데이터분석을 위한 선형대수학

데이터를 벡터로 이해하기

김용담 강사

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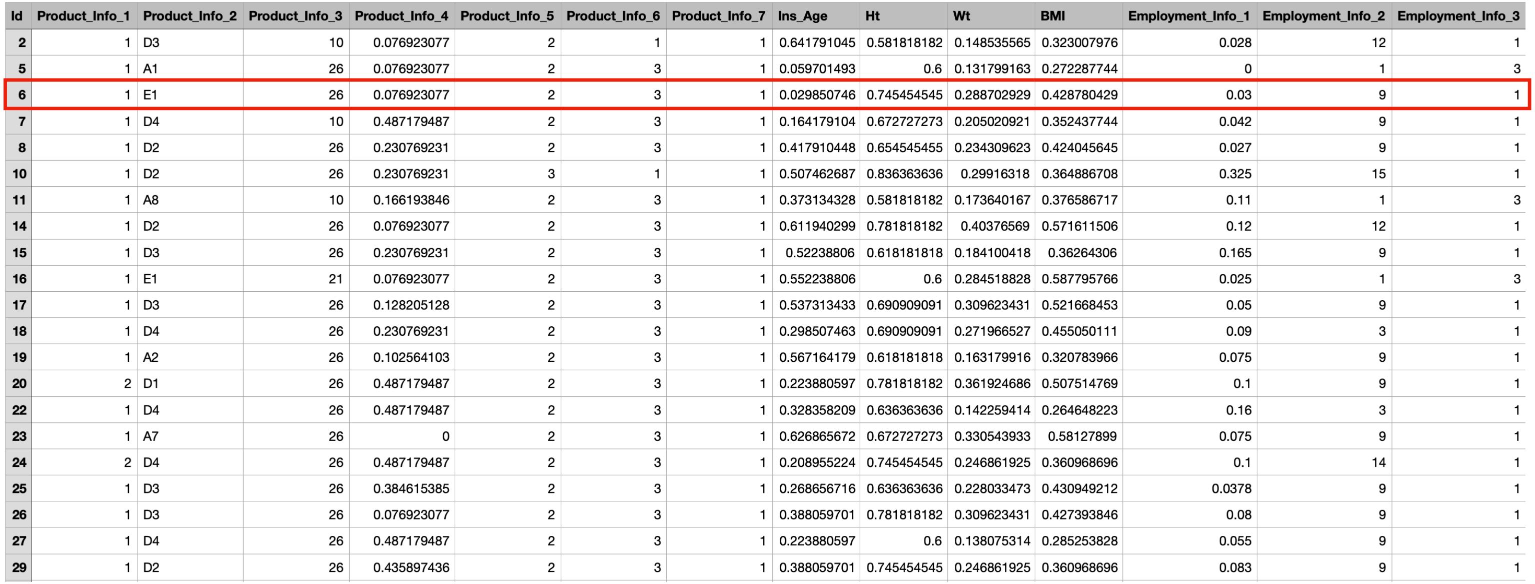
1. 데이터분석과 선형대수

