

Comparing strings

DATA CLEANING 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
---	---	---	---	---	---	---	---	---

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

+ Insertion

- Deletion

↔ Substitution

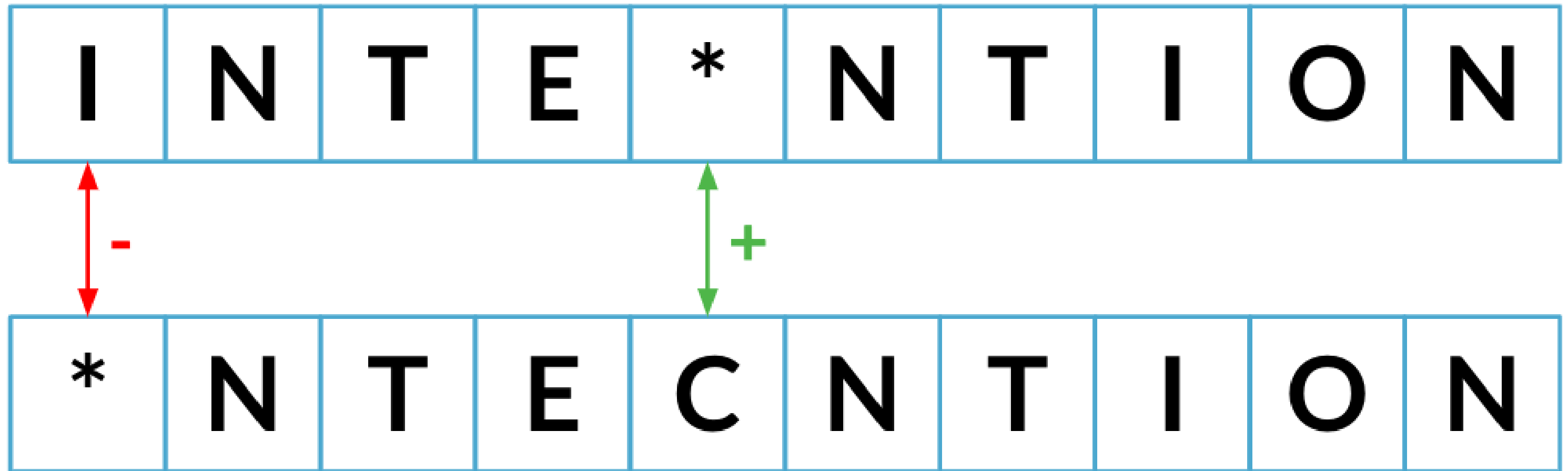
↔ Transposition

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

Minimum edit distance

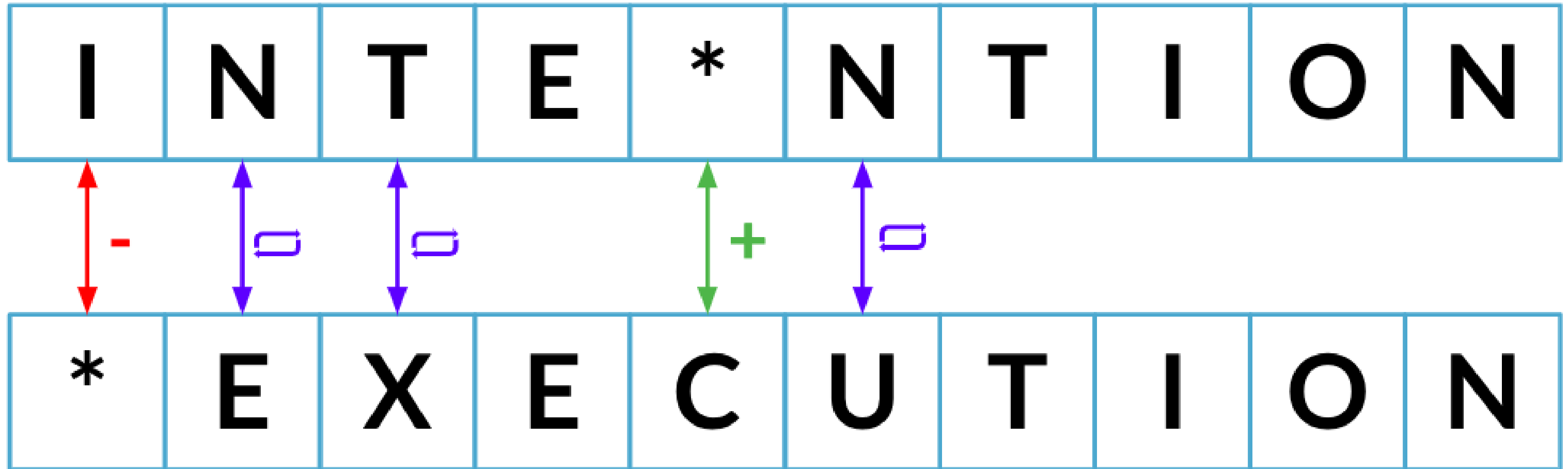
I	N	T	E	N	T	I	O	N
---	---	---	---	---	---	---	---	---

