

Week 3: Non-Parametric Models

Matthew Caldwell

COMP0088 Introduction to Machine Learning • UCL Computer Science • Autumn 2024

Admin

- Pulse surveys

Week 3 Recap

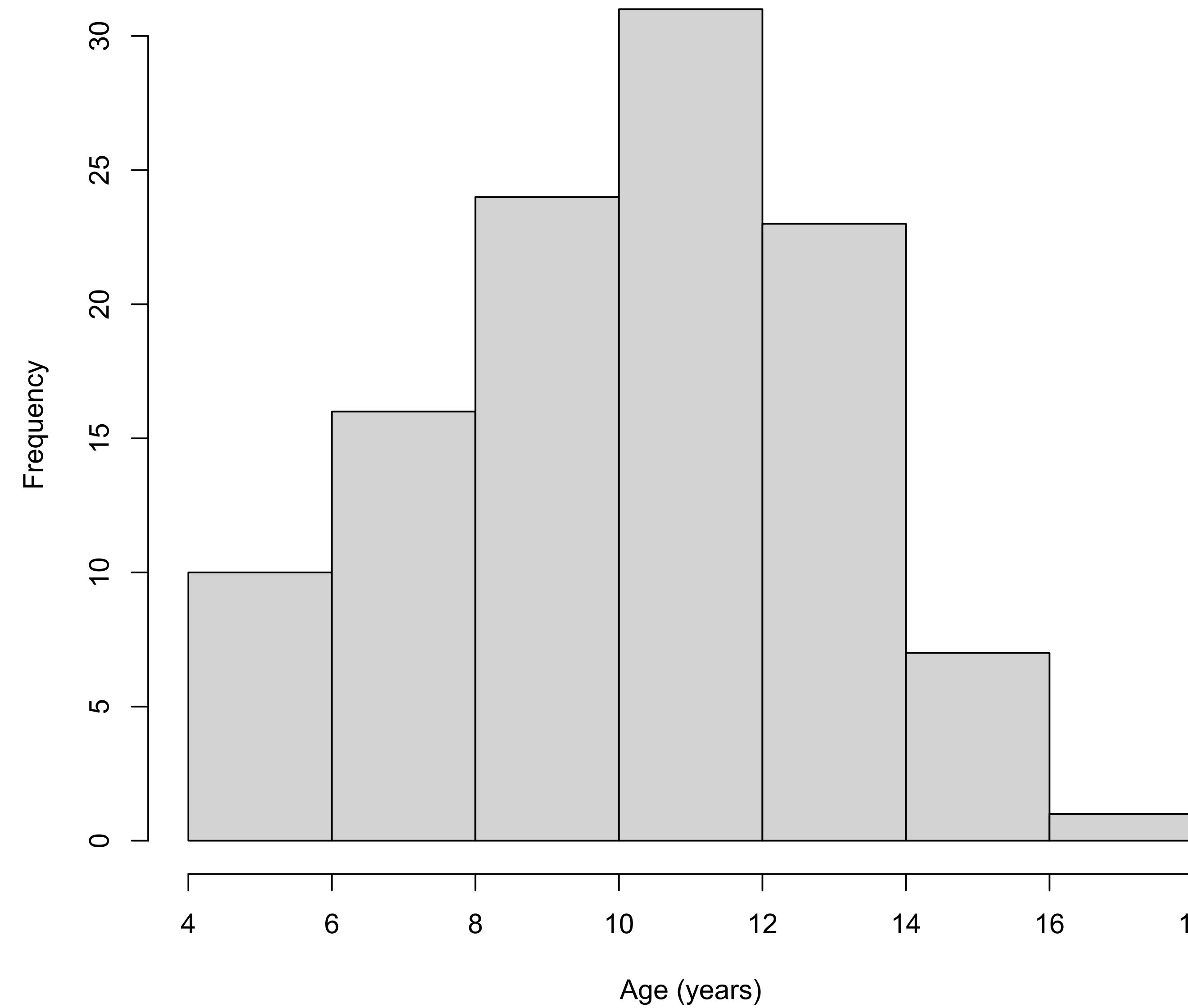
Credit in the Straight World



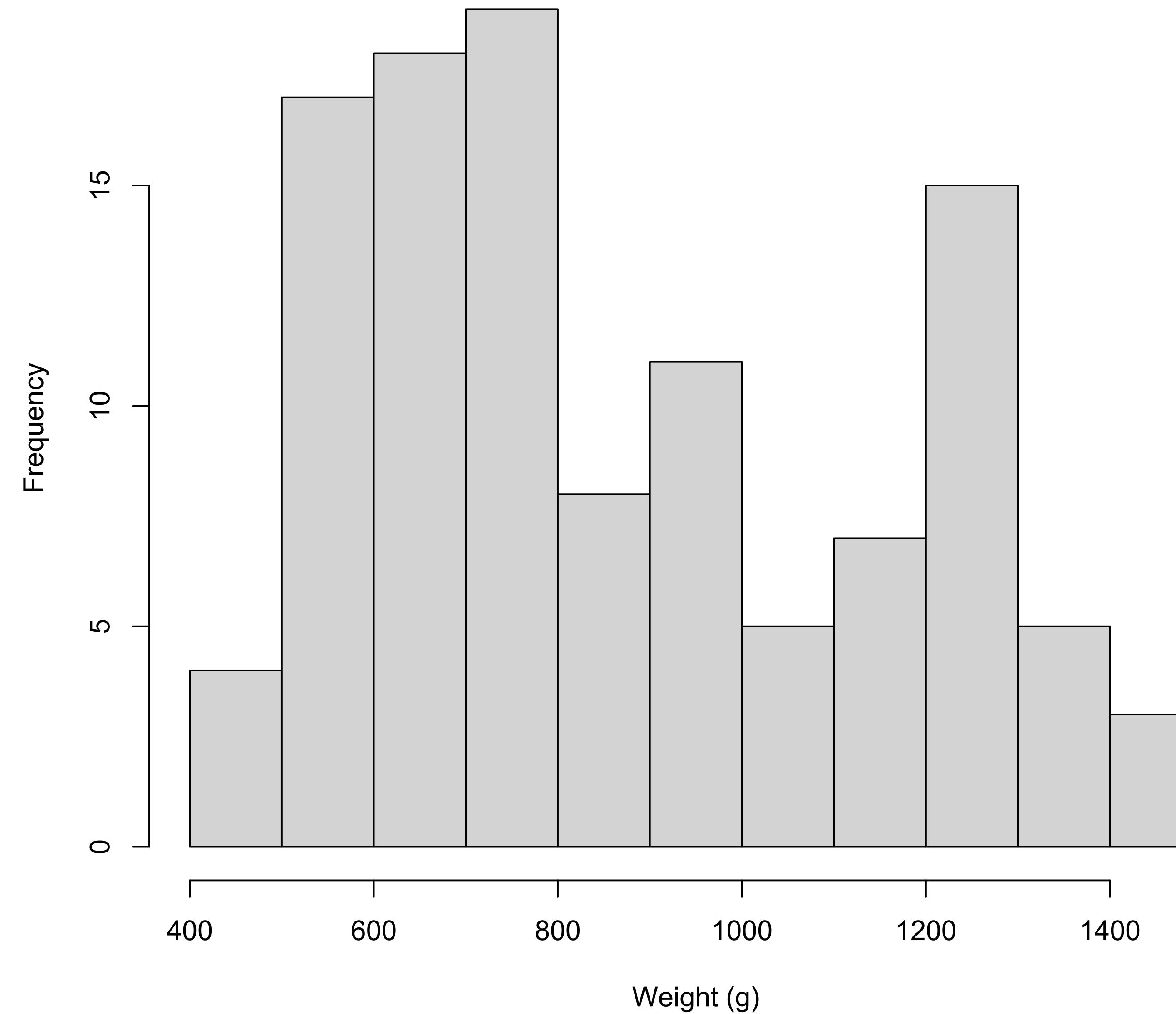
Meerkats

#	Age	Weight	Sex	Captive	...
1	11.8	815	1	0	
2	9.7	672	1	0	
3	8.9	446	1	0	
4	10.8	761	0	0	
5	8.3	1035	0	1	
6	11.7	930	1	1	
7	8.5	1027	0	1	
8	7.6	1234	0	1	
9	15.5	1461	0	1	
10	8.8	720	1	0	
11	12.8	1223	0	1	
12	7.7	711	1	0	
13	7.9	586			