데이터 분석 예시

Q. 6번 고객과 가장 비슷한 고객을 어떻게 찾을것인가?

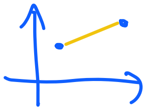


Id	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

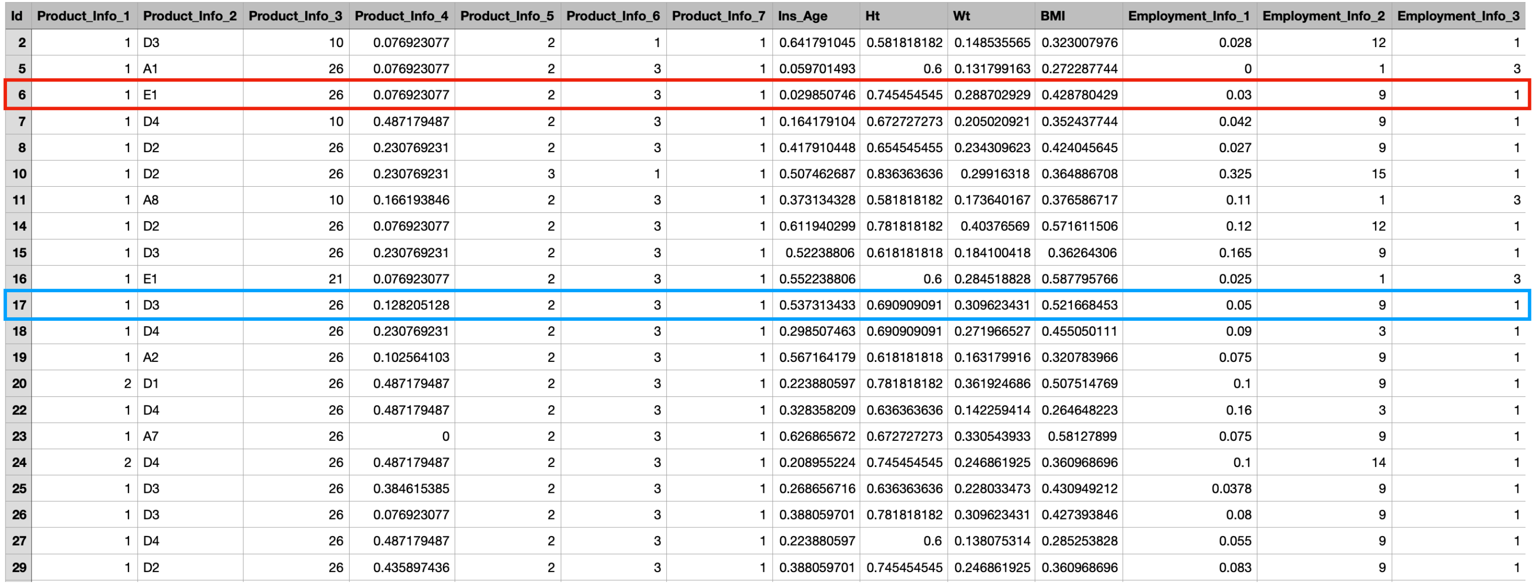
데이터 분석 예시

행끼리 비교 ⇒ 거리 함수를 기준으로 행끼리 거리를 측정

Q. 어떤 기준으로 고객의 유사성을 판단할 것인가?



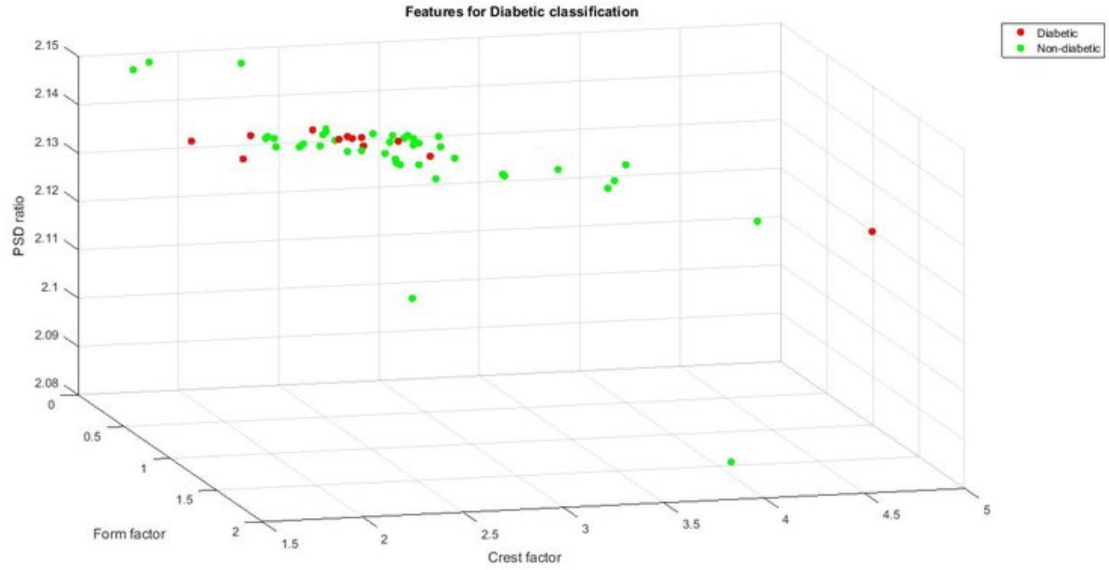
점 = Vector



Id	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

데이터 분석 예시

A. 데이터는 벡터다

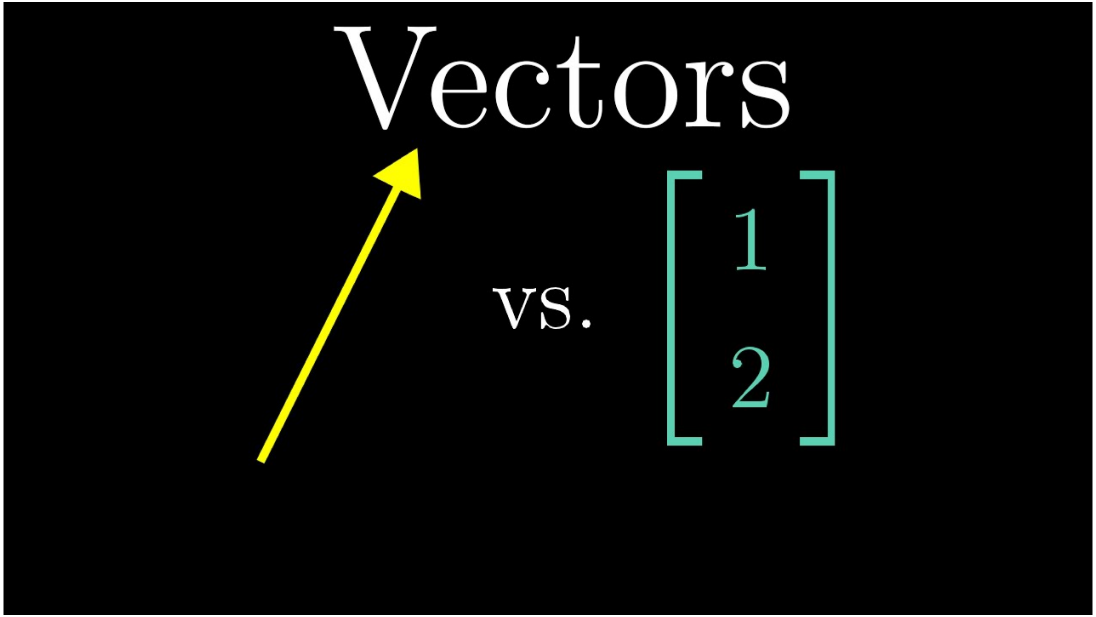


2. 벡터란 무엇인가?

Definition

벡터의 정의 (= 약속)

√ 벡터 공간의 원소



Vectors

vs. $\begin{bmatrix}1\\2\end{bmatrix}$

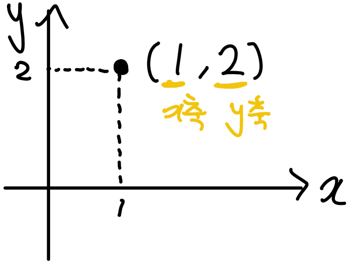
벡터의 정의

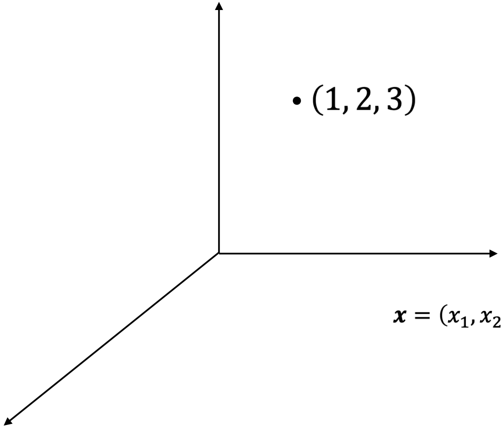
√ 여러 개의 숫자 모음 (list of numbers)

- 행 벡터 $(1, 2, 3)$

- 열 벡터 $\begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$

- 여러 개의 "숫자"를 묶어서 표현한 것





$\boldsymbol{x} = (x_1, x_2, \cdots, x_N)$

벡터와 관련된 용어들

벡터 공간에 대한 이해

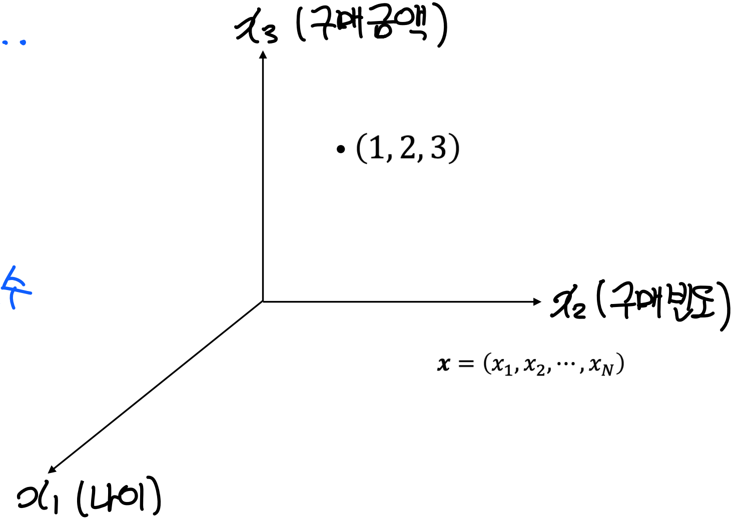
" Vector Space "

✓
- 기저(basis) = 축(axis) x축, y축, z축, · · ·

- 차원(dimension) = 벡터의 원소 개수

  = 벡터공간의 기저 개수

- 원소(element) = 벡터



$\boldsymbol{x} = (x_1, x_2, \cdots, x_N)$

벡터와 관련된 용어들

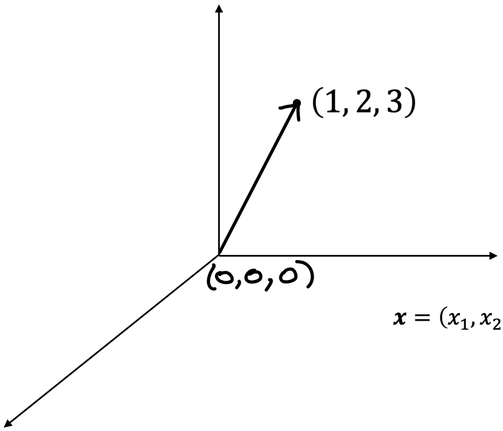
벡터 공간에 대한 이해

- 벡터 공간(Vector Space) = 집합

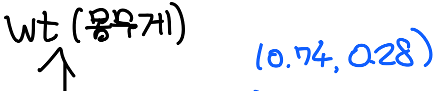
벡터의

- 크기(norm) = 벡터의 길이

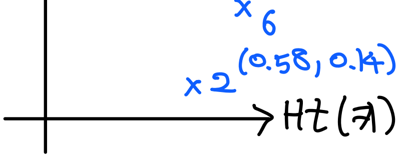
- 방향(direction) = 단위 벡터(unit vector)