Minimum edit distance



Minimum edit distance so far: 2

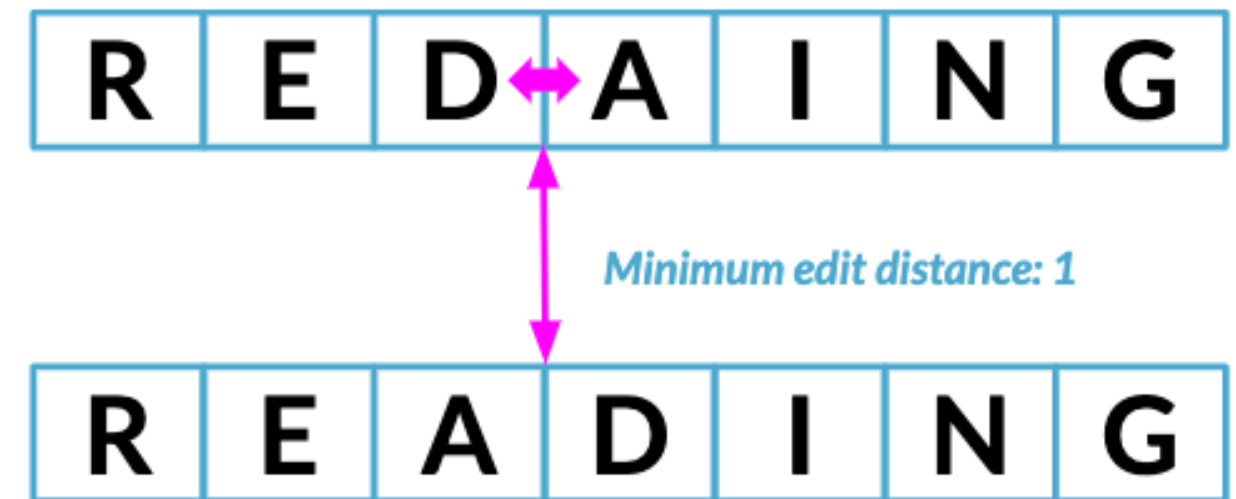
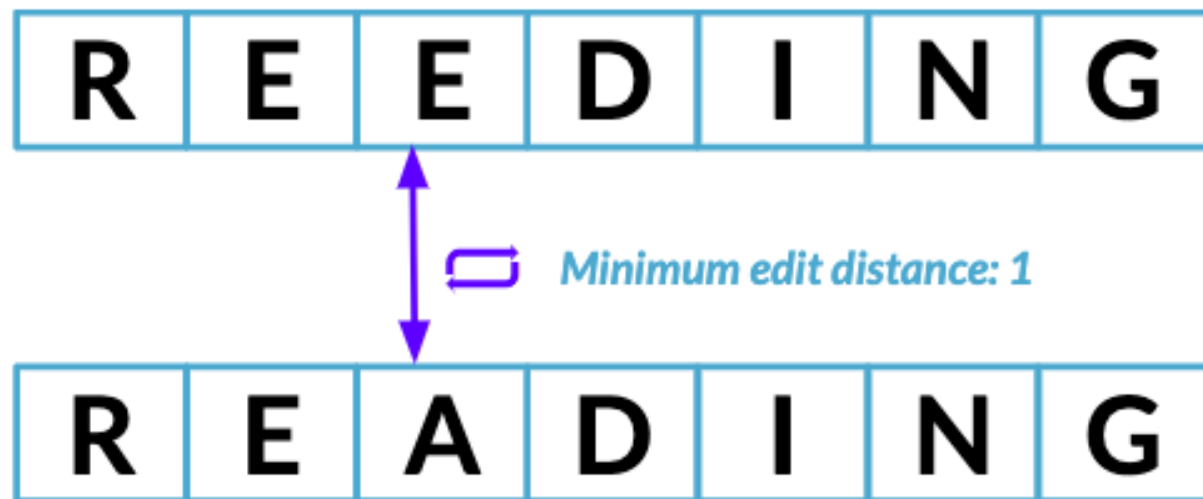
Minimum edit distance



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)
```

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

```
categories
```

```
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
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	8 pm	
NBA: Bulls vs Rockets	9 pm	
NBA: Heat vs Lakers	7 pm	
NBA: Grizzlies vs Heat	10 pm	✓
NBA: Heat vs Cavaliers	9 pm	✓

Let's practice!