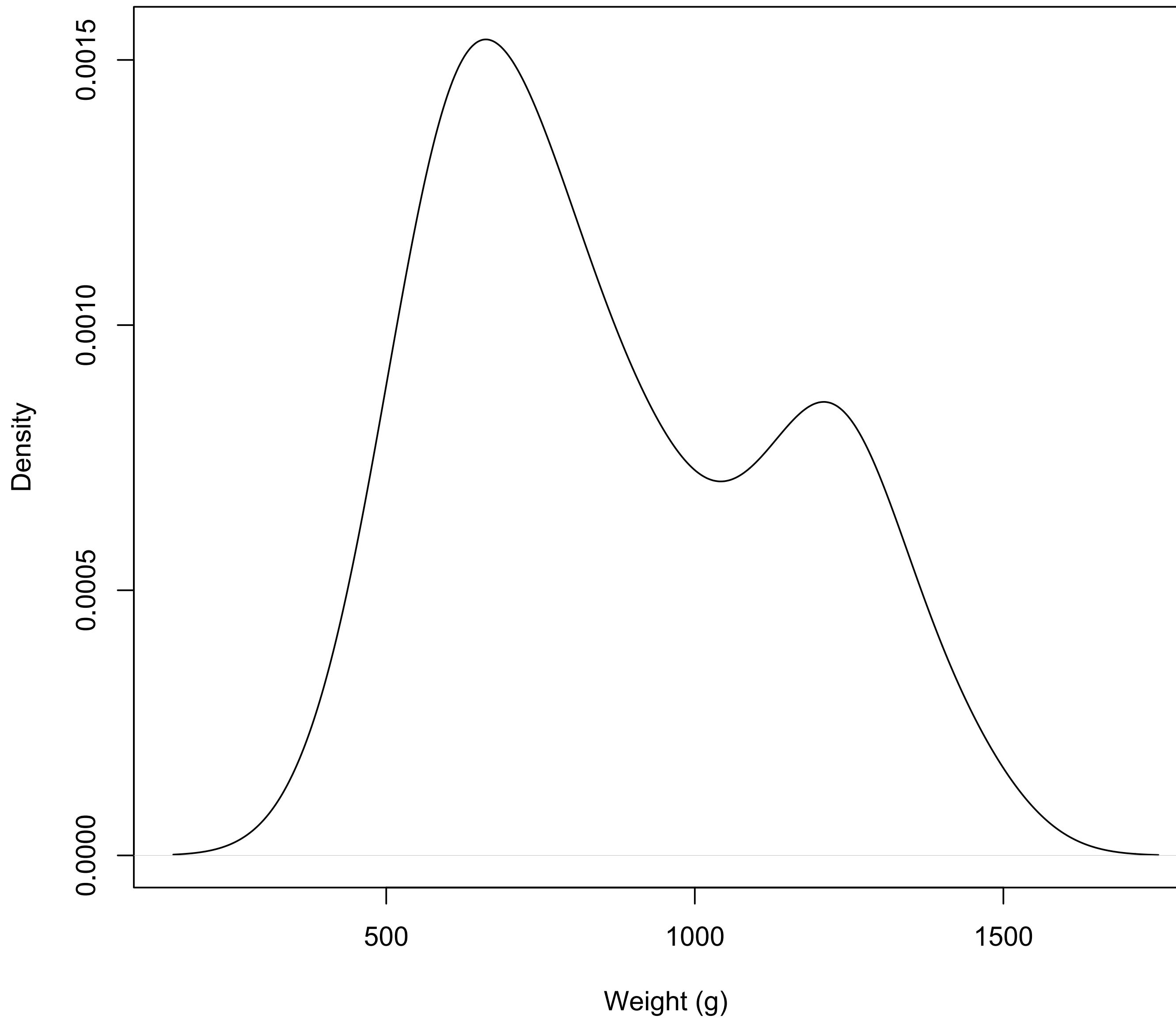
Meerkat Age Distribution



