Oracle Financial Services Financial Crime and Complaince Studio

Matching Guide

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Financial Crime Graph Model Matching Guide

Document Control

Version Number	Revision Date	Change Log
8.0.8.2.0	Updated: January 2021	Updated the Scoring Method section in the document.
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8.0.7.3.0	Created: March 2019	Created the first version of the Financial Crime Graph Model Matching Guide for v8.0.7.3.0 Release.

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1 Introduction

In FCC Studio, data is obtained from FCDM (Financial Crime Data Model) to generate Financial Crime Graph Model. The graph model includes nodes for entities such as Customers, Accounts, Events, and Derived Entities, and edges for transactions and relationships.

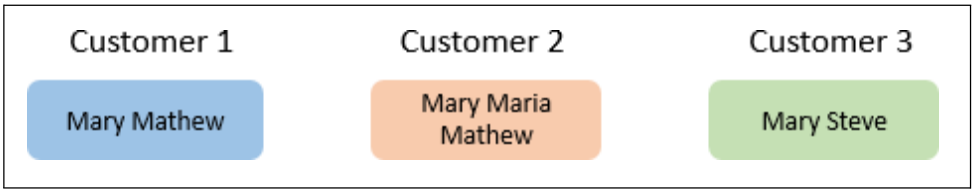
Entity Resolution compares nodes with the objective to identify pairs or groups of nodes that refer to the same entity. Entity Resolution creates Similarity Edges between nodes by comparing the attributes of the nodes and identifying where the similarity is significant enough to create an edge so the nodes are linked with the graph model and can be analyzed as a single entity.

Entity matching rules are used to compare nodes of different types. For example, deduplicating customers, resolving derived entities, or linking customers or derived entities to external data such as panama papers or sanctions lists with different rules and thresholds.

For example:

A customer holds three different accounts in a bank with three different customer details.

Figure 1: Customers in a Bank



The following table provides the customer details of Customer 1, Customer 2, and Customer 3 in a bank.

Table 1: Customer Details

Customer Details	Customer 1	Customer 2	Customer 3
Source	Source System 1	Source System 2	Source System 3
Name	Mary Mathew	Mary Maria Mathew	Mary Steve
Email	Mary.Mathew@gmail.com	Mary.Mathew@gmail.com	Mary.Steve@gmail.co m
Phone	Phone Number 1	Phone Number 2	Phone Number 3
Country	United States	United States	United States
State	California	California	Washington
Address	Redwood City	Redwood City	15th St NW
DOB	1 Jan 1995	1 Jan 1995	1 Jan 1995
Tax ID	Tax ID 1	-	Tax ID 1

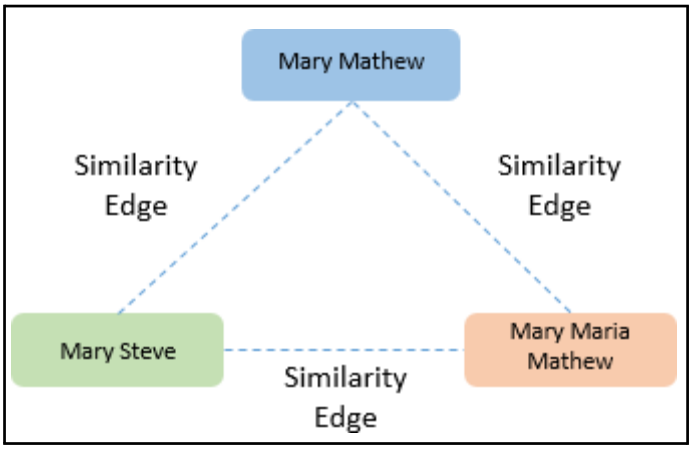
The customer details include source from which the customer data is obtained, name, Email, phone number, country, state, address, date of birth, and tax ID of the customer.

Using Entity Resolution, you can execute the Customer to Customer Ruleset on the customer data to compare the nodes such as Customer Name, Email, Phone, Country, State, Address, DOB, and Tax ID.

The result obtains an exact match on the DOB and TaxID, and fuzzy match on the Customer Name, Email ID, Address, State, and Country, and no match for the phone number.