DATA CLEANING IN PYTHON

Generating pairs

DATA CLEANING 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	8 pm
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NBA: Heat vs Cavaliers	9 pm

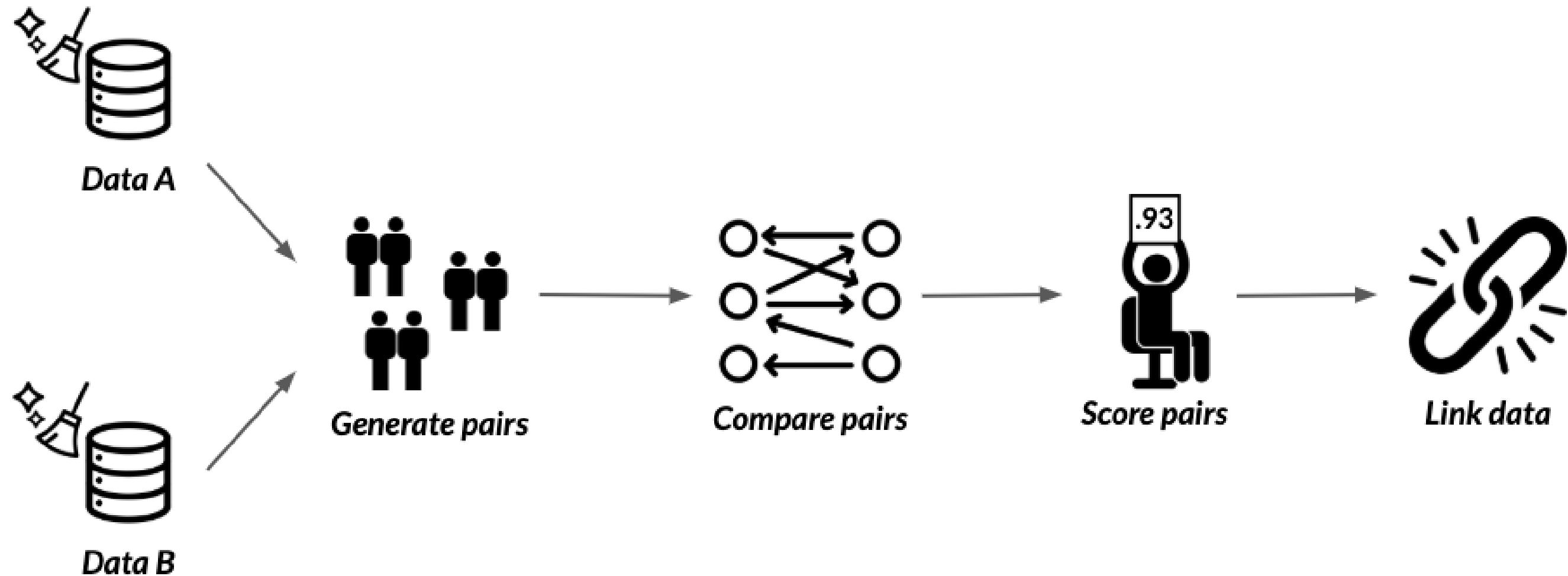
When joins won't work

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	8 pm	
NBA: Bulls vs Rockets	9 pm	
NBA: Heat vs Lakers	7 pm	
NBA: Grizzlies vs Heat	10 pm	✓
NBA: Heat vs Cavaliers	9 pm	✓

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
...
```

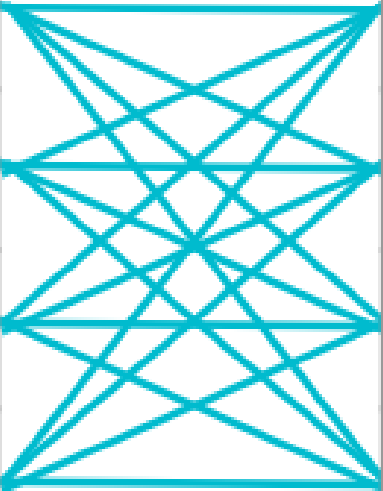
census_B

