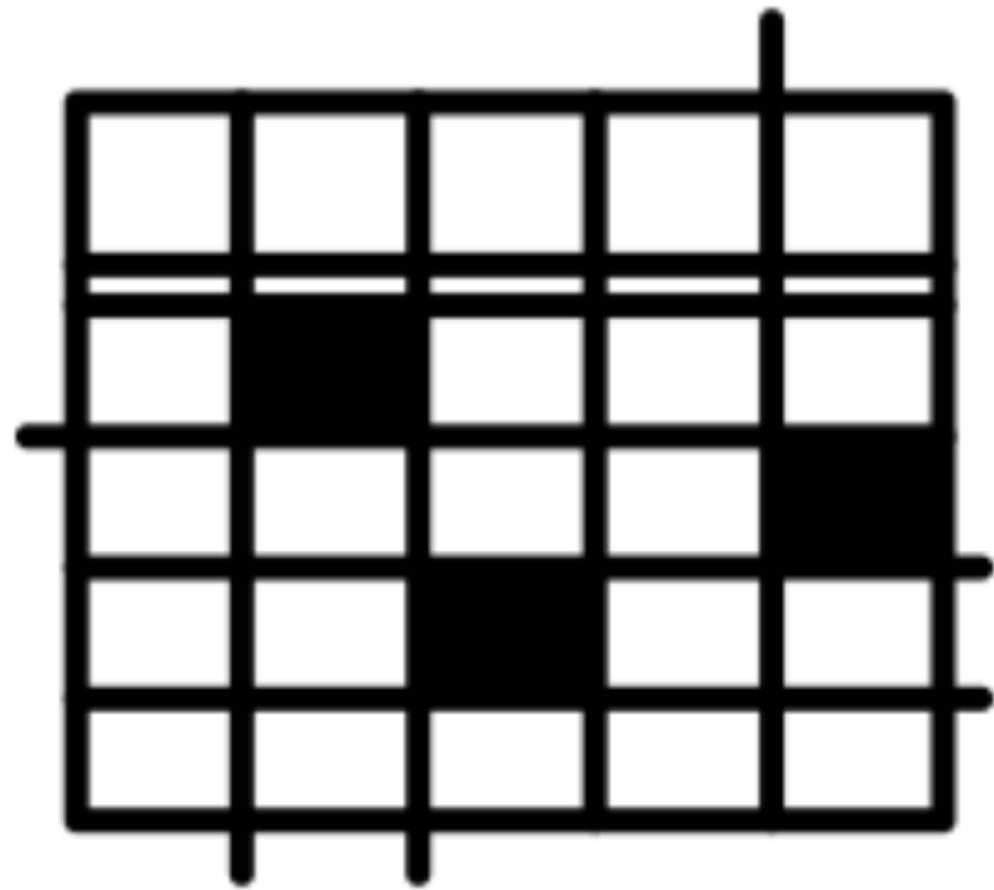
What we've already done

```
# Import recordlinkage and generate full pairs
import recordlinkage
indexer = recordlinkage.Index()
indexer.block('state')
full_pairs = indexer.index(census_A, census_B)

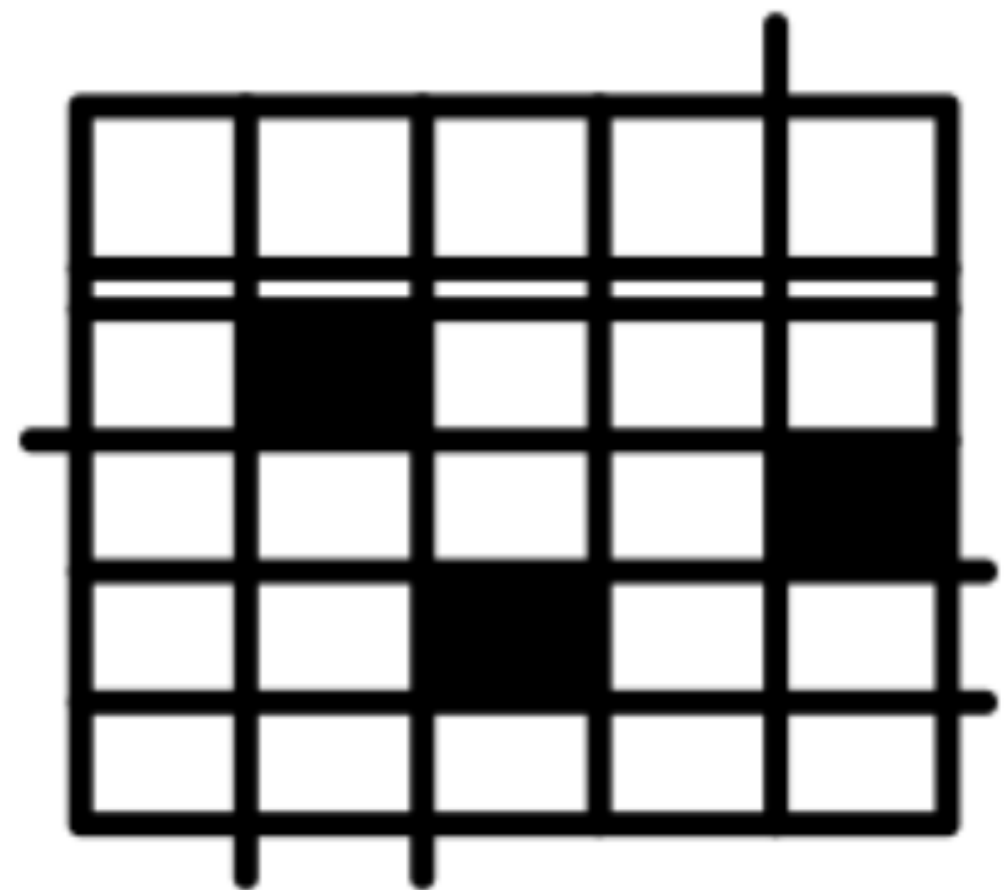
# Comparison step
compare_cl = recordlinkage.Compare()
compare_cl.exact('date_of_birth', 'date_of_birth', label='date_of_birth')
compare_cl.exact('state', 'state', label='state')
compare_cl.string('surname', 'surname', threshold=0.85, label='surname')
compare_cl.string('address_1', 'address_1', threshold=0.85, label='address_1')

potential_matches = compare_cl.compute(full_pairs, census_A, census_B)
```

