COMP3055
Machine Learning

Topic 6 – Instance Based Learning

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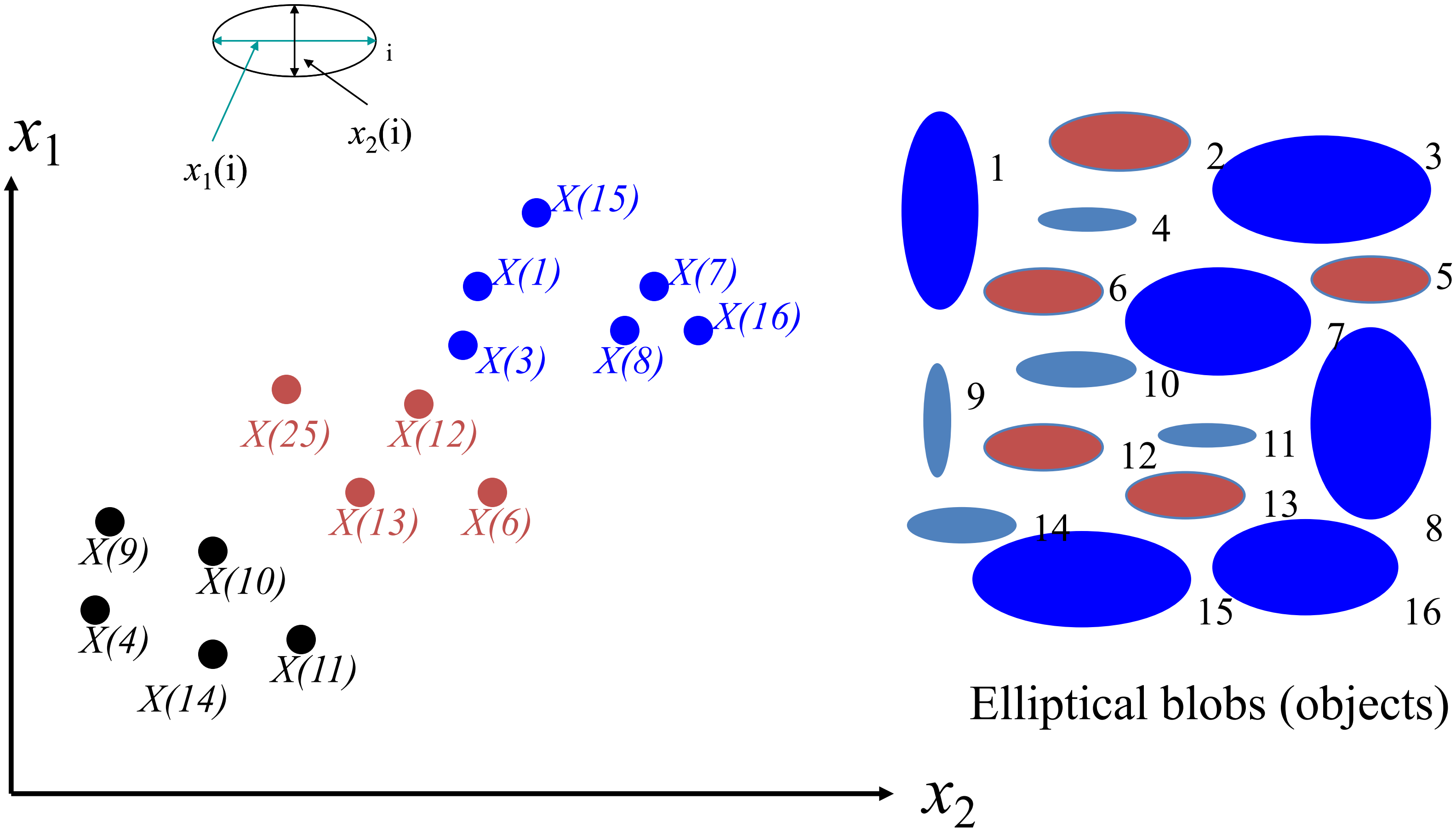
2018 Autumn