```
      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

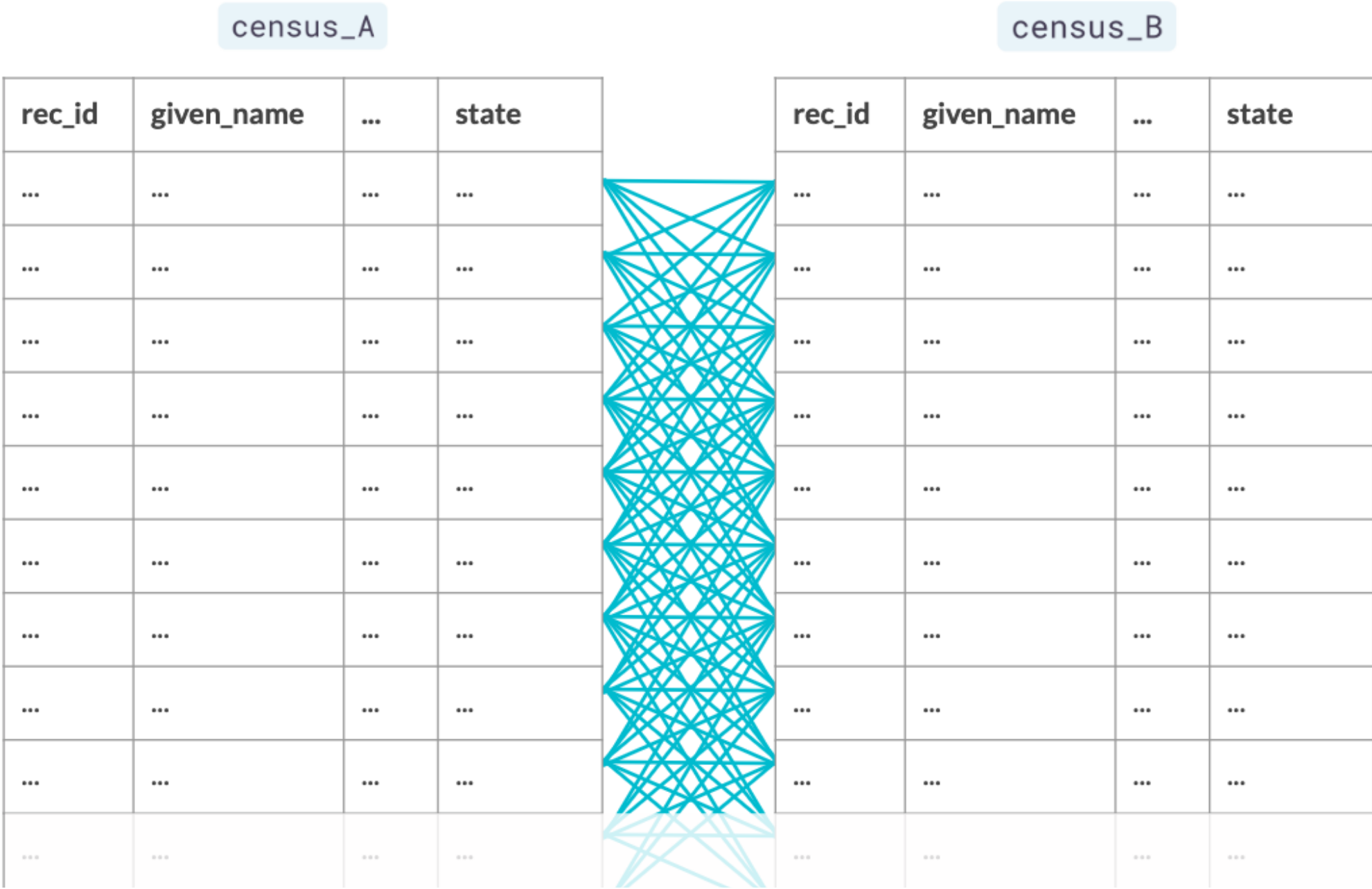
rec_id	given_name	...	state
...
...
...
...