What we're doing now



census_A



census_B

Our potential matches

```
potential_matches
```

		date_of_birth	state	surname	address_1
rec_id_1	rec_id_2				
rec-1070-org	rec-561-dup-0	0	1	0.0	0.0
	rec-2642-dup-0	0	1	0.0	0.0
	rec-608-dup-0	0	1	0.0	0.0
...	
rec-1631-org	rec-1697-dup-0	0	1	0.0	0.0
	rec-4404-dup-0	0	1	0.0	0.0
	rec-3780-dup-0	0	1	0.0	0.0
...	

Our potential matches

```
potential_matches
```

```
census_A      date_of_birth  state  surname  address_1
rec_id_1  rec_id_2
rec-1070-org  rec-561-dup-0      0      1      0.0      0.0
              rec-2642-dup-0      0      1      0.0      0.0
              rec-608-dup-0      0      1      0.0      0.0
...
rec-1631-org  rec-1697-dup-0      0      1      0.0      0.0
              rec-4404-dup-0      0      1      0.0      0.0
              rec-3780-dup-0      0      1      0.0      0.0
...
...      ...      ...      ...      ...
```


Our potential matches

potential_matches

census_A	census_B	date_of_birth	state	surname	address_1
rec_id_1	rec_id_2				
rec-1070-org	rec-561-dup-0	0	1	0.0	0.0
	rec-2642-dup-0	0	1	0.0	0.0
	rec-608-dup-0	0	1	0.0	0.0
...	
rec-1631-org	rec-1697-dup-0	0	1	0.0	0.0
	rec-4404-dup-0	0	1	0.0	0.0
	rec-3780-dup-0	0	1	0.0	0.0
...	