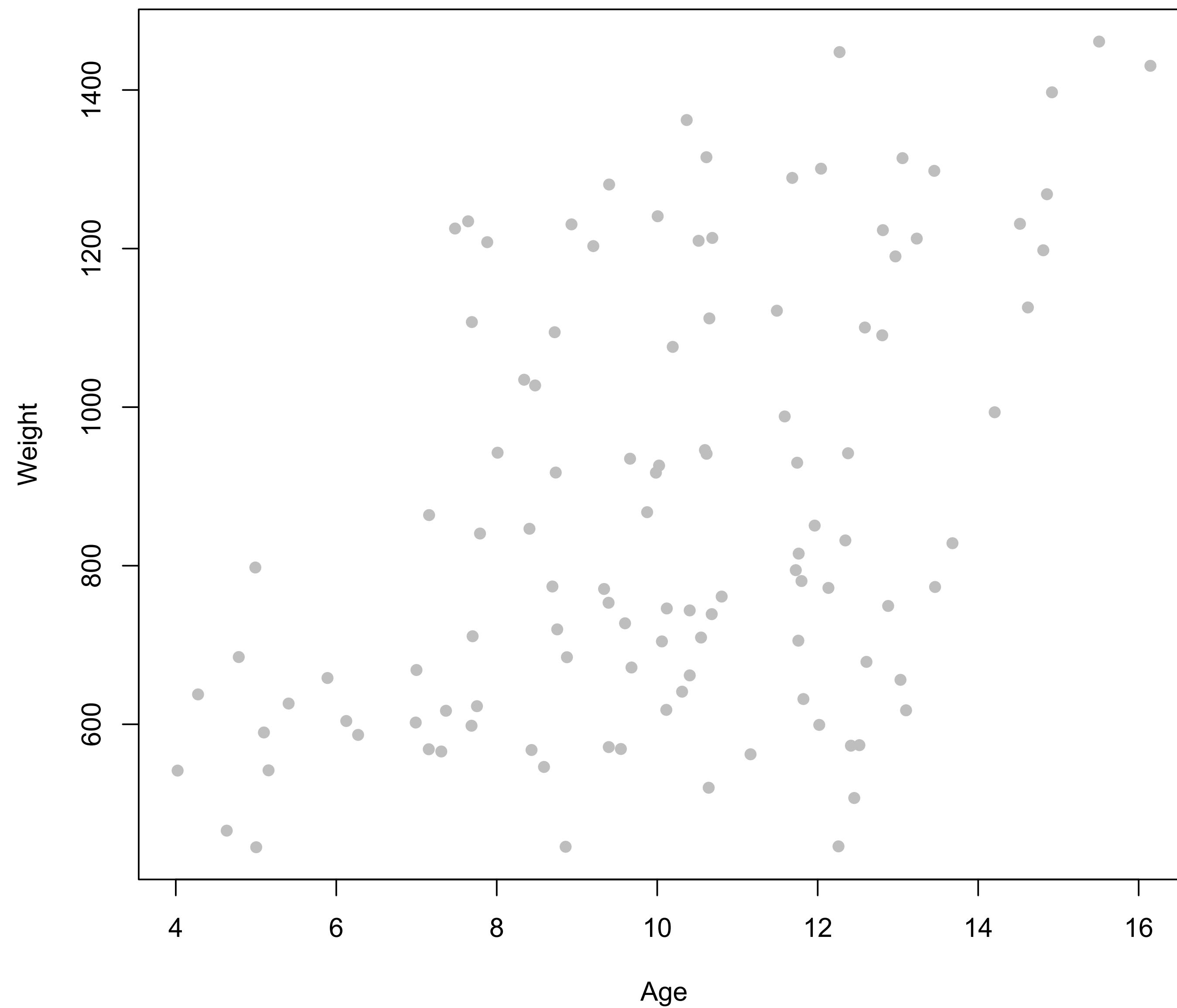
Meerkat Weight Distribution