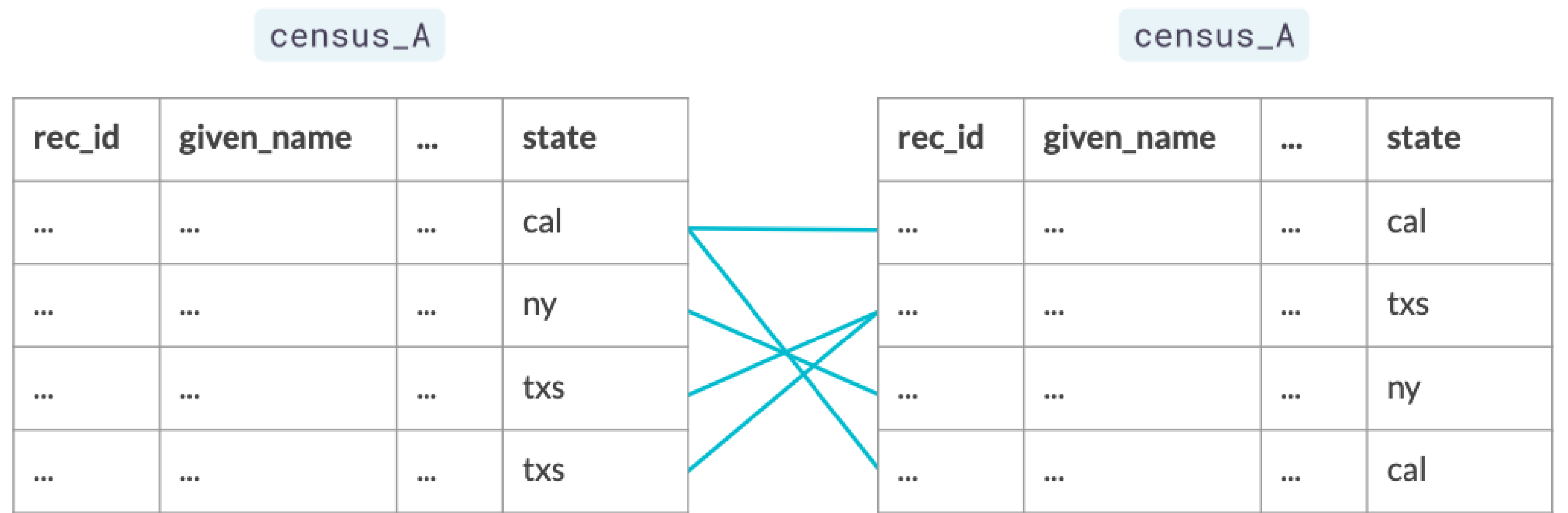
census_B

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

Generating pairs



Blocking



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]
```

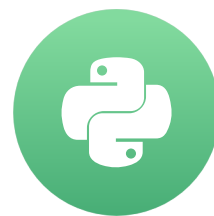
rec_id_1	rec_id_2	date_of_birth	state	surname	address_1
rec-4878-org	rec-4878-dup-0	1	1	1.0	0.0
rec-417-org	rec-2867-dup-0	0	1	0.0	1.0
rec-3964-org	rec-394-dup-0	0	1	1.0	0.0