$\boldsymbol{x} = (x_1, x_2, \cdots, x_N)$

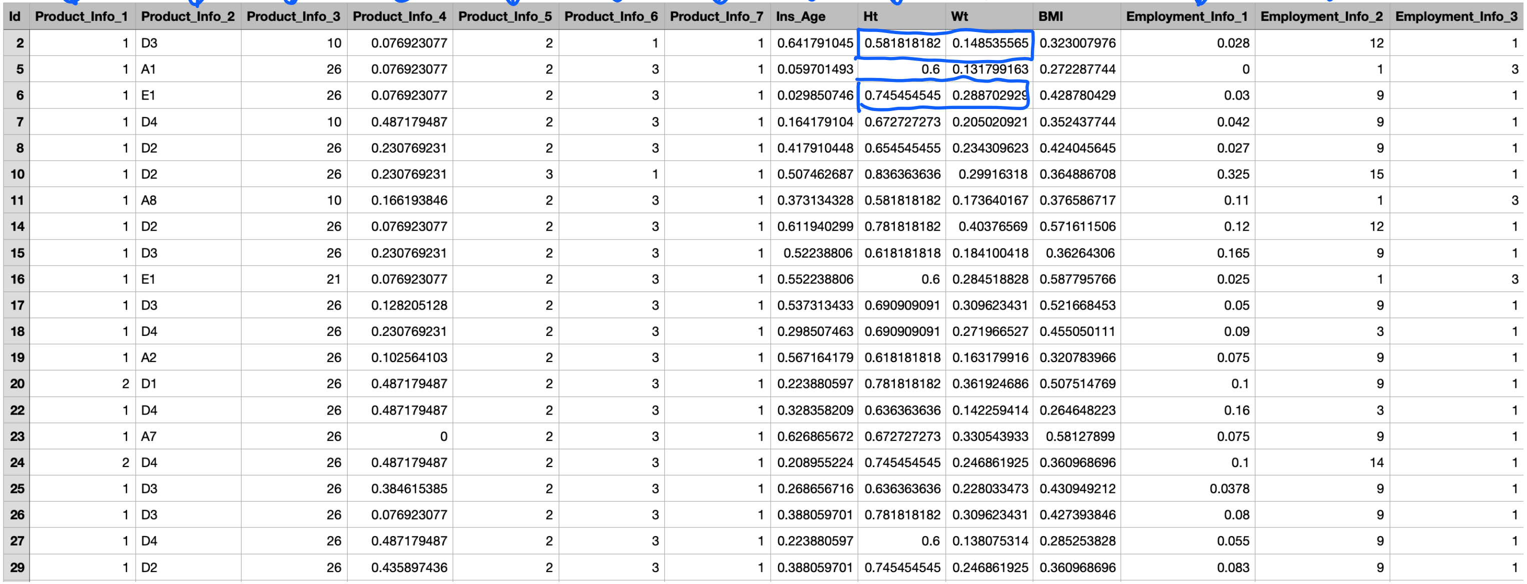


데이터 분석 예시



Q1. 다음 주어진 데이터를 벡터로 표현한다면 기준은 무엇으로 잡을까?

(축)



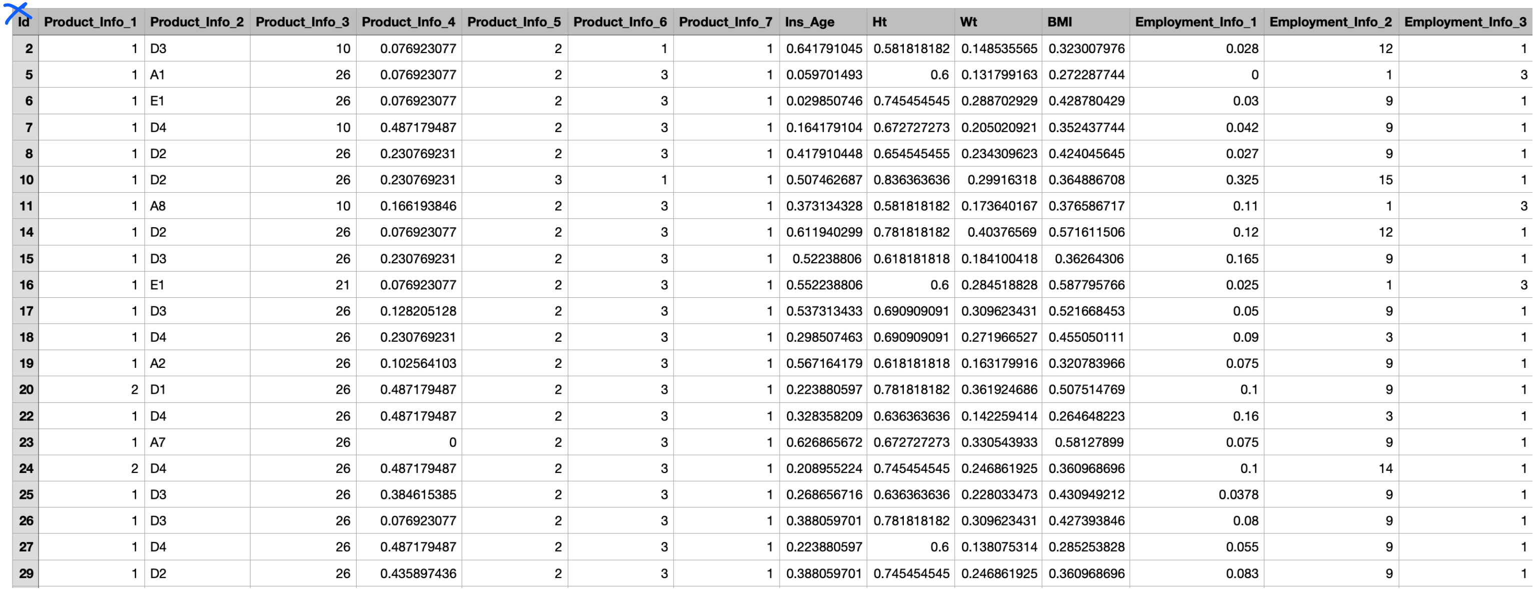
Id	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

데이터 분석 예시

(= 원소 개수)

Q2. 다음 주어진 데이터는 몇 차원 벡터일까?

14차원 (다 씀.)

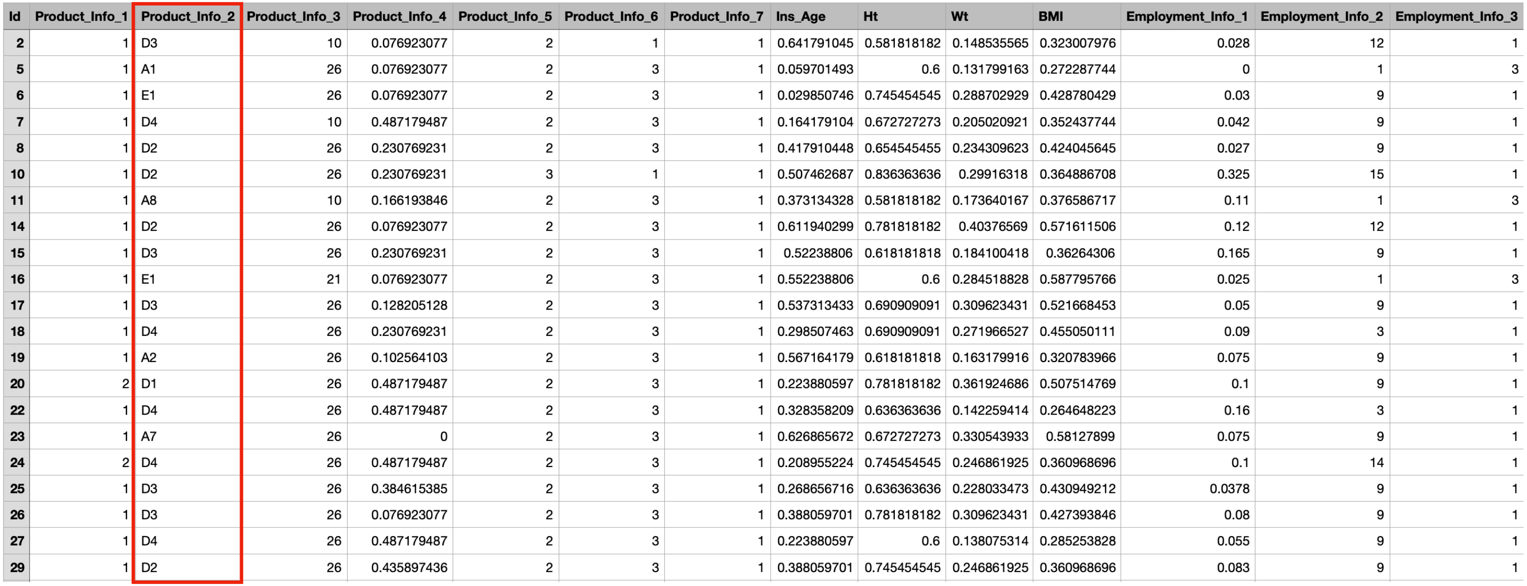


~~Id~~	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

데이터 분석 예시

Q3. 다음 데이터의 Product_Info_2 열의 경우엔 공간에 어떻게 표현되는가?

