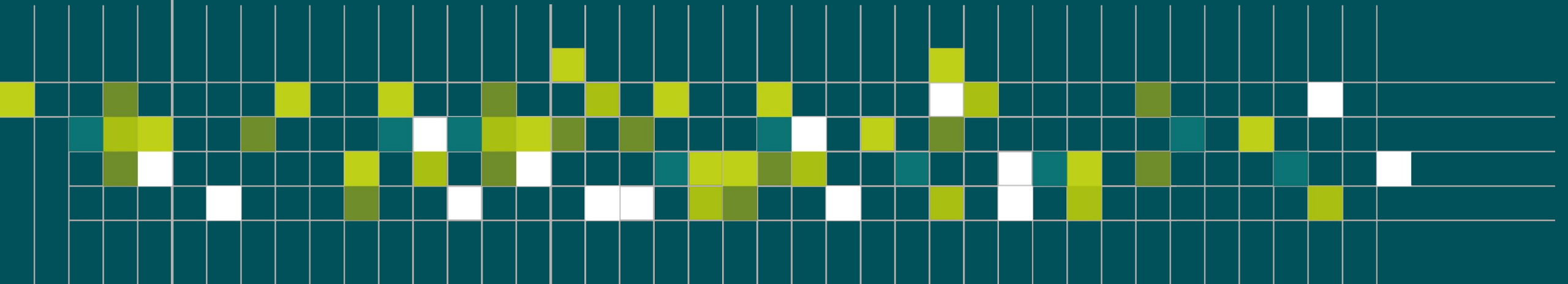
loco

Tabular dataset analysis

Concepts and principles



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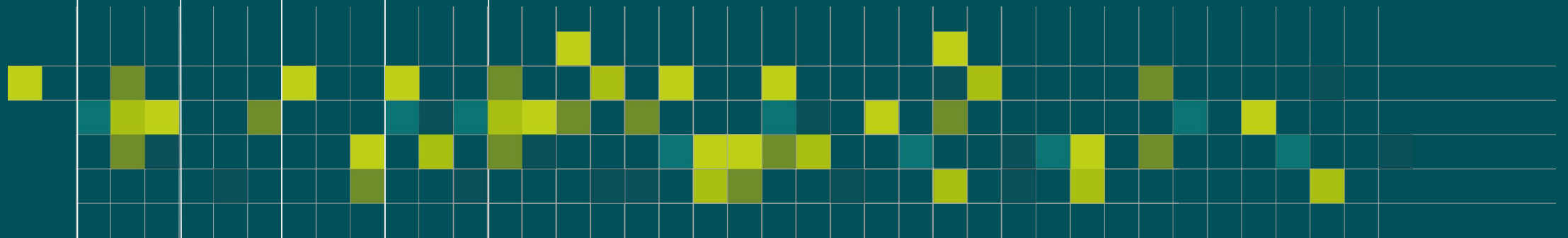
Contents