rec-1373-org	rec-4051-dup-0	0	1	1.0	0.0
	rec-802-dup-0	0	1	1.0	0.0
rec-3540-org	rec-470-dup-0	0	1	1.0	0.0

Let's practice!

DATA CLEANING IN PYTHON

Linking DataFrames

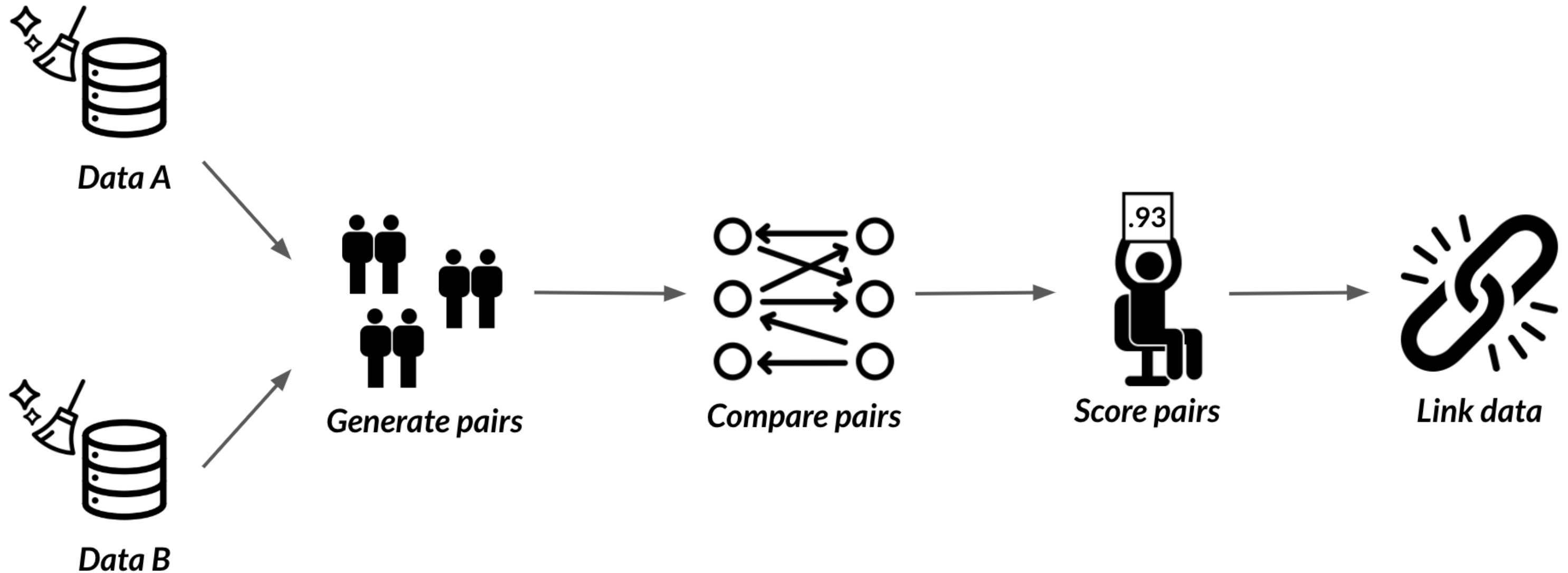
DATA CLEANING IN PYTHON



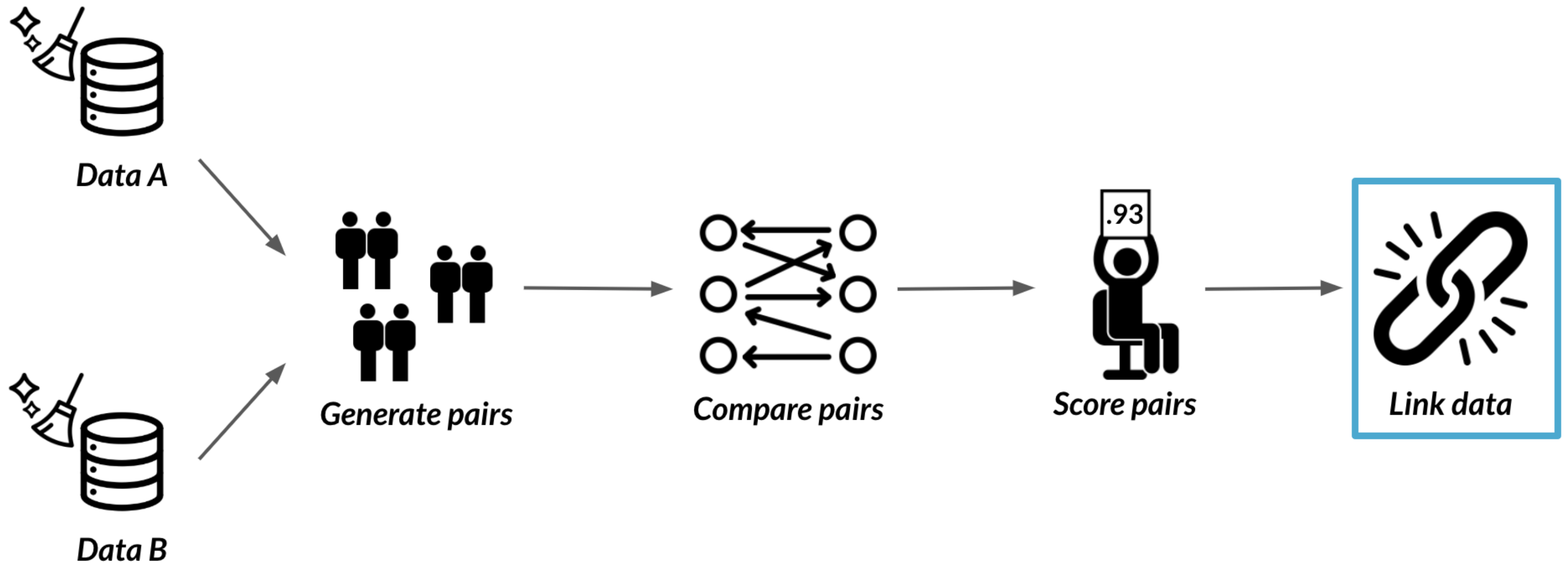
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Record linkage



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
...
```