This helps to derive to a conclusion to draw Similarity Edges between the three customers in the Bank.

Figure 2: Derived Similarity Edges for Customers in a Bank



2 Scoring Method

The scoring methods used in the entity resolution component are as follows:

- Default Method
- Jaro Winkler
- ML Boosted Name Matching
- Reverse Jaro
- Fuzzy Tokenized

2.1 Default Method

The distance is computed by finding the number of edits which transforms one string to another. The transformations allowed are as follows:

Insertion: Adding a new character

Deletion: Deleting a character

Substitution: Replace one character with another

By performing these operations, the algorithm attempts to modify the first string to match the second one. The final result obtained is the edit distance.

For example:

- `textdistance.levenshtein('arrow', 'arow') 1`
- `textdistance.levenshtein.normalized_similarity('arrow', 'arow')0.8`

Here, if you insert single 'r' in string 2, that is, 'arow', it becomes same as the string 1. Hence, the edit distance is 1. Similar with Hamming distance, you can generate a bounded similarity score between 0 and 1. The similarity score obtained is 80%.

2.2 Jaro Winkler

This algorithms gives high scores for the following strings:

The strings that contain same characters, but within a certain distance from one another.

The order of the matching characters is same.

To be precise, the distance of finding similar character is one character less than half of the length of the longest string. So if the longest string has a length of five, a character at the start of the string 1 must be found before or on ((5/2)–1) ~ 2nd position in the string 2. This is considered a valid match. Hence, the algorithm is directional and gives high score if matching is from the beginning of the strings.

For example:

- `textdistance.jaro_winkler("mes", "messi") 0.86`
- `textdistance.jaro_winkler("crate", "crat") 0.96`
- `textdistance.jaro_winkler("crate", "atcr") 0.0`

In first case, as the strings are matching from the beginning, high score is given. Similarly, in the second case, only one character was missing and that too at the end of the string 2, hence a very high score is given. In third case, the last two character of string 2 are rearranged by bringing them at front and hence results in 0% similarity.

2.3 ML Boosted Name Matching

This scoring method uses Machine Learning to calculate a similarity score between two candidate name strings.

It uses the Catboost model, which is an ensemble of decision trees built using gradient boosting embedding algorithm. The input to the model are numerical features. The features are calculated as various similarity metrics between the two candidate names.

For example, Q-gram distance, longest common subsequence, Levenshtein distance, Jaro-Winkler distance, set letter distance, Editex, and so on. The output of the model is a similarity score between 0 and 1. For this, a pre-trained model is provided. The pre-trained model is built from names from publicly available datasets depending on whether we mention the names of the datasets or not, we should use the term “publicly available” accordingly. The names are transformed, by inserting typos, concatenations, abbreviations, and so on.

The the original and transformed names are matched by a smart filter to produce a list of possible matches called candidates, along with information indicating whether two names started from the same name (ground truth). Then you can calculate the numerical similarity feature metrics of the candidate names.

The name strings are dropped, and the numerical features along with ground truth is used for training of the ensemble of decision trees model (Catboost model).

Following are the examples using the pre-trained model:

- **Name 1**: Carolyn Joyce
- **Name 2**: Caroline Joyce
- **Resulting score**: 0.9821176658138586

Other example,

- **Name 1**: Donatella Collombini
- **Name 2**: Donatello di Betto Bardi
- **Resulting score**: 0.0000005237652440222384

2.4 Reverse Jaro

This algorithm tokenises source and target tokens, then uses Jaro Winkler algorithm to calculate the score between tokens, and then consolidate the scores to a single score.

Tokenization:

The source and target strings are tokenised with each space. For instance, if the source name is **ANTONY EDWARD STARK** and target name is **TONY STARK**, we tokenise source name to source array as, **EDWARD**, **STARK** and target string as **TONY**, **STARK**.

Scoring:

The array is represented as a 2-d matrix, with source token array as rows and target token array as columns and then scores between those tokens will be calculated using Jaro Winkler algorithm.