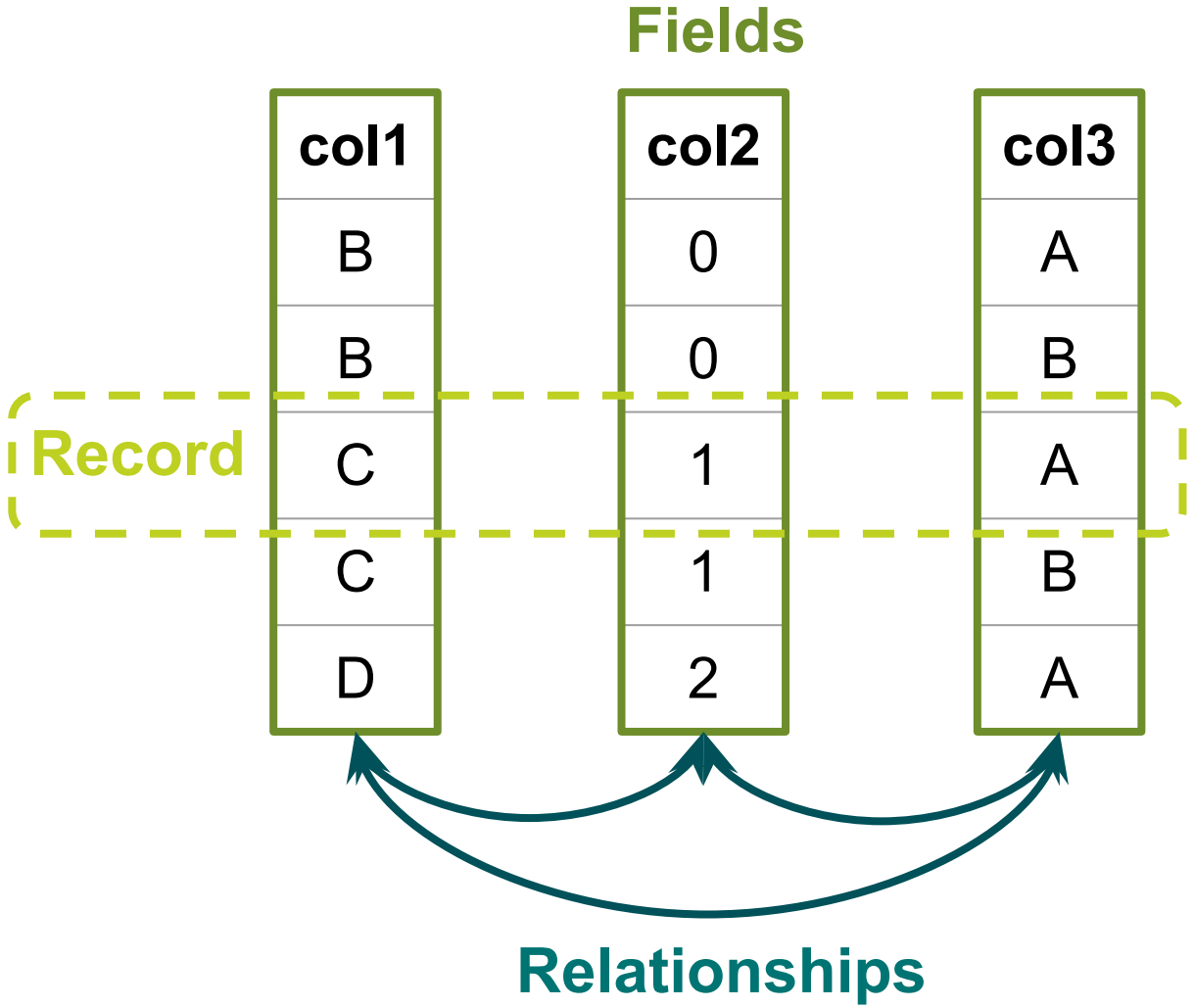
Dataset structure

Record oriented

- Dataset is a list of records
- A semantic entity is a record
- Length is variable

Field oriented

- Fields have semantics
- Fields are dependent
- A semantic entity is a set of record or the entire Dataset

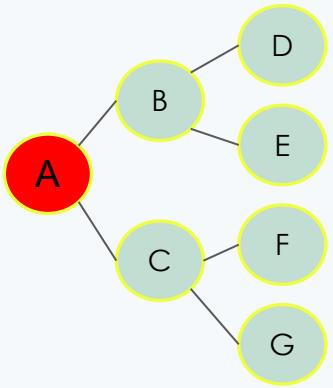


Dataset structure analysis

Dataset structure

- Tree structure
- Matrix structure
- Mixed structure

root	col1	col2
A	B	D
A	B	E
A	C	F
A	C	G



Tree structure

val	col3	col4
1	A	C
2	A	D
3	B	C
4	B	D

	A	B
C	1	3
D	2	4

Matrix structure

Analysis structure

- Field
- Relationship

col1
B
B
C
C

Values

=

col1
0
0
1
1

Keys

+

B	C
0	1

Codec

Field structure analysis

col1
0
0
1
1

Keys

<->

col4
0
1
0
1

Keys

=

1-4
0 0
0 1
1 0
1 1

Values

Relationship structure analysis

Definition

Values **[Anne, Paul, Anne, Lea, Lea]**

Codec (row)

