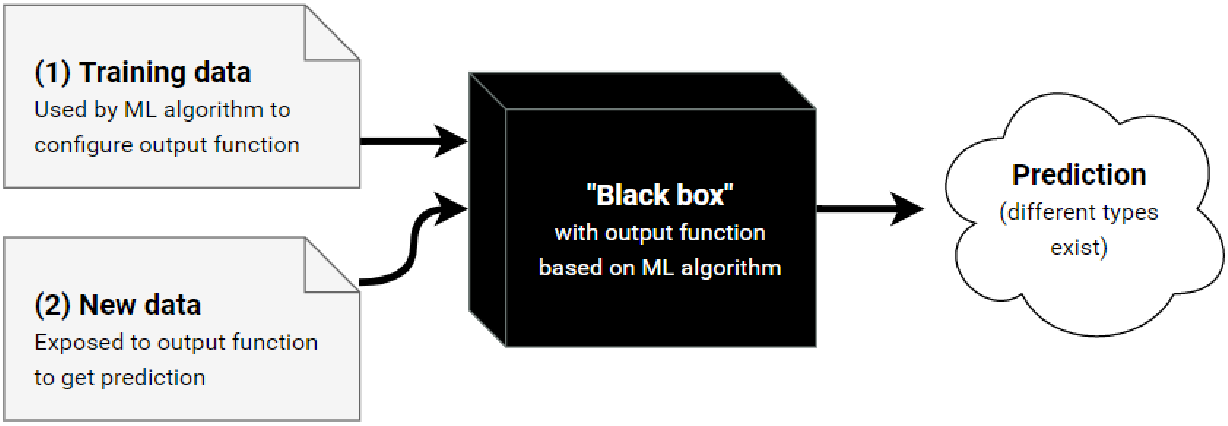
- Lecture 2
  - Linear Regression Models
    - Cat Hearts example:
      - Experience E
      - Learning Task, T
        - Linear Regression Model
      - Performance Measure, P

Lecture 2

Linear Regression Models



Cat Hearts example:

Experience E

- The dataset consists of n data points
  - $((x_1,y_1),...,(x_n,y_n)\in \R^d\times \R)$
  - $x_i \in \R^d$ is the *"input"* for the i^{th} data point as a feature vector with d elements, d being the # of dimensions in the feature space, in this case 1.
  - $y_i \in \R$ is the *"output"* for the i^{th} data point, in this case the weight of the corresponding cat heart.

Learning Task, T

- In this example, our task is: **Linear Regression**
- Find a *"model"*, i.e. a function:
  - $f : \R^d \rightarrow \R$
- s.t. our future observations produce output *"close to"* the true output.

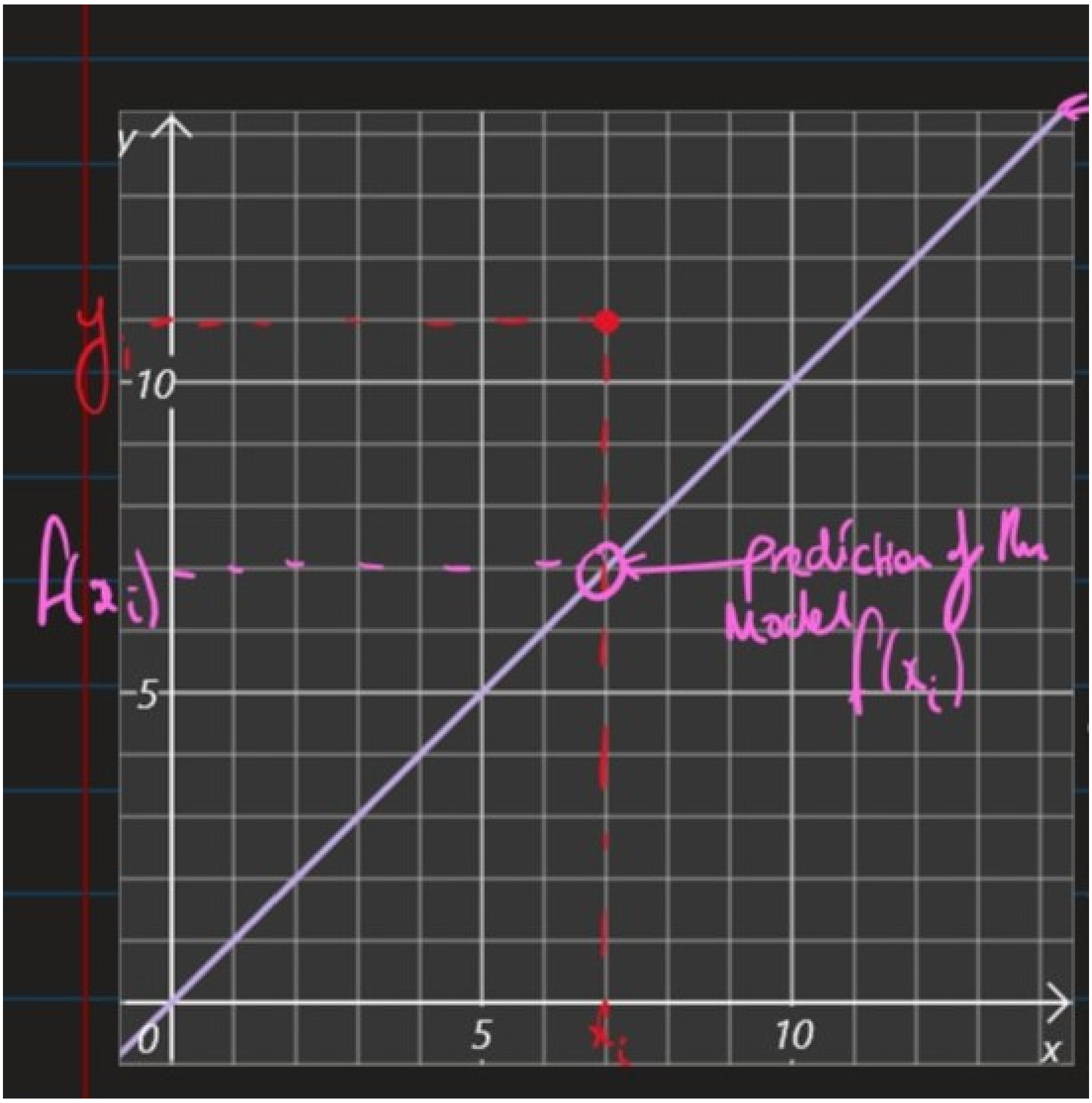
Linear Regression Model

- A linear regression model has the form:
  - $f(x) = (\sum_{i=1}^{d}w_i \cdot x_i)+ b$
  - where:
    - $x \in \R^d$ is the input vector (feature)
    - $w \in \R^d$ is the weight vector (parameters)
    - $b \in \R$ is a bias (parameter)
    - $f(x) \in \R$ is the predicted output

- In our cat example we have:
  - $d=1$ as "body weight" is our only feature
  - $b=0$ as from intuition we expect a cat of 0 weight to have a heart of 0 weight.
  - Our model has one parameter: w

Performance Measure, P

- Want a function, $J(w)$ which quantifies the error in the predictions for a given parameter w



- The following empirical loss function, J takes into account the errors $\forall n$ data points.
  - $J(w) = (1/2N)\sum_{i=1}^N(y_i-wx_i)^2$
  - where the summation term is squared so that:

        - we ignore the sign
        - we penalise large errors more
- To find the optimum weight, solve:
    - $\frac{\delta J}{\delta w}$ = 0