" D3 가 숫자가 아님 "



Id	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

3. 데이터 분석을 위한 벡터 연산

벡터 기본 연산 → 같은 차원의 벡터들 사이에서만 가능!

데이터의 특징을 파악할 수 있는 기본 연산

- N차원의 벡터 $\boldsymbol{x} = (x_1, x_2, \cdots, x_N)$와 $\boldsymbol{y} = (y_1, y_2, \cdots, y_N)$에 대해,

- 벡터의 크기 : $|\boldsymbol{x}| = \sqrt{x_1^2 + x_2^2 + \cdots + x_N^2}$ (L2 norm) e.g. $|(1,2,3)| = \sqrt{1^2+2^2+3^2} = \sqrt{14}$
- 벡터의 덧셈 : $\boldsymbol{x} + \mathbf{y} = (x_1 + y_1, x_2 + y_2, \ldots, x_N + y_N)$ e.g. $(1,2,3) + (-1,2,3) = (0,4,6)$
- 벡터의 뺄셈 : $\boldsymbol{x} - \mathbf{y} = (x_1 - y_1, x_2 - y_2, \ldots, x_N - y_N)$
- 스칼라 배 : $a\boldsymbol{x} = (ax_1, ax_2, \cdots, ax_N)$ e.g. $3 \cdot (1,2,3) = (3,6,9)$
- 백터의 내적 : $\boldsymbol{x} \cdot \mathbf{y} = \cancel{(x_1 \times y_1, x_2 \times y_2, \ldots, x_N \times y_N)} = \underset{\uparrow \text{ x의 크기}}{|\boldsymbol{x}|}|\boldsymbol{y}|\cos\theta$ (단, θ는 $\boldsymbol{x}$와 $\boldsymbol{y}$의 사이각)

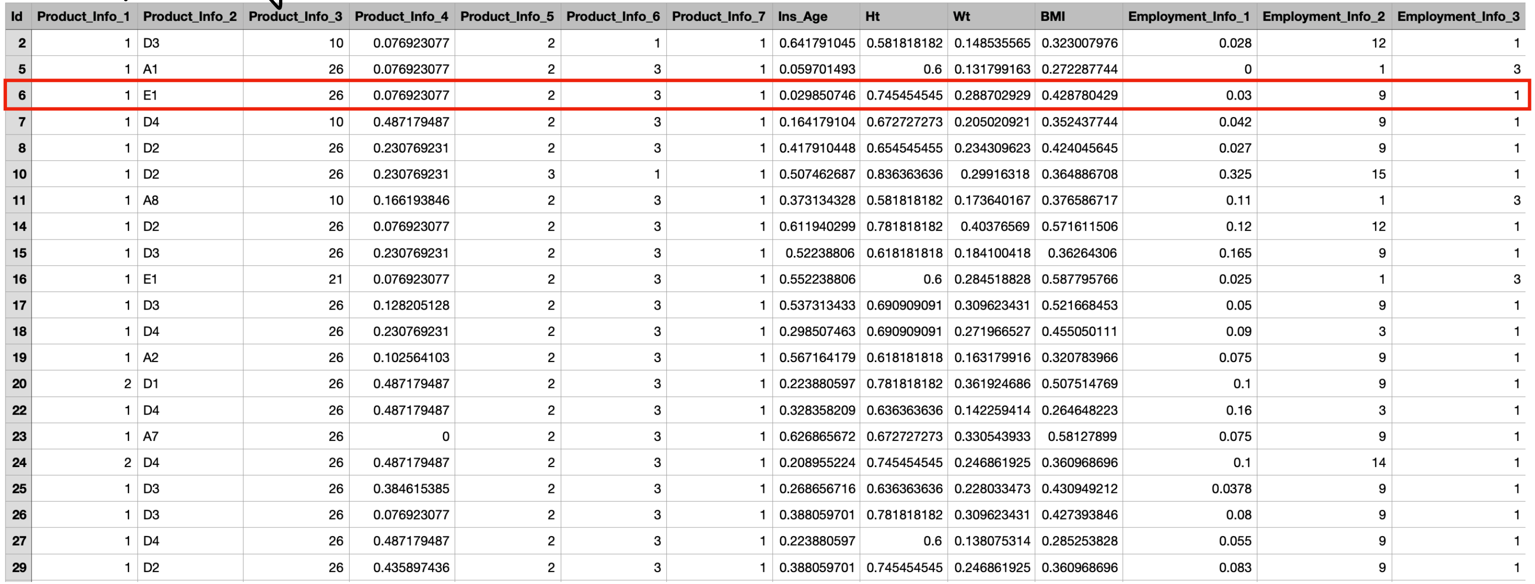
  $= x_1 \times y_1 + x_2 \times y_2 + \cdots + x_N \times y_N$

e.g. $(1,2,3)\cdot(1,-2,3) = 1\times1+2\times(-2)+3\times3 = 6$

데이터 분석 예시

Q1. 6번 고객 벡터의 크기를 계산하여라. (단, 두번째 column 제외)

$$|V_6| = \sqrt{1^2+26^2+0.07^2+2^2+\cdots+9^2+1^2}$$

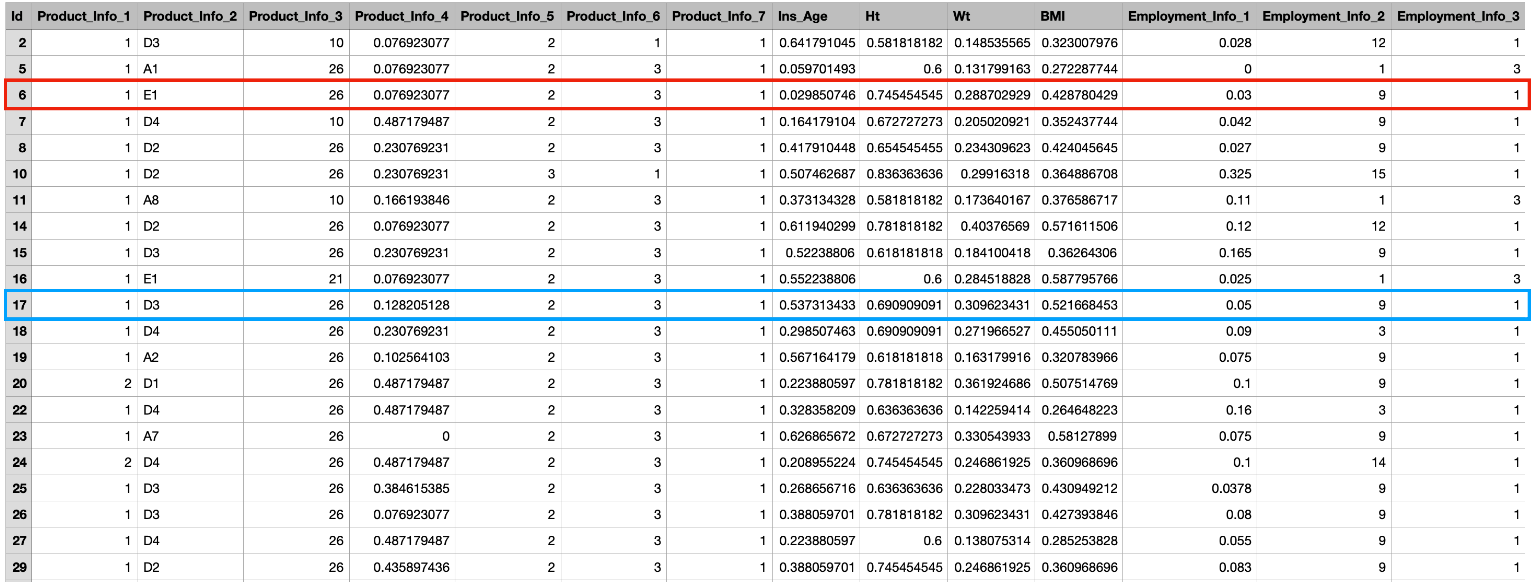


Id	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

데이터 분석 예시

Q2. 6번 고객의 데이터와 17번 고객 데이터의 차이를 구하여라. (단, 두번째 column 제외)