Table 1: Customer Details

Customer Details	TONY	STARK
ANTONY	94	14
EDWARD	43	32
STARK	18	100

The Maximum weighted row scores and maximum column scores will be calculated For the example in the table,

MaximumWeightedRowScore are as follows:

- 94 (maximum of 94, 14)
- 43 (maximum of 43, 32)
- 100 (maximum of 18,100)

MaximumWeightedColScore are as follows

- 94 (maximum of 94, 43, 18)
- 100 (maximum of 14,32,100)

To get the final score, you can calculate the sum of maximumWeightedRowScore and MaximumWeightedColumnScore **(237+194)** divided by the sum of row size and column size **(3+2).** In this case **431/5 = 86.2**

2.5 Fuzzy Tokenized

This algorithm tokenises source and target tokens, then uses Jaro Winkler algorithm to calculate the score between tokens, and then consolidate the scores to a single score.

Tokenisation:

The source and target strings are tokenised with each space. For instance, if the source name is **ANTONY EDWARD STARK** and target name is **TONY STARK**, we tokenise source name to source array as **ANTONY**, **EDWARD**, **STARK** and target string as **TONY**, **STARK**.

Always the string with maximum number of tokens will be passed as source token array and the other will be target token array.

Scoring:

The array is represented as a 2-d matrix, with source token array as rows and target token array as columns and then scores between those tokens will be calculated using Jaro Winkler algorithm.

The Maximum weighted row scores and maximum column scores will be calculated

Table 2: Customer Details

Customer Details	TONY	STARK
ANTONY	94	14
EDWARD	43	32
STARK	18	100

- STARK in third row matching against STARK in second column
- STARK in second column matching against STARK in third row

In this scenario both returns the same score for same source and target token, so we won't consider this value twice.

- Such instances will be counted as a resCount (residue Count).
- Similar to reverse jaro, MaximumWeightedColScore score is calculated, and Weighted score of Row without duplicates will be calculated as MaximumWeightedResRowScore

Then finally similar to Reverse Jaro, we calculate

Fuzzy tokenised score = (MaximumWeightedColScore + MaximumWeightedResRowScore) / (colSize + resCount)

only if the score is greater than the threshold.

In othercase,

Word Match Percentage is calculated. For more information, see this link.

Then resScore is calculated,

which is **(MaximumWeightedRowScore * (1-threshold)) / (resCount +1)**

After the calculations, we will count the no. of tokens in column which has score > threshold. if *(count >= 2)* then the **Fuzzy tokenised score = threshold + (word match percentage * resScore)**

3 Matching Rulesets

Each ruleset comprises of multiple rules. The ruleset compares the attributes that are defined in the rules for the source entity with the target entity.

The following table provides the list of rulesets that are packaged with the FCC Studio application.

Table 1: List of Rulesets

Ruleset Name	Source Node Type	Target Node Type
Customer To Customer Match	customer	customer
Customer To Derived Entity	customer	derived_entity
Derived Entity To Derived Entity	derived_entity	derived_entity
Customer To Ext Source - Offshore	customer	external_entity_offshore
Customer To Ext Source - Bahamas	customer	external_entity_bahamas
Customer To Ext Source - Paradise	customer	external_address_paradise
Customer To Ext Source - Panama	customer	external_entity_panama
Customer To Ext Source - Offshore Addr	customer	external_address_offshore
Customer To Ext Source - Bahamas Addr	customer	external_address_bahamas
Customer To Ext Source - Paradise Addr	customer	external_address_panama
Customer To Ext Source - Panama Addr	customer	external_address_paradise

Each ruleset contains pre-defined source and target node types. Each ruleset is used to compare the parameters/attributes of the source and target node types to obtain a match.

3.1 Example

The following table provides the customer details of Customer 1, Customer 2, and Customer 3 in a bank.