Instance Based Learning

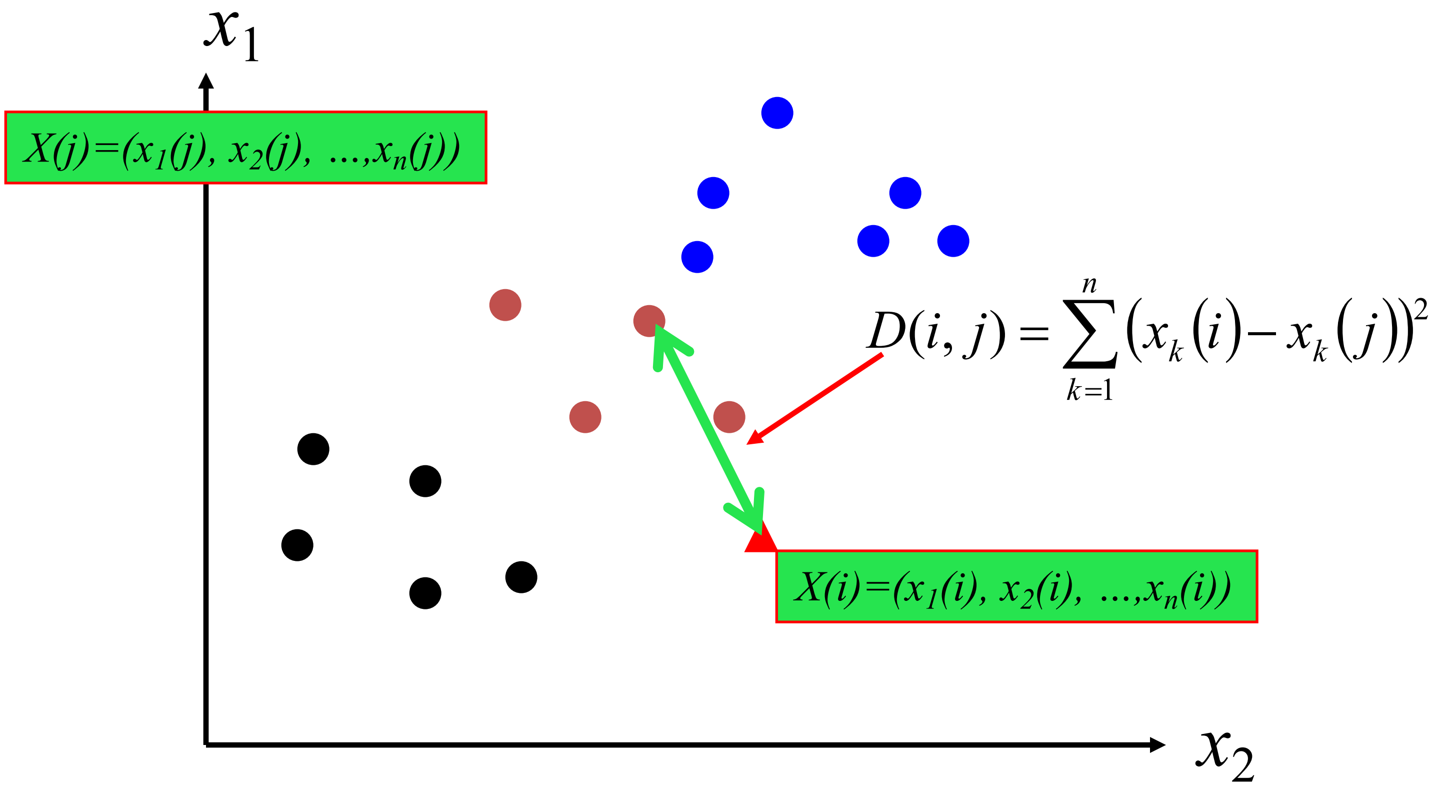
- Directly compare new problem instances with instances seen in training
- No explicit modeling of the training data
- Complexity grows with the training data
- Classical instance based learning technique
  - **K Nearest Neighbor**

Objects, Feature Vectors, Points



Elliptical blobs (objects)

Nearest Neighbours



$X(j)=(x_1(j), x_2(j), \ldots, x_n(j))$

$$D(i, j) = \sum_{k=1}^{n} \left(x_k(i) - x_k(j)\right)^2$$

$X(i)=(x_1(i), x_2(i), \ldots, x_n(i))$

Nearest Neighbour Algorithm

Given training data *(X(1),D(1)), (X(2),D(2)), …, (X(N),D(N)),*

Define a distance metric between points in inputs space. Common measures are:

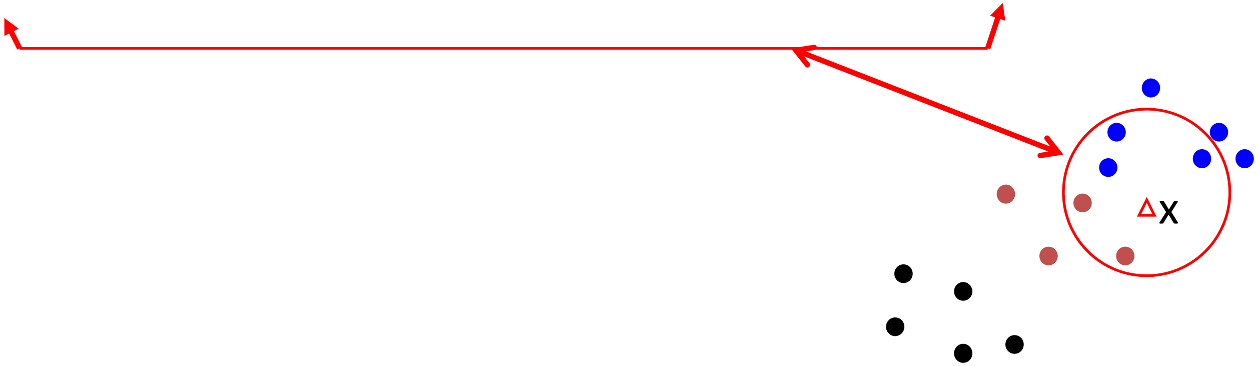
Euclidean Distance $$D(i,j) = \sum_{k=1}^{n} \left(x_k(i) - x_k(j) \right)^2$$

K-Nearest Neighbour Model

Given test point X

- Find the K nearest training inputs to X
- Denote these points as

$$(X(1),D(1)),\ (X(2),\ D(2)),\ \ldots,\ (X(k),\ D(k))$$

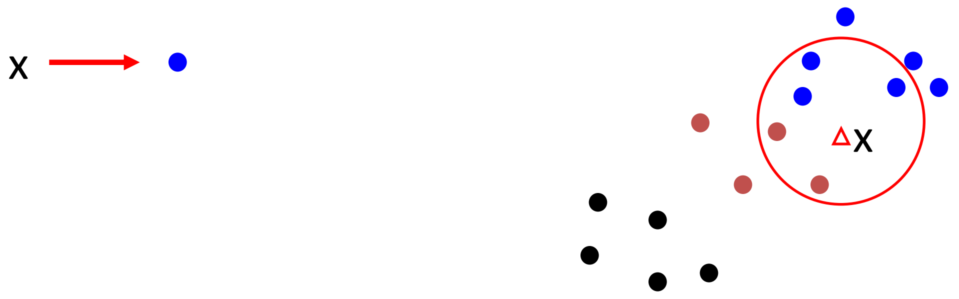


K-Nearest Neighbour Model

Instance based learning

The class identification of X

Y = most common class in set $\{D(1), D(2), \dots, D(k)\}$



K-Nearest Neighbour Model

Example

Classify whether a customer will respond to a survey question using a 3-Nearest Neighbor classifier.

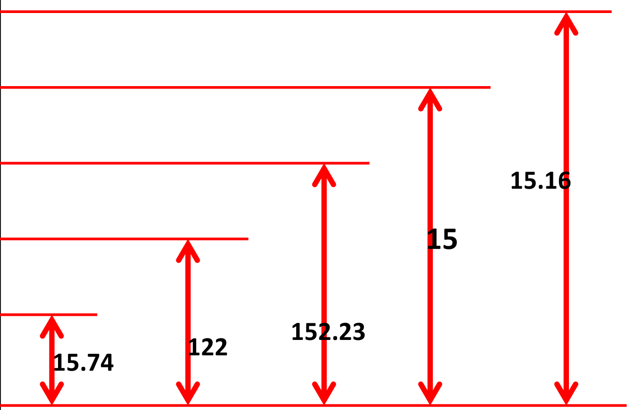
Customer	Age	Income	No. credit cards	Response
John	35	35K	3	No
Rachel	22	50K	2	Yes
Hannah	63	200K	1	No
Tom	59	170K	1	No
Nellie	25	40K	4	Yes
David	37	50K	2	?