$V_6 - V_{17} = (1-1, 26-26, \cdots\cdots, 9-9, 1-1)$

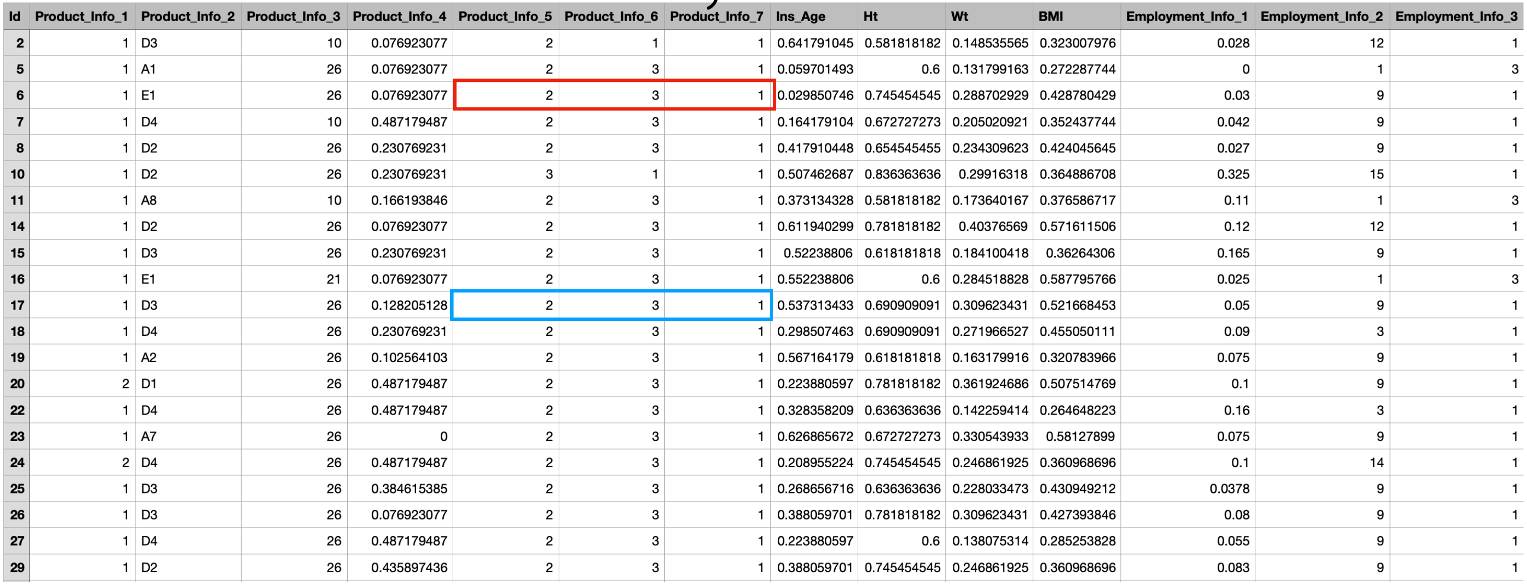


Id	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

데이터 분석 예시

Q3. 주어진 6, 17번 데이터의 일부를 벡터로 표현할 때, 두 벡터는 같은가?

$v_6 = (2,3,1) = (2,3,1) = v_{17}$

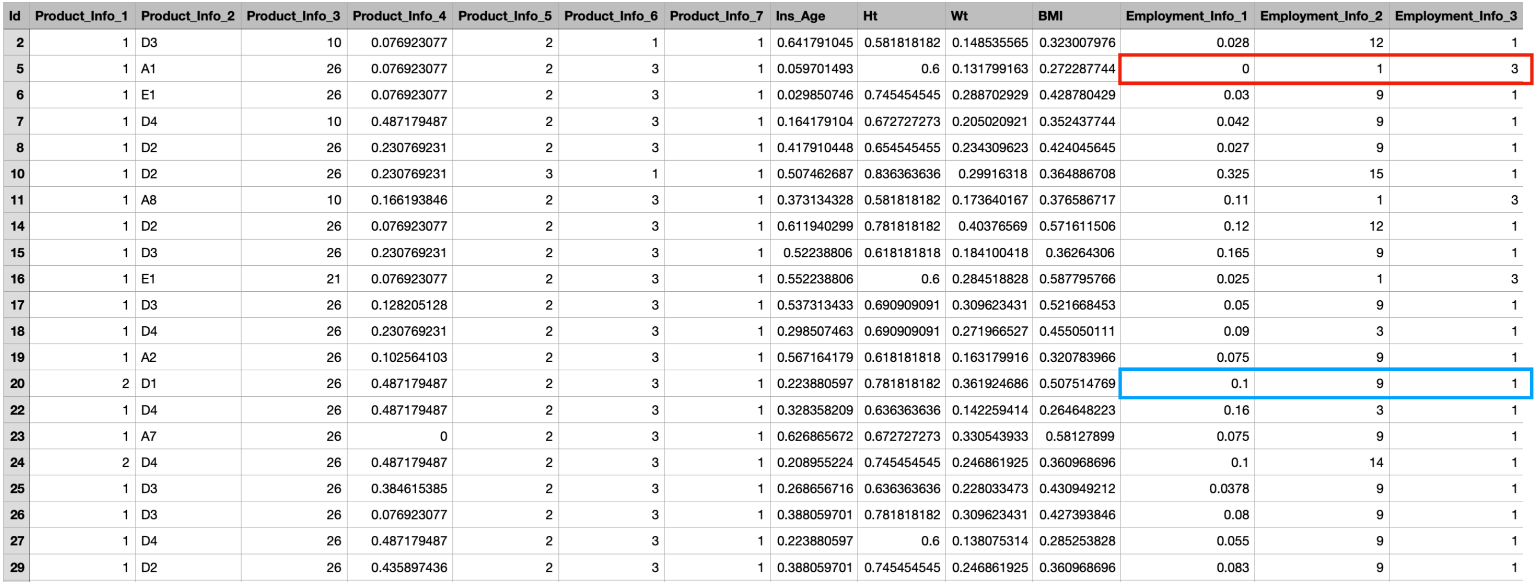


Id	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

데이터 분석 예시

Q4. 주어진 5, 20번 데이터의 일부를 벡터로 표현할 때, 두 벡터의 내적값을 구하여라.

$$v_5 \cdot v_{20} = 0\times0.1 + 1\times9 + 3\times1 = 12$$



Id	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

벡터 간 거리

데이터 사이의 "유사성" 측정

→ 벡터 사이의 유사성 측정

↓

거리 함수
(distance function)

$x = (1, 2, 3)$

$y = (3, 2, 1)$

- N차원의 벡터 $\boldsymbol{x} = (x_1, x_2, \cdots, x_N)$와 $\boldsymbol{y} = (y_1, y_2, \cdots, y_N)$에 대해,

√ $d_1(x, y) = |1-3| + |2-2| + |3-1|$
$= 2 + 0 + 2 = 4$

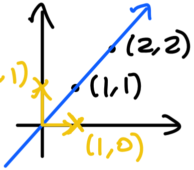
[(OPTIONAL)

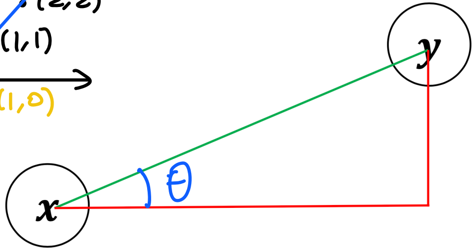
- Manhattan Distance (L1 distance) : $\sum_{i=1}^{N} |x_i - y_i|$ $= |x_1 - y_1| + |x_2 - y_2| + \cdots + |x_N - y_N|$
- Euclidean Distance (L2 distance) : $\sqrt{\sum_{i=1}^{N} (x_i - y_i)^2}$

√ $d_2(x, y) = \sqrt{(1-3)^2 + (2-2)^2 + (3-1)^2}$
$= \sqrt{4+0+4}$
$= \sqrt{8}$

cosine distance
$= 1 - \cos\theta$

- 기하학적 표현





🟥 맨하탄 거리 (1-놈)

🟩 유클리디안 거리 (2-놈)

