University of Amsterdam
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AMLAB
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Machine Learning Lab

Machine Learning 1

Lecture 7.1 - Supervised Learning Classification - Classification With Basis Functions

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(Bishop 4.3.1)

Slide credits: Patrick Forré and Rianne van den Berg

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Example: Use of Basis Functions

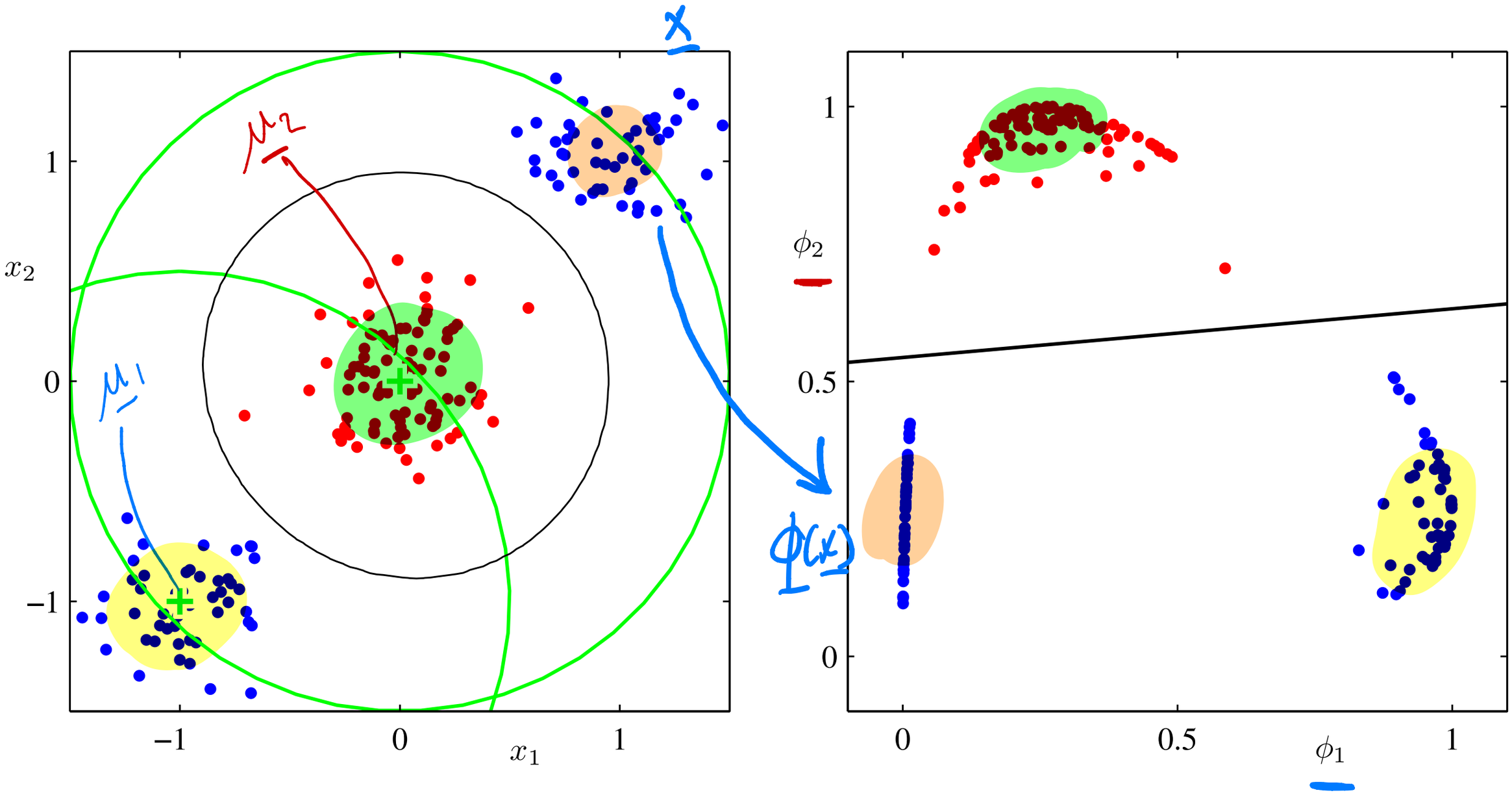

Figure: Left: original input space (x_1, x_2) , right: space of two gaussian basis functions with centres shown by the green crosses. (Bishop 4.12)

$$\phi_1(\underline{x}) = \exp\left(-\tfrac{1}{2}(\underline{x}-\underline{\mu}_1)^T(\underline{x}-\underline{\mu}_2)\right)$$

$$\phi_2(\underline{x}) = \exp\left(-\tfrac{1}{2}(\underline{x}-\underline{\mu}_2)^T(\underline{x}-\underline{\mu}_2)\right)$$

Limitations of Fixed Basis Functions

Advantages:

- Closed form solution for least-squares problem
- Tractable Bayesian treatment
- Nonlinear models mapping input variables to target variables through basis functions

Limitations:

- Assumption: Basis functions $\phi_j(\mathbf{x})$ are fixed, not learned.
- Curse of dimensionality: to cover growing dimensions D of input vectors, the number of basis functions needs to grow rapidly / exponentially