Anne	0
Paul	1
Anne	2
Lea	3
Lea	4

Anne	0
Paul	1
Lea	2
Anne	3

Anne
Paul
Lea

0
1
2

A Codec defines the correspondence between values and keys (e.g.) :

- *1 : Anne*
- *0 : Paul*
- *2 : John*

A Codec may not be bijective (e.g.) :

- *0 : Anne*
- *1 : Paul*
- *2 : Anne*

Keys

[0, 1, 2, 3, 4]

[0, 1, 3, 2, 2]

[0, 1, 0, 2, 2]

Full
codec : all values
keys: no duplicate

Default
codec : different values

A Keys is a list of integers where :

- *the maximum is the length of Codec - 1*
- *Each integer is present in the list*

- A Field is a representation of a list of Values
- A Field is defined by a Keys list and a Codec list
- A Field is canonical if the keys is ordered
- A Field where values are row number is the “root field”

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1 - Field

Definition

Values	[Anne, Paul, Anne]	[Anne, Anne, Anne]	[Anne, Paul, Anne]
Keys	[0, 1, 2]	[0, 0, 0]	[0, 1, 0]
Length (number of values)	3	3	3
Codec (row)	0 1 2	0	0 1
Type codec	*full*	*unique*	*default*
Property	R : 1 DM : 0	R : 0 Dm : 0	R : 0 Dm : 0
Representation	**Codec :[Anne, Paul, Anne]** **Keys: implicit ([0,1,2])**	**Codec :[Anne]** **Keys: implicit ([0, 0, 0])**	**Codec :[Anne, Paul]** **Keys: [0, 1, 0]**

Indicators :

M: len(values) *maxcodec*
m: len(set(values)) *mincodec*
x: len(codec) *lencodec*
k: maxc(keys) *maxkeys*
* *maxc : max(counter( ))*

R: (M – x) / (M – m) *ratecodec*
Dm: x - m *dmincodec*
DM: M - x *dmaxcodec*
Mm: M - m *rancodec*

Keys typology

M = 0	Keys empty
M = x (k = 1)	Keys without duplicate data
x = 1	Keys with unique 0 value
[0, 1, 2, … , M]	identity Keys
k = M / x	Keys is distributed

Codec typology

M = 0 (m = x = 0)	null
x = 1 (m = 1)	unique
m = M = x (x > 1)	complete (rooted)
[0, 1, 2, … , m]	Identity Codec
m < M = x	full (rooted)
x = m < M (x > 1)	default
m < x < M	mixed

The Root Field is the Field with Identity Keys and Identity Codec

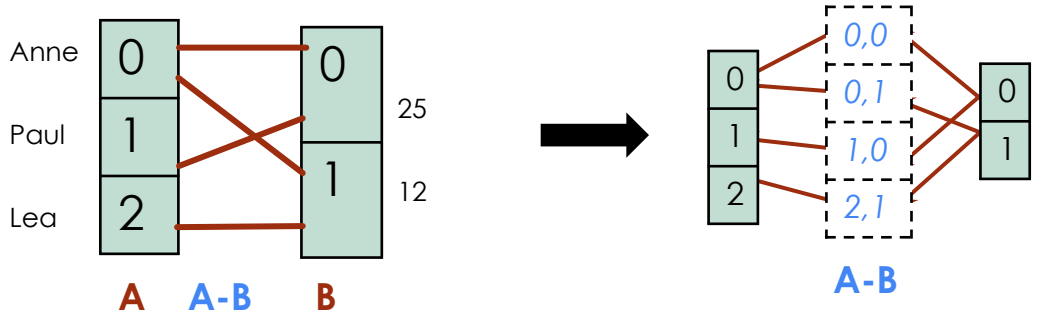
Properties

- Any Field have ***default*** Codec and ***rooted*** Codec
- ***Default*** Codec is the shortest Codec, ***rooted*** is the longest
- The only bijective Codec is the ***default*** (or ***complete***) Codec
- The ***Identity*** Codec is ***default*** or ***complete*** Codec
- The maximum Keys value is the length of Codec plus one
- If Codec is the ***Identity*** Codec, Keys and Values are equals
- If Keys is the ***Identity*** Keys, Codec and Values are equals
- In a ***distributed*** Field all values are present with the same frequency
- ***Full*** and ***unique*** Field are ***distributed***
- The ***Root*** Field is ***complete***
- The ***Root*** Field has identical Keys, Values and Codec