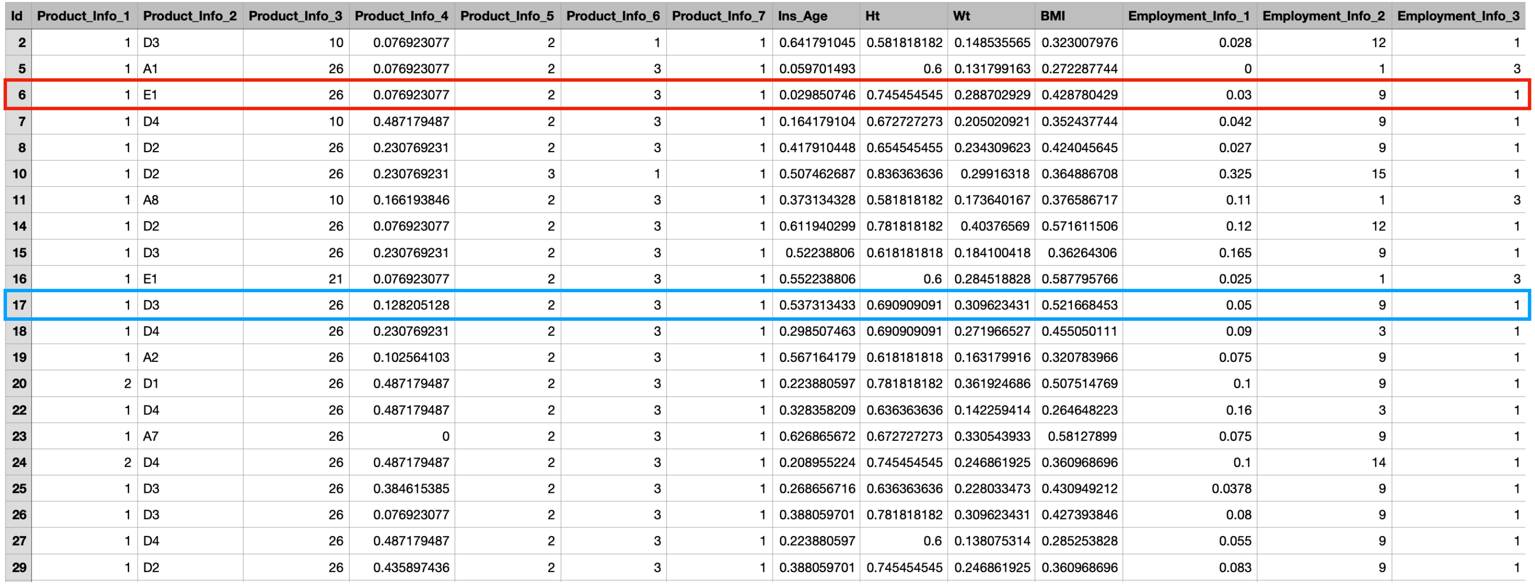
√ 코사인 유사도
(cosine similarity)

$\cos\theta = \frac{x \cdot y}{|x| \cdot |y|}$

데이터 분석 예시

Q5. 6, 17번 고객 데이터 사이의 L1 distance를 구하여라. (단, 두번째 column 제외)

$$d_1(v_6, v_{17}) = |1-1| + |26-26| + \cdots + |0.03-0.05| + |9-9| + |1-1|$$



Id	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

√ L1 norm ⟺ 벡터와 원점 사이의 L1 distance

데이터 분석 예시

Q6. 주어진 6, 16번 데이터의 일부를 벡터로 표현할 때, 두 벡터 사이의 L2 distance를 구하여라.

$$d_2(V_6, V_{16}) = \sqrt{(0.03-0.025)^2+(9-1)^2+(1-3)^2} = \sqrt{0.005^2+8^2+2^2} = \sqrt{64+4+\sim} = \sqrt{68+\alpha}$$