Our potential matches

potential_matches

census_A	census_B	date_of_birth	state	surname	address_1
rec_id_1	rec_id_2				
rec-1070-org	rec-561-dup-0	0	1	0.0	0.0
	rec-2642-dup-0	<u>0</u>	<u>1</u>	<u>0.0</u>	<u>0.0</u>
	rec-608-dup-0	0	1	0.0	0.0
...	
rec-1631-org	rec-1697-dup-0	0	1	0.0	0.0
	rec-4404-dup-0	0	1	0.0	0.0
	rec-3780-dup-0	0	1	0.0	0.0
...	

Probable matches

```
matches = potential_matches[potential_matches.sum(axis = 1) >= 3]
print(matches)
```

		date_of_birth	state	surname	address_1
rec_id_1	rec_id_2				
rec-2404-org	rec-2404-dup-0	1	1	1.0	1.0
rec-4178-org	rec-4178-dup-0	1	1	1.0	1.0
rec-1054-org	rec-1054-dup-0	1	1	1.0	1.0
...
rec-1234-org	rec-1234-dup-0	1	1	1.0	1.0
rec-1271-org	rec-1271-dup-0	1	1	1.0	1.0

Probable matches

```
matches = potential_matches[potential_matches.sum(axis = 1) >= 3]
print(matches)
```

	census_B	date_of_birth	state	surname	address_1
rec_id_1	rec_id_2				
rec-2404-org	rec-2404-dup-0	1	1	1.0	1.0
rec-4178-org	rec-4178-dup-0	1	1	1.0	1.0
rec-1054-org	rec-1054-dup-0	1	1	1.0	1.0
...
rec-1234-org	rec-1234-dup-0	1	1	1.0	1.0
rec-1271-org	rec-1271-dup-0	1	1	1.0	1.0

Get the indices

```
matches.index
```

```
MultiIndex(levels=[['rec-1007-org', 'rec-1016-org', 'rec-1054-org', 'rec-1066-org',  
'rec-1070-org', 'rec-1075-org', 'rec-1080-org', 'rec-110-org', ...
```

```
# Get indices from census_B only  
duplicate_rows = matches.index.get_level_values(1)  
print(census_B_index)
```

```
Index(['rec-2404-dup-0', 'rec-4178-dup-0', 'rec-1054-dup-0', 'rec-4663-dup-0',  
      'rec-485-dup-0', 'rec-2950-dup-0', 'rec-1234-dup-0', ... , 'rec-299-dup-0'])
```

Linking DataFrames

```
# Finding duplicates in census_B
census_B_duplicates = census_B[census_B.index.isin(duplicate_rows)]
```

```
# Finding new rows in census_B
census_B_new = census_B[~census_B.index.isin(duplicate_rows)]
```

```
# Link the DataFrames!
full_census = census_A.append(census_B_new)
```

```
# Import recordlinkage and generate pairs and compare across columns
...
# Generate potential matches
potential_matches = compare_cl.compute(full_pairs, census_A, census_B)

# Isolate matches with matching values for 3 or more columns
matches = potential_matches[potential_matches.sum(axis = 1) >= 3]

# Get index for matching census_B rows only
duplicate_rows = matches.index.get_level_values(1)

# Finding new rows in census_B
census_B_new = census_B[~census_B.index.isin(duplicate_rows)]

# Link the DataFrames!
full_census = census_A.append(census_B_new)
```

Let's practice!
CLEANING DATA IN PYTHON

Congratulations!

CLEANING DATA IN PYTHON



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What we've learned



Diagnose dirty
data



Side effects of
dirty data



Clean data

What we've learned



**Data Type
Constraints**

*Strings
Numeric data*

...



**Data Range
Constraints**

*Out of range data
Out of range dates*

...



**Uniqueness
Constraints**

*Finding duplicates
Treating them*

...

Chapter 1 - Common data problems

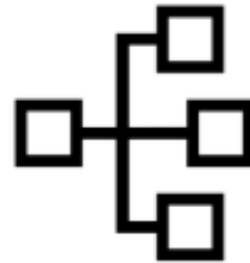
What we've learned



Membership Constraints

*Finding inconsistent categories
Treating them with joins*

...