Definition

	values	*codec*	*keys*
Field A	**[Anne, Paul, Anne, Lea]**	***[Anne, Paul, Lea]***	***[0, 1, 0, 2]***
Field B	**[25, 25, 12, 12]**	***[25, 12]***	***[0, 0, 1, 1]***
Relationship A - B	**[0-0, 1-0, 0-1, 2-1]**	***[0-0, 1-0, 0-1, 2-1]***	***[0, 1, 2, 3]***

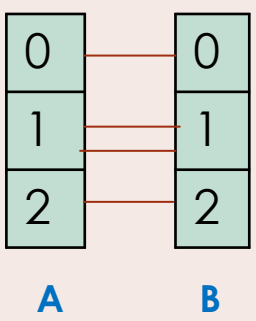
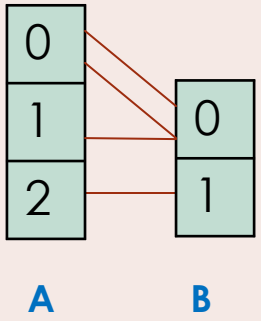
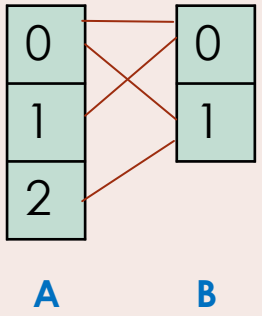
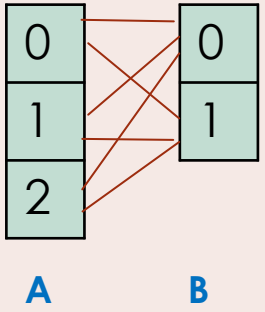
Notation



- A Relationship is a virtual Field where
  - values are pairs of each keys
  - codec is the default codec
- The value of a Relationship is the lencodec of the virtual Field : $X_{A\text{-}B}$

2 - Relationship

Definition

		coupled	derived	linked	Crossed
Values	A	[Anne, Paul, John, Paul]	[Anne, Paul, Anne, Lea]	[Anne, Paul, Anne, Lea]	[Anne, Anne, Paul, Paul, Lea, Lea]
	B	[25, 26, 15, 26]	[25, 25, 25, 12]	[25, 25, 12, 12]	[25, 12, 25, 12, 25, 12]
Codec					
Type		dist = dmin diff = 0	dist = dmin 0 < diff < dmin	dmin < dist < dmax 0 ⩽ diff ⩽ dmin	dist = dmax 0 ⩽ diff < dmin
Keys	B	Implicit (equal Keys A)	Relative to keys A	Absolute	Implicit (Matrix order)
Example B		**Codec :[25, 26, 15, 35]** **Keys: implicit**	**Codec :[25, 12]** **Keys: relative** **[0,0,1]**	**Codec :[25, 12]** **Keys: absolute** **[0,0,1,1]**	**Codec :[25, 12]** **Keys: implicit** ***([0,1,0,1,0,1])***

Indicators :

dmax = $x_A * x_B$
dmin = $\max(x_A, x_B)$
dran = dmax - dmin
diff = $\text{abs}(x_A - x_B)$
dist = $x_{(A, B)}$

Rules :

A and B : derived
$x_{(A, B)} =$ dmin
A and B : coupled
$x_{(A, B)} = x_B = x_A$
A and B : crossed
$x_{(A, B)} = x_B * x_A$

Additional rules:

A and B : distributed
$k_{(A, B)} * x_{(A, B)} = M_A = M_B$
A and B : full distributed
$k_{(A, B)} = 1$
$x_{(A, B)} = M_A = M_B$