8 $\sqrt{64}$

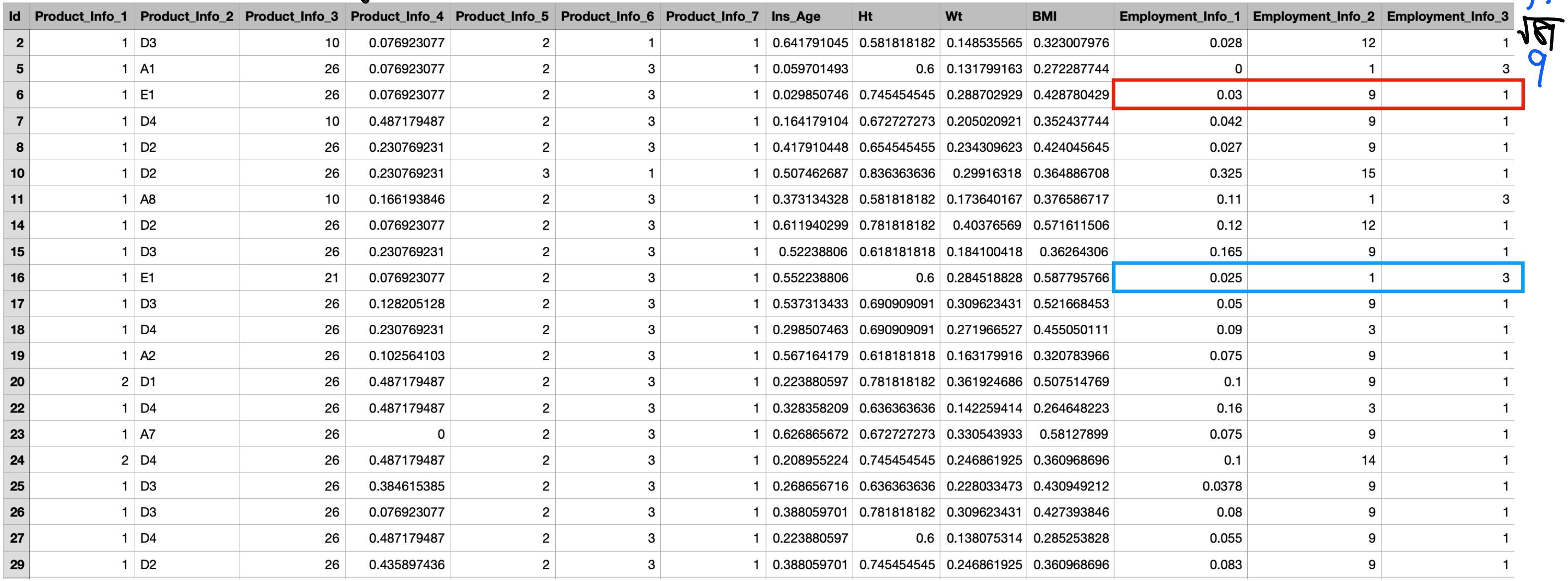
$\wedge$

$\sqrt{68+\alpha}$

$\wedge$

$\sqrt{81}$

9

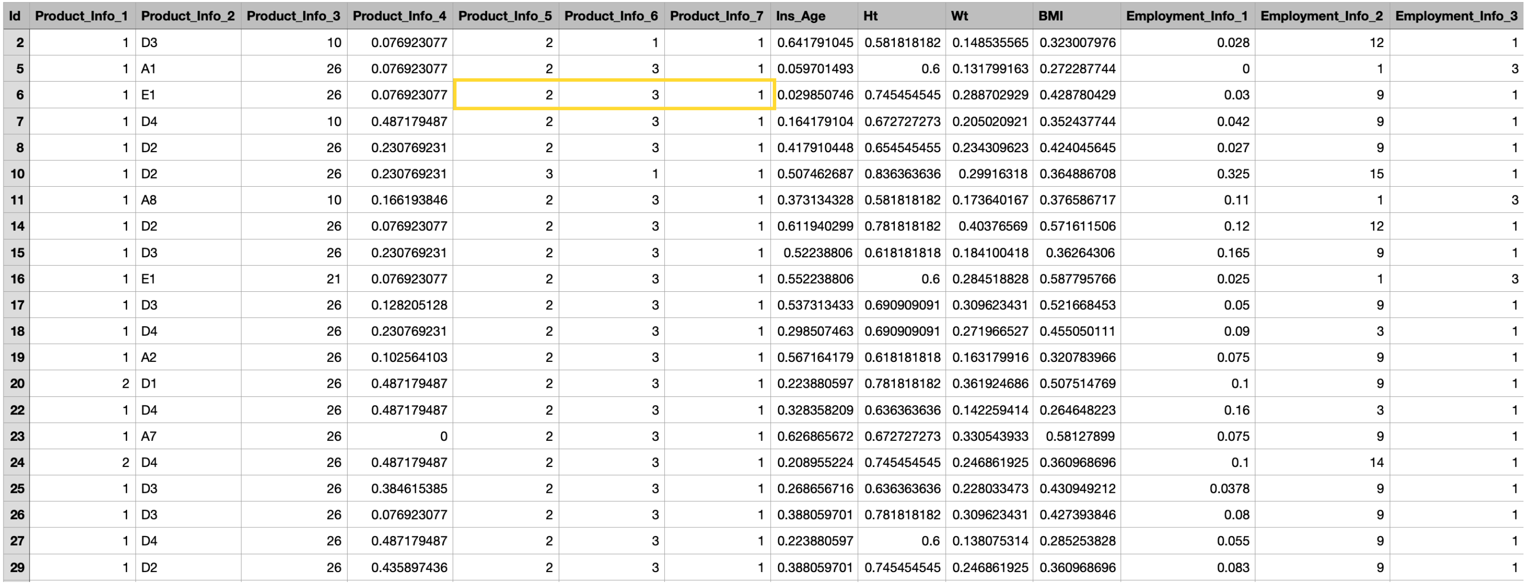


Id	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

데이터 분석 예시

- V_6와 나머지 $= 0$
- V_6와 V_2 $= \sqrt{4} = 2$
- V_6와 V_{10} $= \sqrt{5}$

Q7. 주어진 6번 데이터의 일부를 기준으로, 가장 유사하지 않은 고객은 누구인가? (단, L2 distance를 기준으로 한다.)



Id	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

4. Feature Space

Feature Space의 정의

$\text{raw data} \xrightarrow{\text{feature engineering}} \text{feature vector}$

주어진 데이터의 특징을 정의한 벡터 공간

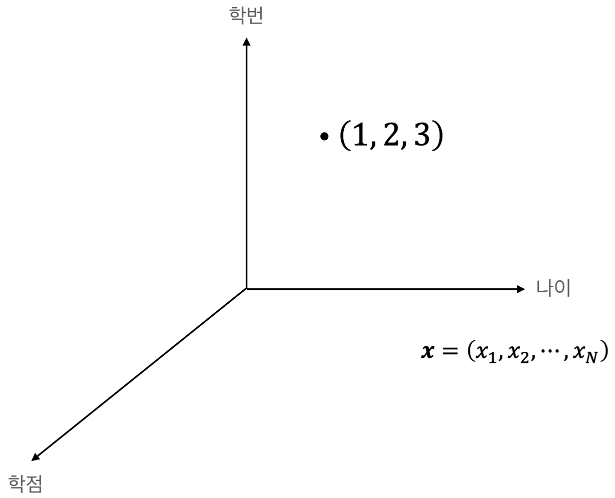
raw data

- 주어진 데이터를 input vector라고 할 때, input vector 중에 필요한 특징만을 추출(또는 선별)하여 벡터로 표현한 것을 "feature vector" 라고 한다.

feature selection

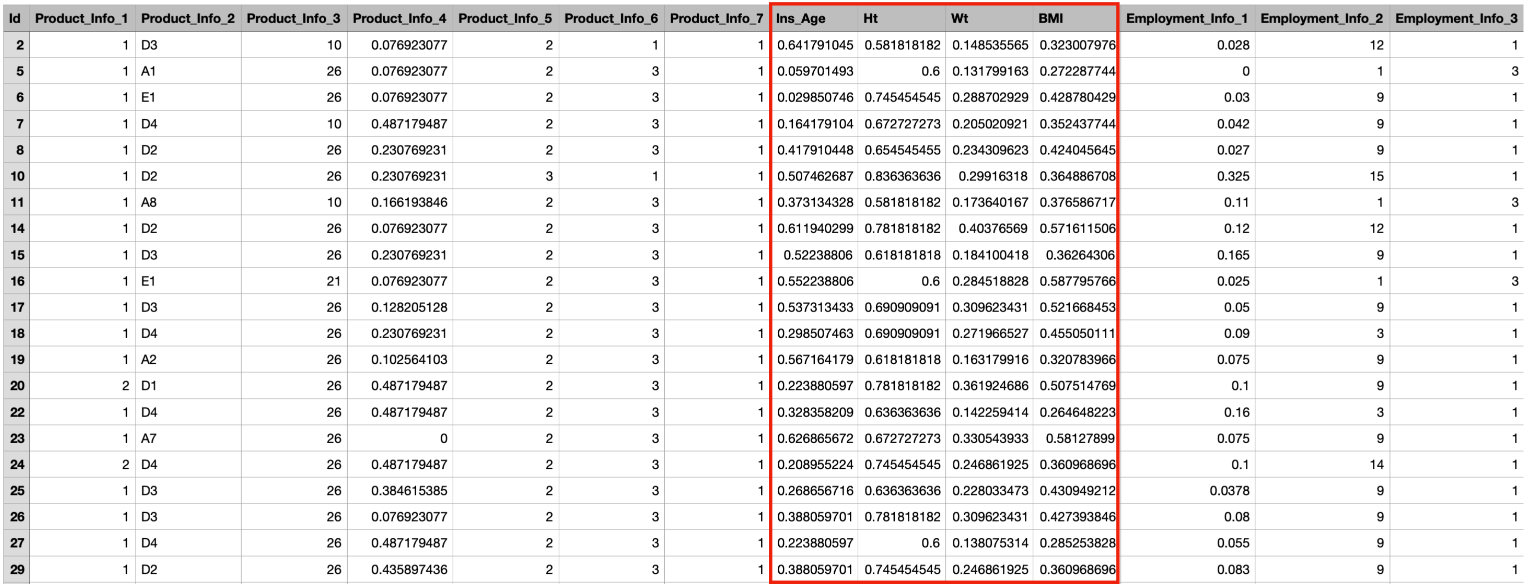
- 필요한 특징을 선별하는 방법은 데이터를 잘 이해하고 있는 분석가가 담당한다.
- 필요한 특징을 추출하는 방법은 차원 축소 모델을 사용한다.