Categorical Variables

*Finding inconsistent categories
Collapsing them into less*

...



Cleaning Text Data

*Unifying formats
Finding lengths*

...

Chapter 2 - Text and categorical data problems

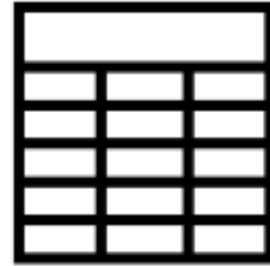
What we've learned



Uniformity

Unifying currency formats
Unifying date formats

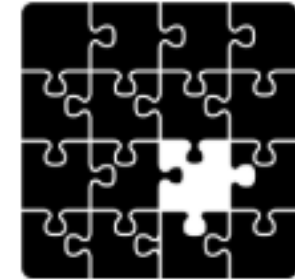
...



Cross field validation

Summing across rows
Building assert functions

...



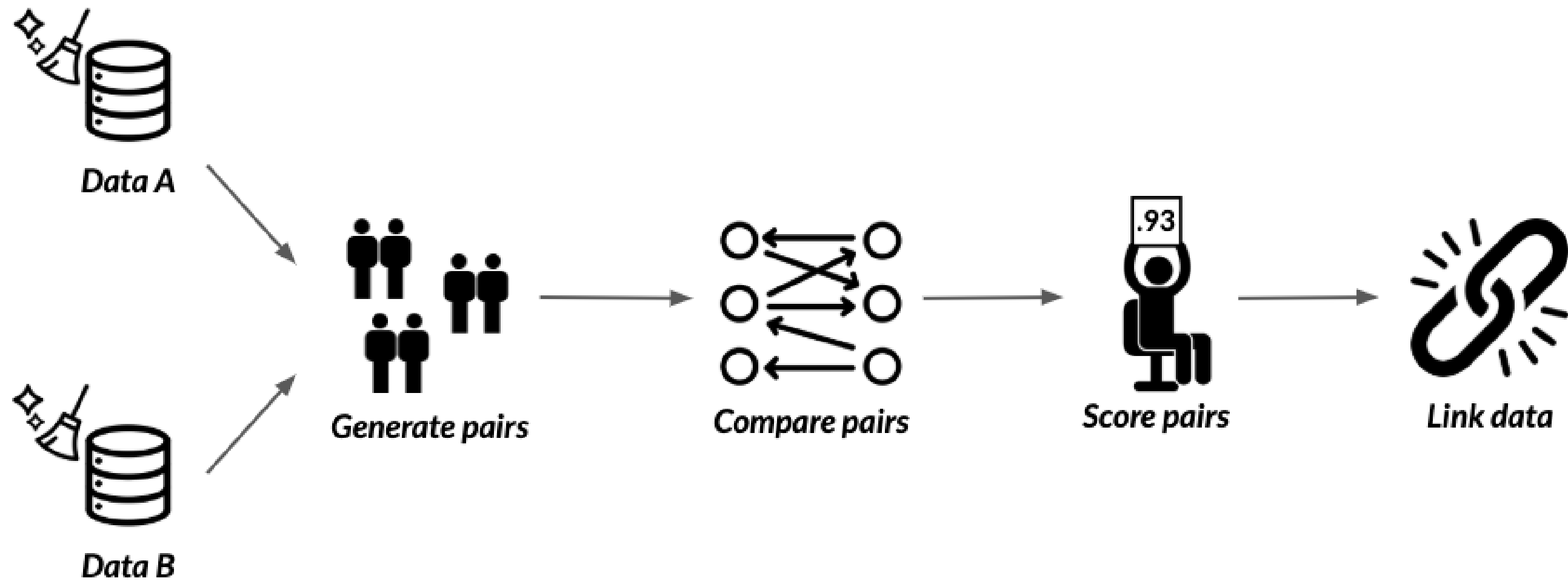
Completeness

Finding missing data
Treating them

...