K-Nearest Neighbour Model

Example

3-Nearest Neighbors

Customer	Age	Income	No. credit cards	Response
John	35	35K	3	No
Rachel	22	50K	2	Yes
Hannah	63	200K	1	No
Tom	59	170K	1	No
Nellie	25	40K	4	Yes
David	37	50K	2	?

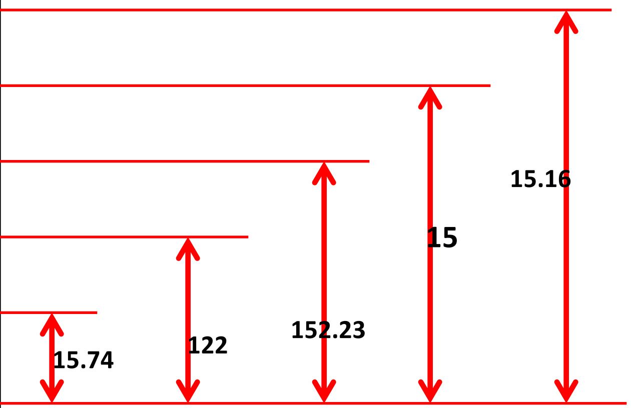


K-Nearest Neighbour Model

Example

3-Nearest Neighbors

Customer	Age	Income	No. credit cards	Response
John	[redacted]	[redacted]	[redacted]	No
Rachel	[redacted]	[redacted]	[redacted]	Yes
Hannah	63	200K	1	No
Tom	59	170K	1	No
Nellie	[redacted]	[redacted]	[redacted]	Yes
David	37	50K	2	?



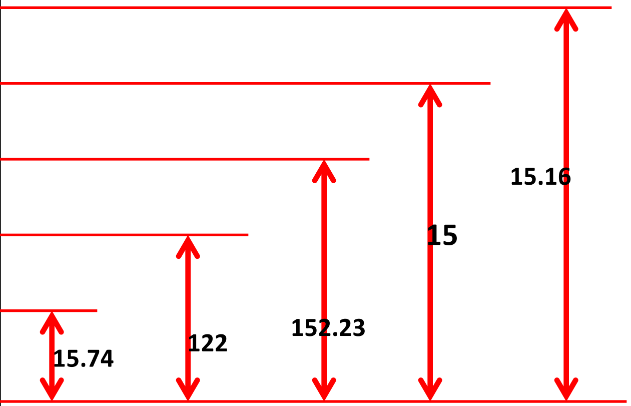
Three nearest ones to David are: No, Yes, Yes

K-Nearest Neighbour Model

Example

3-Nearest Neighbors

Customer	Age	Income	No. credit cards	Response
John	[redacted]	[redacted]	[redacted]	No
Rachel	[redacted]	[redacted]	[redacted]	Yes
Hannah	63	200K	1	No
Tom	59	170K	1	No
Nellie	[redacted]	[redacted]	[redacted]	Yes
David	37	50K	2	Yes



Three nearest ones to David are: No, Yes, Yes

K-Nearest Neighbour Model

Picking K

- Use *N fold cross validation* – Pick K to minimize the cross validation error

- For each of N training example
  - Find its K nearest neighbours
  - Make a classification based on these K neighbours
  - Calculate classification error
  - Output average error over all examples

- Use the K that gives lowest average error over the N training examples

K-Nearest Neighbour Model

Example

For the example we saw earlier, pick the best K from the set {1, 2, 3} to build a K-NN classifier.

Customer	Age	Income	No. credit cards	Response
John	35	35K	3	No
Rachel	22	50K	2	Yes
Hannah	63	200K	1	No
Tom	59	170K	1	No
Nellie	25	40K	4	Yes
David	37	50K	2	?

Further Readings

Chapter 8, T. M. Mitchell, Machine Learning, McGraw-Hill International Edition, 1997