Relative keys :

Length:
length(parent.codec)
Values:
Keyder(parent.key(i)) = key(i)

Properties

- Type and Indicators are independent of Values (order or value)

- All Fields are ***derived*** or ***coupled*** with an ***unique*** Field
- All Fields are ***derived*** or ***coupled*** with a ***rooted*** Field

- If A is ***derived*** (***coupled***) with B ($x_B \leqslant x_A$) and B is ***derived*** (***coupled***) with C ($x_C \leqslant x_B$), A is ***derived*** (***coupled***) with C and diff(A,C) = diff(A,B) + diff(B,C)

- If A and B are ***coupled***, all the relationships with other indexes are identical

- If A and B are ***crossed***
  - if C is ***derived*** (***coupled***) with A ($x_C \leqslant x_A$): B and C are ***crossed***
  - $x_A * x_B \leqslant M_A$ If $x_A * x_B = M_A$, A and B are ***full distributed***
  - All combinations of values are present
  - If A and B are ***distributed***, the relationship is ***distributed***

- **Keys can be deduced with *coupled* relationship**
  - A and B are ***coupled*** => keys(B) = keys(A)
- **Keys can be reduced with derived relationship (relative keys)**
  - B is ***derived*** with A ($x_B \leqslant x_A$) => len(relative_keys(B)) = len(codec(A))

Distance

Distance (resp distomin): number of codec links to remove to be coupled (resp derived)
Distomax: number of codec links to add to be crossed

$X_B \leqslant X_A$: $dmin = X_A$ $diff = X_A - X_B$ $dmin - diff = X_B$

Distance:	**dist - dmin + diff**	$X_{(A, B)} - X_B$
Distomin:	**dist - dmin**	$X_{(A, B)} - X_A$
Distomax:	**dmax - dist**	$X_A * X_B - X_{(A, B)}$
RateCpl:	**distance / (distance + distomax)**	
1 - RateCpl:	**distomax / (distance + distomax)**	
RateDer:	**distomin / (dmax - dmin)**	
1- RateDer:	**distomax / (dmax - dmin)**	

$X_B \leqslant X_A$	**distance**	**distomin**	**distomax**	**rateCpl**	**rateDer**
coupled	0	0	$X_A * X_A - X_A$	0	0
derived	$X_A - X_B$		$X_A * X_B - X_A$	$(X_A - X_B)/(X_A * X_B - X_B)$	
linked	$X_{(A, B)} - X_B$	$X_{(A, B)} - X_A$	$X_A * X_B - X_{(A, B)}$	$(X_{(A, B)} - X_B)/(X_A * X_B - X_B)$	$(X_{(A, B)} - X_A)/(X_A * X_B - X_A)$
crossed	$X_A * X_B - X_B$	$X_A * X_B - X_A$	0	1	1

Distance properties

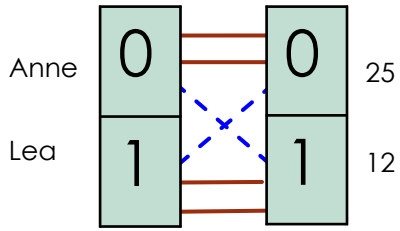
- If distance(A,B) = 0, A and B are coupled
- If A is derived from B and B is derived from C:
  distance(A,C) = distance(A,B) + distance(B,C)
- The maximal distance is between root Field and unique Field
- The distance of a Field to the Root Field is equal to the "dmaxcodec"

$X_B \leqslant X_A$	**distance**	**distomin**	**distomax**	**rateCpl**	**rateDer**
X_A and X_B unique	0	0	0	0	0
X_B unique	X_A - 1			1	
X_A root (len)	len - X_B		len * X_B - len	(len - X_B)/ (len * X_B - X_B)	
X_A root X_B unique	len - 1		0	1	
A = B	0		X_A * X_A - X_A	0	
X_A = X_B	distance = distomin			rateCpl = rateDer	