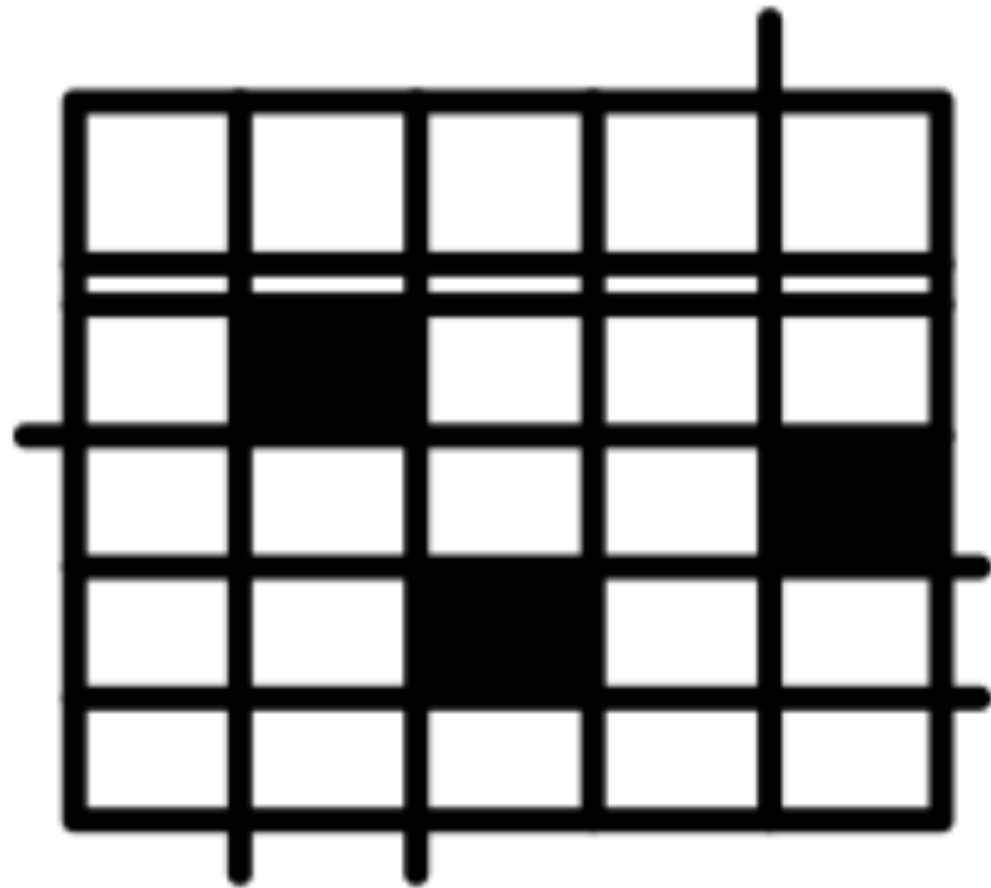
What we've already done

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

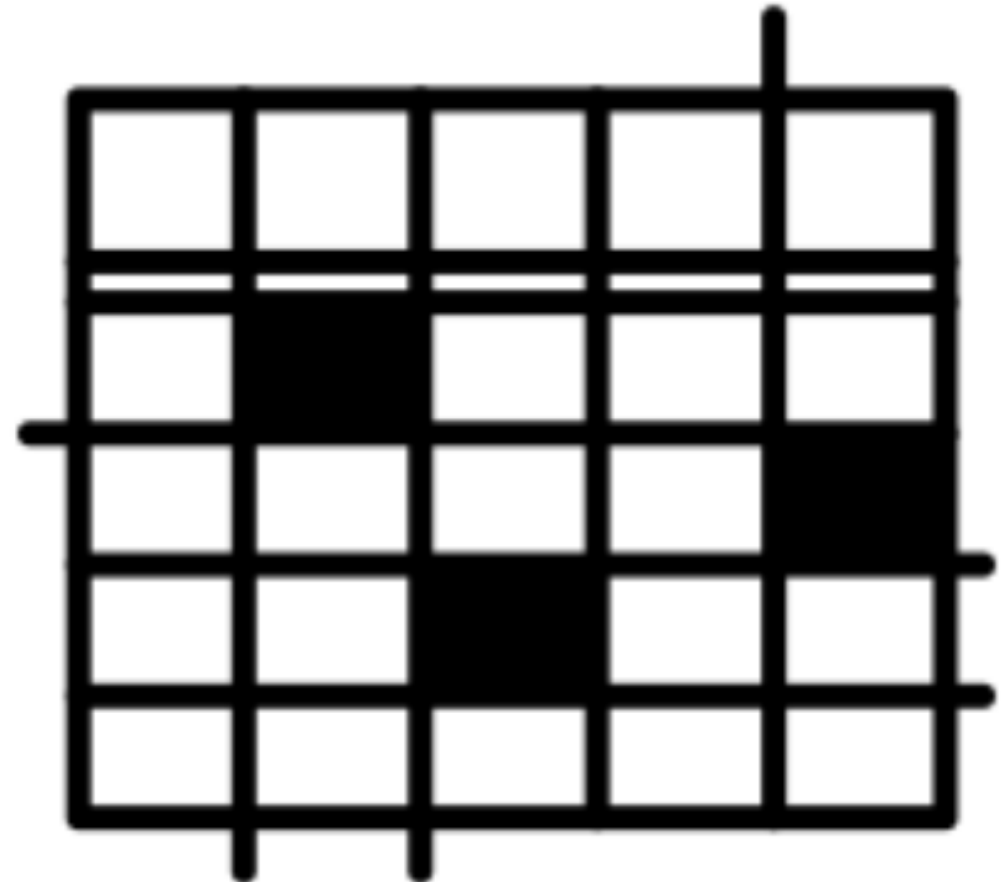
# Comparison step
compare_cl = recordlinkage.Compare()
compare_cl.exact('date_of_birth', 'date_of_birth', label='date_of_birth')
compare_cl.exact('state', 'state', label='state')
compare_cl.string('surname', 'surname', threshold=0.85, label='surname')
compare_cl.string('address_1', 'address_1', threshold=0.85,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

DATA CLEANING IN PYTHON

Congratulations!