Table 2: Customer Details

Customer Details	Customer 1	Customer 2	Customer 3
Source	Source System 1	Source System 2	Source System 3
Name	Mary Mathew	Mary Maria Mathew	Mary Steve
Email	Mary.Mathew@gmail.com	Mary.Mathew@gmail.com	Mary.Steve@gmail.co m
Phone	Phone Number 1	Phone Number 2	Phone Number 3
Country	United States	United States	United States
State	California	California	Washington
Address	Redwood City	Redwood City	15th St NW

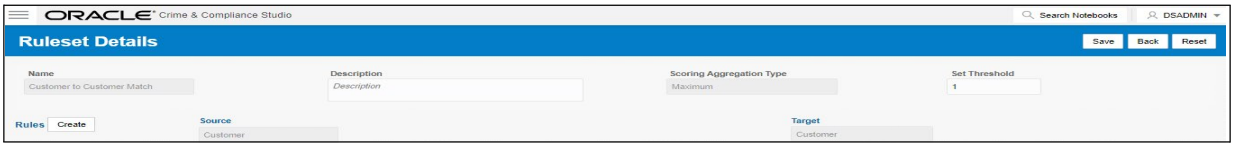
DOB	1 Jan 1995	1 Jan 1995	1 Jan 1995
Tax ID	Tax ID 1	-	Tax ID 1

The customer details include source from which the customer data is obtained, name, Email, phone number, country, state, address, date of birth, and tax ID of the customer.

The Customer to Customer Match ruleset compares the attributes defined for the source (customer) and target (customer) entities of each rule. If the score of the combination of the result obtained for all the rules in a ruleset is equal to or greater than the threshold set for the ruleset, a Similarity Edge is formed between the source and the target entity.

The Customer to Customer Match ruleset is given a follows:

Figure 1: Ruleset Details



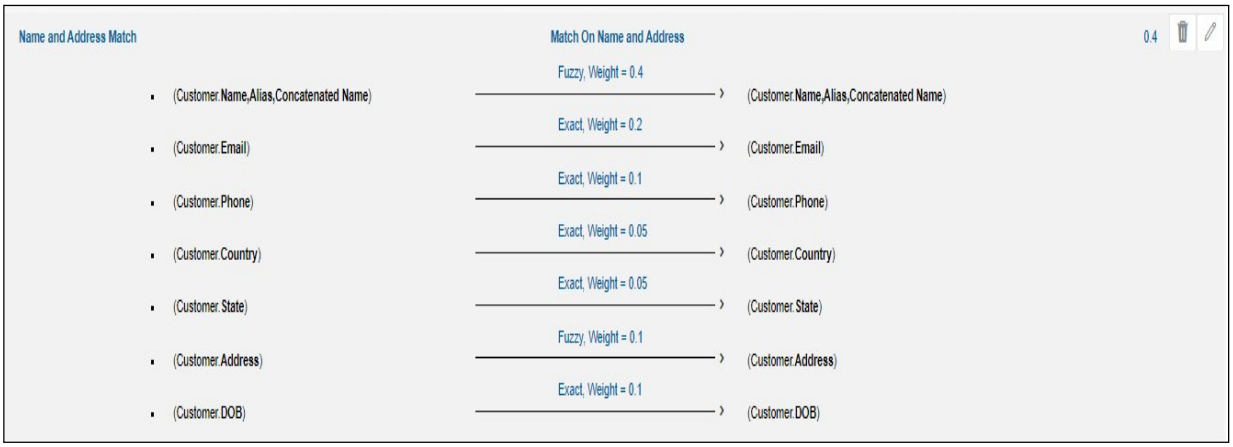
The following table provides the details of the Customer to Customer Ruleset.

Table 3: Customer to Customer Ruleset

Ruleset	Rules	Parameters/Attributes
Customer to Customer Ruleset	Name and Address Match	Name, Alias, Concatenated Name Email Phone Country State Address DOB Tax ID
Customer to Customer Ruleset	Tax ID	Tax ID

The Customer to Customer ruleset comprises of two rules, namely Name and Address Match and Tax ID. Each of these rules are applicable to pre-defined parameters/attributes. The rules are used to compare the parameters/attributes of the source and target node to obtain a match.

Figure 2: Name and Address Match Rule



The following table provides the how the Name and Address Match rule works.