Distance - example

coupled

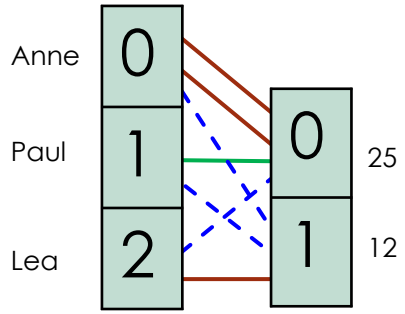
[Anne, Anne, Lea, Lea]
[25, 25, 12, 12]



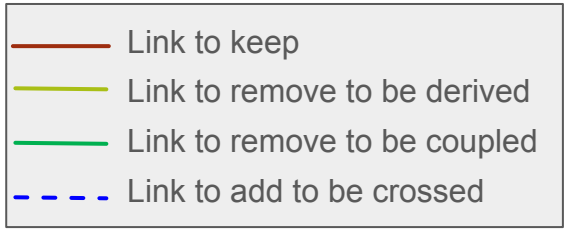
Dmax :	4
Dmin :	2
Diff :	0
Dist :	2
Distance :	**0**
Distomin:	**0**
Distomax:	**2**

derived

[Anne, Paul, Anne, Lea]
[25, 25, 25, 12]



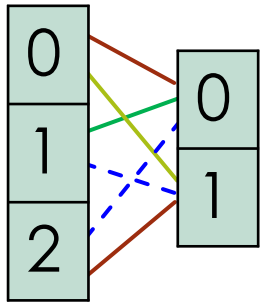
Dmax :	6
Dmin :	3
Diff :	1
Dist :	3
Distance:	**1**
Distomin:	**0**
Distomax:	**3**



Distance - Examples

linked

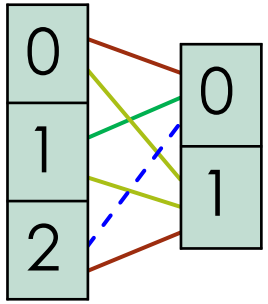
[Anne, Paul, Anne, Lea]
[25, 25, 12, 12]



Dmax :	6
Dmin :	3
Diff :	1
Dist :	4
Distance:	**1 + 1**
Distomin:	**1**
Distomax:	**2**

linked

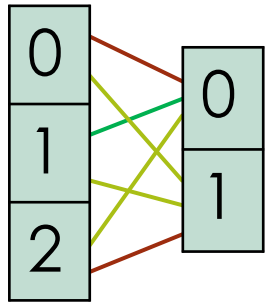
[Anne, Anne, Paul, Paul, Lea]
[25, 12, 25, 12, 12]



Dmax :	6
Dmin :	3
Diff :	1
Dist :	5
Distance :	**1 + 2**
Distomin:	**2**
Distomax:	**1**

crossed

[Anne, Anne, Paul, Paul, Lea, Lea]
[25, 12, 25, 12, 25, 12]



Dmax :	6
Dmin :	3
Diff :	1
Dist :	6
Distance :	**1 + 3**
Distomin:	**3**
Distomax:	**0**

Link to keep
Link to remove to be derived
Link to remove to be coupled
Link to add to be crossed

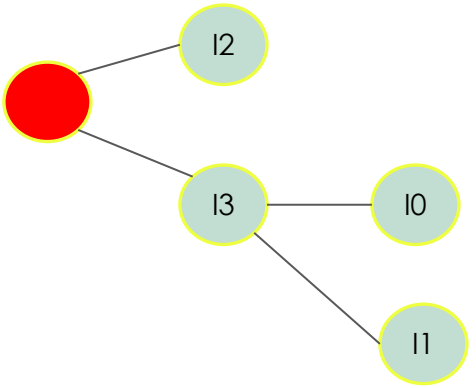
Definition - properties

- **Dataset definition**
  - Datasets have a hidden Field: ***Root*** Field
  - Fields are ordered (***Root*** Field is the first)
  - Relationships are oriented :
    - ***Parent*** Field has the highest lencodec, ***Child*** Field has the lowest
    - If lencodec are equal, ***Parent*** Field has the lowest row (order of Fields)