DATA CLEANING 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

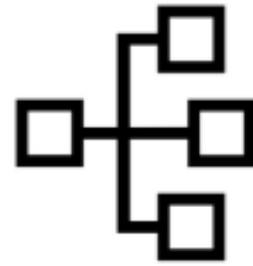
What we've learned



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

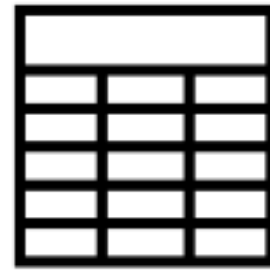
What we've learned



Uniformity

*Unifying currency formats
Unifying date formats*

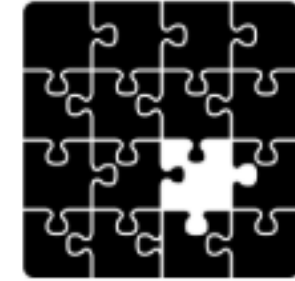
...



Cross field validation

*Summing across rows
Building assert functions*

...



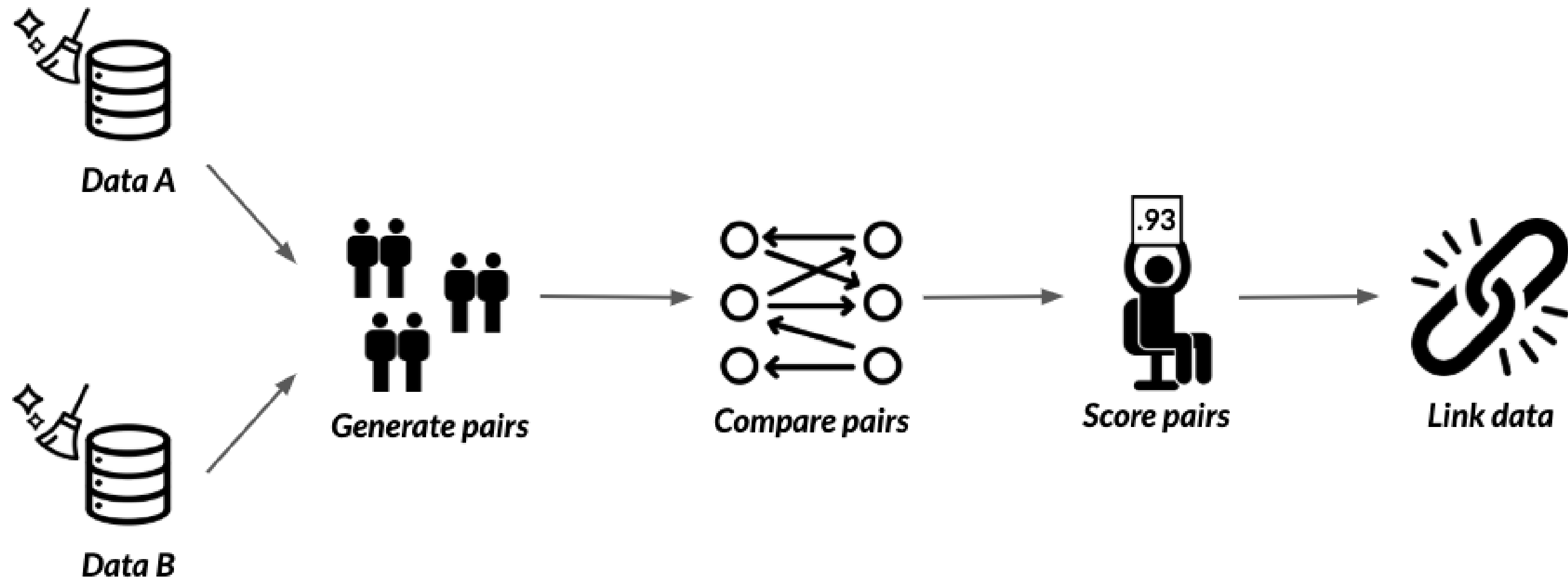
Completeness

*Finding missing data
Treating them*

...

Chapter 3 - Advanced data problems

What we've learned



Chapter 4 - Record linkage

More to learn!



And much more!

More to learn!



More to learn!



Thank you!

DATA CLEANING IN PYTHON