Chapter 3 - Advanced data problems

What we've learned

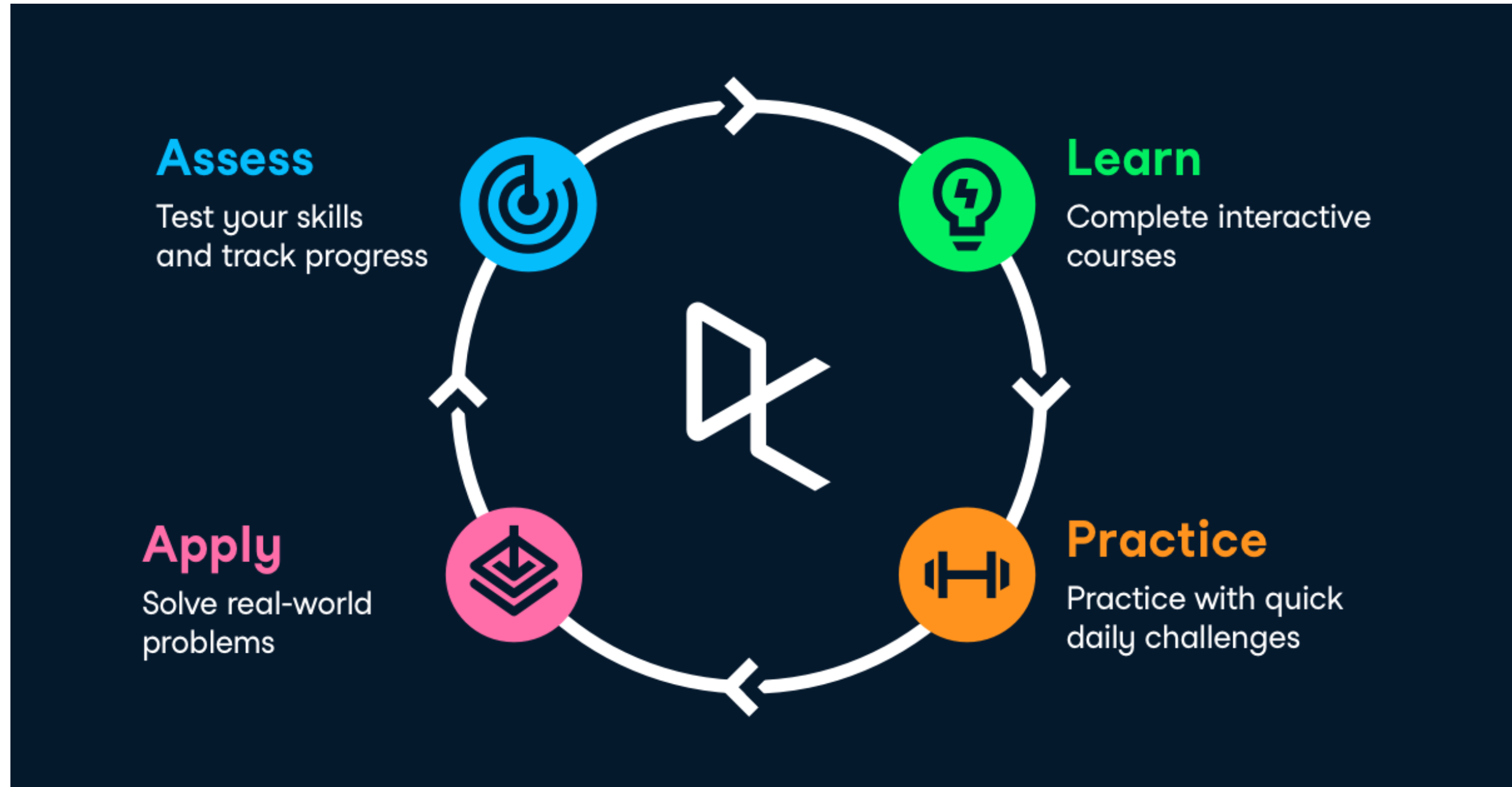


Chapter 4 - Record linkage

More to learn on DataCamp!

- [Working with Dates and Times in Python](#)
- [Regular Expressions in Python](#)
- [Dealing with Missing Data in Python](#)
- And more!

More to learn!



More to learn!



Thank you!
CLEANING DATA IN PYTHON