Deep Learning

2.1 Quick visit to ML concepts

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Machine Learning

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2. In our linear regression example: we modeled the x and y as linearly related for fitting a line and predict y from x
3. Broadly these are types of the inferences
   - Regression (e.g. customer satisfaction, stock prediction, etc.)
   - Classification (e.g. object recognition, speech processing, disease detection etc.)
   - Density estimation (e.g. sampling/synthesize, outlier detection, etc.)

Standard formalization

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2. Density estimation: distribution f_X and $x_n, n = 1, \ldots N$

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3. Conditional distribution $f_{X/Y}$ stands for the distribution of observable signal for category y (e.g. image of a dog, weight of a 30 year Indian male)

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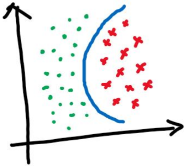
2. First generate X, given its value generate Y

Summary: three types of inferences

1. Classification
   - X, Y random variables on $\mathcal{L} = \mathcal{R}^D \times \{1, \ldots, C\}$
   - Aim is to estimate the $\text{argmax}_y \; P(Y = y/X = x)$



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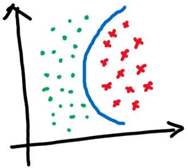

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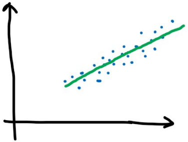

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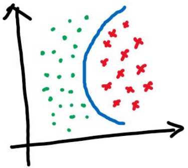

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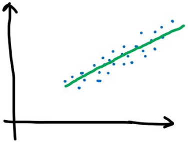
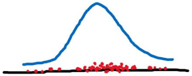


1. Density estimation
   - X is random variable $\mathcal{R}^D$
   - Aim is to estimate the f_X



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2. Density estimation can perform classification using Baye's rule

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6. Loss may have additional terms (from prior knowledge)

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2. $f^* = \underset{f \in \mathcal{F}}{\operatorname{argmin}} R(f)$
3. This is unknown. However, if the training data $\mathcal{D} = \{z_1, \ldots, z_N\}$ is i.i.d. we can estimate the risk empirically (known as empirical risk),

   $\hat{R}(f; \mathcal{D}) = \hat{\mathbb{E}}_{\mathcal{D}}(l(f,z)) = \frac{1}{N} \sum_{i=1}^{N} l(f, z_n)$