- **Dataset properties**
  - Each Field is ***derived*** (***coupled***) from at least one ***parent*** Field (the ***root*** Field)
  - A dataset with only ***derived*** or ***coupled*** relationships is equivalent to a tree
  - A dataset with only ***crossed*** relationships is equivalent to a multi-dimensional data
  - With relationship adjustment, a dataset can translated in a tree or a multi-dimensional data

Tree properties

- A dataset can be represented by a rooted tree where
  - ***Nodes*** are Field
  - ***Root*** is root Field
  - Each node has a single parent node (relationship parent)



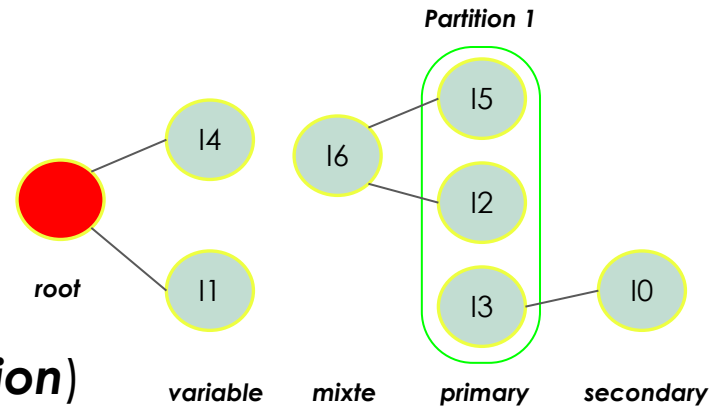
- Different rules are available to define the parent node:
  - Option derived : First (row) derived Field with minimal distance
  - Option distance : First (row) Field with minimal distance
  - Option distomin : First (row) Field with minimal distomin

Fields tree typology

unique	Codec is Unique	leaf	Parent is root
rooted	Codec is complete or full (root coupled)	leaf	Parent is root
coupled	Field is coupled with a parent Field	leaf	Parent is the first previous coupled Field
derived	The Field is not derived with a Child Field	leaf	
mixed	Other Fields	Node	

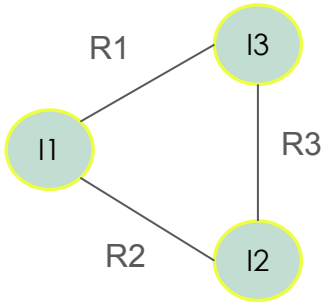
Partition properties

- **Dataset partition**
  - A ***partition*** is a set of Fields full distributed (i.e. each record is associated to a single combination of Field keys)
  - Four categories of Fields are defined in a ***partition*** :
    - ***Primary*** Fields: Fields included in the ***partition***
    - ***Secondary*** Fields: Fields ***derived*** / ***coupled*** with a ***primary*** Field
    - ***Mixte*** Fields: Fields ***derived*** *(2 or more)* or ***coupled*** *(1 or more)* with all ***primary*** Fields
    - ***Variable*** Fields: other Fields (including ***unique*** Fields)
  - The ***default partition*** is the ***partition*** with the largest size
  - The ***dimension*** of a Dataset is the ***default partition*** size



- **Properties**
  - A Dataset has at least one implicit ***partition*** (the ***root partition***)
  - A multi dimensional array is associated to each ***partition***
  - Keys data may be implicit for ***primary*** Fields
  - ***Dimension*** can be reduced by *codec extension*
  - ***Dimension*** can be increased by *values extension*
  - In a ***root partition***, all the Fields are ***variable***, the ***dimension*** is 0 (the ***primary*** Field is the ***root*** Field)

How to analyse ?