feature extraction



데이터 분석 예시

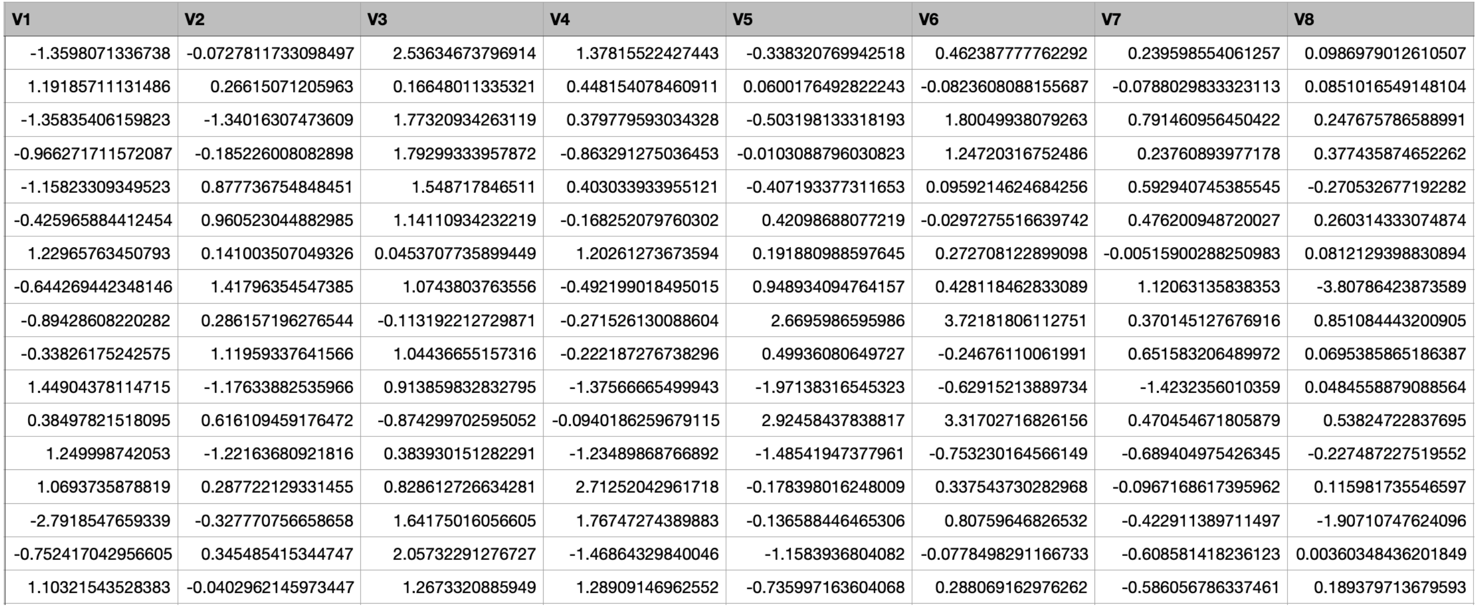
column의 의미를 기준으로 선별하는 경우



Id	Product_Info_1	Product_Info_2	Product_Info_3	Product_Info_4	Product_Info_5	Product_Info_6	Product_Info_7	Ins_Age	Ht	Wt	BMI	Employment_Info_1	Employment_Info_2	Employment_Info_3
2	1	D3	10	0.076923077	2	1	1	0.641791045	0.581818182	0.148535565	0.323007976	0.028	12	1
5	1	A1	26	0.076923077	2	3	1	0.059701493	0.6	0.131799163	0.272287744	0	1	3
6	1	E1	26	0.076923077	2	3	1	0.029850746	0.745454545	0.288702929	0.428780429	0.03	9	1
7	1	D4	10	0.487179487	2	3	1	0.164179104	0.672727273	0.205020921	0.352437744	0.042	9	1
8	1	D2	26	0.230769231	2	3	1	0.417910448	0.654545455	0.234309623	0.424045645	0.027	9	1
10	1	D2	26	0.230769231	3	1	1	0.507462687	0.836363636	0.29916318	0.364886708	0.325	15	1
11	1	A8	10	0.166193846	2	3	1	0.373134328	0.581818182	0.173640167	0.376586717	0.11	1	3
14	1	D2	26	0.076923077	2	3	1	0.611940299	0.781818182	0.40376569	0.571611506	0.12	12	1
15	1	D3	26	0.230769231	2	3	1	0.52238806	0.618181818	0.184100418	0.36264306	0.165	9	1
16	1	E1	21	0.076923077	2	3	1	0.552238806	0.6	0.284518828	0.587795766	0.025	1	3
17	1	D3	26	0.128205128	2	3	1	0.537313433	0.690909091	0.309623431	0.521668453	0.05	9	1
18	1	D4	26	0.230769231	2	3	1	0.298507463	0.690909091	0.271966527	0.455050111	0.09	3	1
19	1	A2	26	0.102564103	2	3	1	0.567164179	0.618181818	0.163179916	0.320783966	0.075	9	1
20	2	D1	26	0.487179487	2	3	1	0.223880597	0.781818182	0.361924686	0.507514769	0.1	9	1
22	1	D4	26	0.487179487	2	3	1	0.328358209	0.636363636	0.142259414	0.264648223	0.16	3	1
23	1	A7	26	0	2	3	1	0.626865672	0.672727273	0.330543933	0.58127899	0.075	9	1
24	2	D4	26	0.487179487	2	3	1	0.208955224	0.745454545	0.246861925	0.360968696	0.1	14	1
25	1	D3	26	0.384615385	2	3	1	0.268656716	0.636363636	0.228033473	0.430949212	0.0378	9	1
26	1	D3	26	0.076923077	2	3	1	0.388059701	0.781818182	0.309623431	0.427393846	0.08	9	1
27	1	D4	26	0.487179487	2	3	1	0.223880597	0.6	0.138075314	0.285253828	0.055	9	1
29	1	D2	26	0.435897436	2	3	1	0.388059701	0.745454545	0.246861925	0.360968696	0.083	9	1

데이터 분석 예시

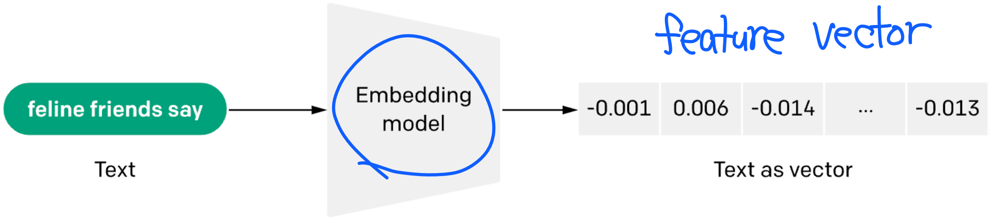
추출 기법을 통하여 새로운 Feature vector를 생성한 경우 (e.g. PCA)



V1	V2	V3	V4	V5	V6	V7	V8
-1.3598071336738	-0.0727811733098497	2.53634673796914	1.37815522427443	-0.338320769942518	0.462387777762292	0.239598554061257	0.0986979012610507
1.19185711131486	0.26615071205963	0.16648011335321	0.448154078460911	0.0600176492822243	-0.0823608088155687	-0.0788029833323113	0.0851016549148104
-1.35835406159823	-1.34016307473609	1.77320934263119	0.379779593034328	-0.503198133318193	1.80049938079263	0.791460956450422	0.247675786588991
-0.966271711572087	-0.185226008082898	1.79299333957872	-0.863291275036453	-0.0103088796030823	1.24720316752486	0.23760893977178	0.377435874652262
-1.15823309349523	0.877736754848451	1.548717846511	0.403033933955121	-0.407193377311653	0.0959214624684256	0.592940745385545	-0.270532677192282
-0.425965884412454	0.960523044882985	1.14110934232219	-0.168252079760302	0.42098688077219	-0.0297275516639742	0.476200948720027	0.260314333074874
1.22965763450793	0.141003507049326	0.0453707735899449	1.20261273673594	0.191880988597645	0.272708122899098	-0.00515900288250983	0.0812129398830894
-0.644269442348146	1.41796354547385	1.0743803763556	-0.492199018495015	0.948934094764157	0.428118462833089	1.12063135838353	-3.80786423873589
-0.89428608220282	0.286157196276544	-0.113192212729871	-0.271526130088604	2.6695986595986	3.72181806112751	0.370145127676916	0.851084443200905
-0.33826175242575	1.11959337641566	1.04436655157316	-0.222187276738296	0.49936080649727	-0.24676110061991	0.651583206489972	0.0695385865186387
1.44904378114715	-1.17633882535966	0.913859832832795	-1.37566665499943	-1.97138316545323	-0.62915213889734	-1.4232356010359	0.0484558879088564
0.38497821518095	0.616109459176472	-0.874299702595052	-0.0940186259679115	2.92458437838817	3.31702716826156	0.470454671805879	0.53824722837695
1.249998742053	-1.22163680921816	0.383930151282291	-1.23489868766892	-1.48541947377961	-0.753230164566149	-0.689404975426345	-0.227487227519552
1.0693735878819	0.287722129331455	0.828612726634281	2.71252042961718	-0.178398016248009	0.337543730282968	-0.0967168617395962	0.115981735546597
-2.7918547659339	-0.327770756658658	1.64175016056605	1.76747274389883	-0.136588446465306	0.80759646826532	-0.422911389711497	-1.9071074762409‌6
-0.752417042956605	0.345485415344747	2.05732291276727	-1.46864329840046	-1.1583936804082	-0.0778498291166733	-0.608581418236123	0.00360348436201849
1.10321543528383	-0.0402962145973447	1.2673320885949	1.28909146962552	-0.735997163604068	0.288069162976262	-0.586056786337461	0.189379713679593

데이터 분석 예시

학습을 통하여 새로운 Feature vector를 생성한 경우 (e.g. embedding)



feature vector

Questions?