Table 4: Name and Address Match Rule

Parameters/ Attributes	Source Entity	Target Entity	Match Type	Weightage	Threshold	Description
Name, Alias, Concatenated Name	Customer	Customer	Fuzzy	0.4	0.5	The Name, Alias, and Concate- nated Name attributes of the source entity (Customer) is com- pared with the target entity (Customer) to obtain a fuzzy match. If the fuzzy match generates a result that is equal to or greater than the threshold value (0.5), a weightage of 0.4 is contributed to this match.
Email	Customer	Customer	Exact	0.2	1	The Email address of the source entity (Customer) is compared with the target entity (Customer) to obtain an exact match. If an exact match is obtained, a weightage of 0.2 is contributed to this match.

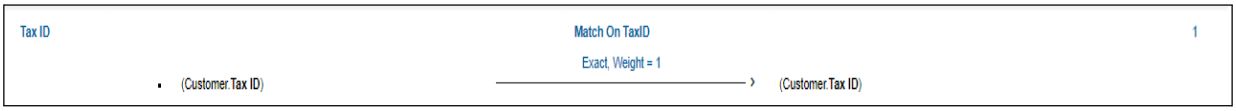
Table 4: Name and Address Match Rule

Parameters/ Attributes	Source Entity	Target Entity	Match Type	Weightage	Threshold	Description

Phone	Customer	Customer	Exact	0.1	1	The phone number of the source entity (Customer) is compared with the target entity (Customer) to obtain an exact match. If an exact match is obtained, a weightage of 0.1 is contributed to this match.
Country	Customer	Customer	Exact	0.05	1	The country of the source entity (Customer) is compared with the target entity (Customer) to obtain an exact match. If an exact match is obtained, a weightage of 0.05 is contributed to this match.
State	Customer	Customer	Exact	0.05	1	The state of the source entity (Customer) is compared with tar- get entity (Customer) to obtain an exact match. If an exact match is obtained, a weightage of 0.05 is contributed to this match.
Addres s	Customer	Customer	Fuzzy	0.1	0.6	The address of the source entity (Customer) is compared with the target entity (Customer) to obtain a fuzzy match. If the fuzzy match generates a result that is equal to or greater than the threshold value (0.6), a weightage of 0.1 is contributed to this match.
DOB	Customer	Customer	Exact	0.1	1	The date of birth of the source entity (Customer) is compared with the target entity (Customer) to obtain an exact match. If an exact match is obtained, a weightage of 0.1 is contributed to this match.

For the Name and Address Match rule, the Source and Target entity is Customer, and the corresponding parameters/attributes are Name, Alias, Concatenated Name, Email, Phone, Country, State, Address, and Date of Birth. Based on the match type, the parameters/attributes of the source entity is compared with the target entity to obtain a match and the result contributes to the total result obtained for all the matches of the rule.

Figure 3: Tax ID Rule



The following table provides the how the Tax ID rule works.

Table 5: Tax ID Rule

Parameters/ Attributes	Source Entity	Target Entity	Match Type	Weightage	Description
Tax ID	Customer	Customer	Exact	1	The Tax ID of the source entity (Customer) is com- pared with the target entity (customer) to obtain an exact match. If an exact match is obtained, a weightage of 1 is contributed to this match.

For the Tax ID rule, the Source and Target entity is Customer, and the corresponding parameters/ attribute is Tax ID. Based on the match type, the parameters/attributes of the source entity is compared with the target entity to obtain a match.

3.1.1 Calculation of Score

The following table provides details on how to calculate the score for the Name and Address Match rule.

Table 6: Calculation of Score

Customer Details	Customer 1	Customer 2	Score	Weight (From Rule)	Weighted Score
Name	Mary Mathew	Mary Maria Mathew	93.07	0.4	37.22
Email	Mary.Mathew@gmail.com	Mary.Mathew@gmail.com	100	0.2	20
Phone	Phone Number 1	Phone Number 2	100	0.1	10
Country	United States	United States	100	0.05	5
State	California	California	100	0.05	5
Address	Redwood City	Redwood City	100	0.1	10
DOB	1 Jan 1995	1 Jan 1995	100	0.1	10
				Total=1	Total=97.22

The weightage obtained from the Name and Address Match rule contributes to the total weighted score.

The total score obtained is greater than the rule threshold of 40%, a Similarity Edge is created between Customer1 and Customer 2. Similar calculation is performed for all possible combination of customers like Customer 2 and Customer 3, Customer 1 and Customer 3.OFSAA Support

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