dataset

Fields

- id
- lencodec
- mincodec

Relationships

- id1, id2
- dist
- distributed

Analysis module

- Properties
- Partitions
- Trees
- Indicators

4 - Example

Example

3 fields are derived
- First name
- Last name
- Group

1 field is coupled
- Surname

1 field is unique
- Year

3 fields are almost crossed
- Full name
- Course
- Examen

1 field is almost rooted
- Score

78% almost crossed

83% almost crossed

1.5 % almost rooted

first name	last name	full name	surname	group	course	year	examen	score
Anne	White	Anne White	skyler	gr1	math	2021	t1	11
Anne	White	Anne White	skyler	gr1	math	2021	t2	13
Anne	White	Anne White	skyler	gr1	math	2021	t3	15
Anne	White	Anne White	skyler	gr1	english	2021	t2	10
Anne	White	Anne White	skyler	gr1	english	2021	t3	12
Philippe	White	Philippe White	heisenberg	gr2	math	2021	t1	15
Philippe	White	Philippe White	heisenberg	gr2	english	2021	t2	8
Camille	Red	Camille Red	saul	gr3	software	2021	t3	17
Camille	Red	Camille Red	saul	gr3	software	2021	t2	18
Camille	Red	Camille Red	saul	gr3	english	2021	t1	2
Camille	Red	Camille Red	saul	gr3	english	2021	t2	4
Philippe	Black	Philippe Black	gus	gr3	software	2021	t3	18
Philippe	Black	Philippe Black	gus	gr3	english	2021	t1	6

coupled

derived

unique

Ratio ratecpl
- *Full name – Examen : 78 %*
- *Score – Root : 1,5 %*
- *Course – Examen : 83 %*

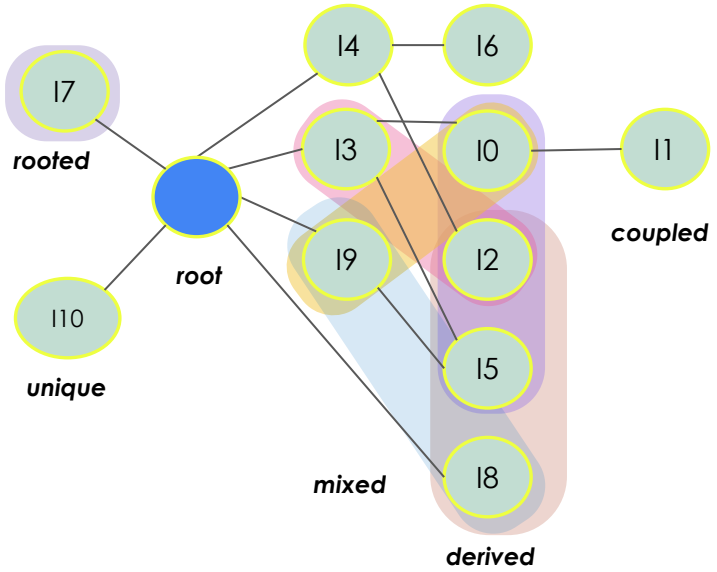
4 - Example

Partition example

product	plants	plts	quantity	price	price level	group	id	supplier	location	valid
apple	fruit	fr	1 kg	1	low	fruit1	1001	sup1	fr	ok
apple	fruit	fr	10 kg	10	low	fruit10	1002	sup1	gb	ok
orange	fruit	fr	1 kg	2	high	fruit1	1003	sup1	es	ok
orange	fruit	fr	10 kg	20	high	veget	1004	sup2	ch	ok
peppers	vegetable	ve	1 kg	1.5	low	veget	1005	sup2	gb	ok
peppers	vegetable	ve	10 kg	15	low	veget	1006	sup2	fr	ok
carrot	vegetable	ve	1 kg	1.5	high	veget	1007	sup2	es	ok
carrot	vegetable	ve	10 kg	20	high	veget	1008	sup1	ch	ok

Derived tree :

-1: root-derived (8)
- 3 : product (4 - 4)
  - 0 : plants (2 - 2)
    - 1 : plts (0 - 2)
  - 5 : price level (2 - 2)
- 4 : price (2 - 6)
  - 2 : quantity (4 - 2)
  - 6 : group (3 - 3)
- 7 : id (0 - 8)
- 8 : supplier (6 - 2)
- 9 : location (4 - 4)
- 10 : valid (7 - 1)



Partitions :

['plants', 'price level', 'quantity'],
['price level', 'quantity', 'supplier'],
['location', 'plants'],
['location', 'supplier'],
['product', 'quantity'],
['id']