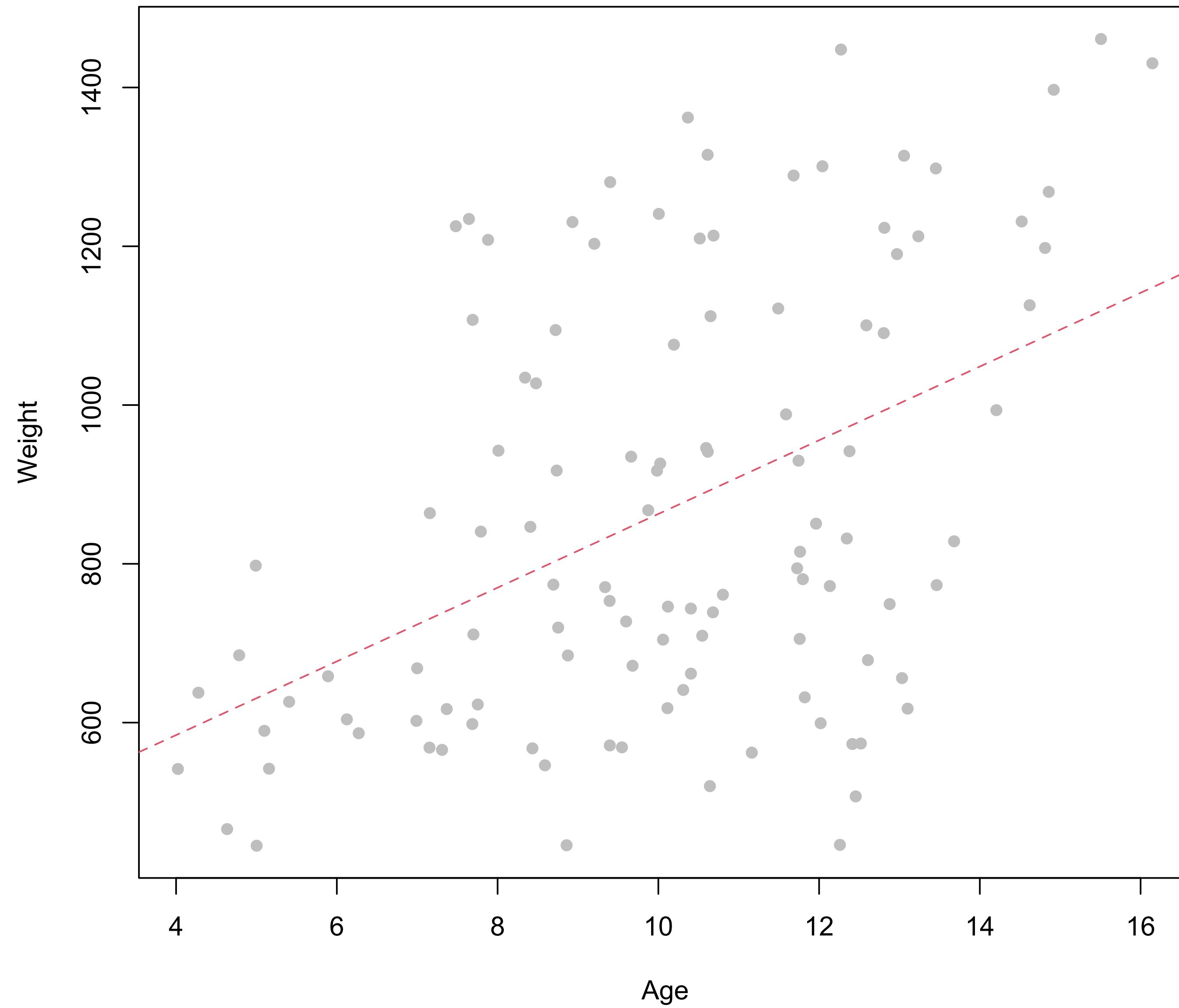
Meerkat Weight Distribution (KDE)



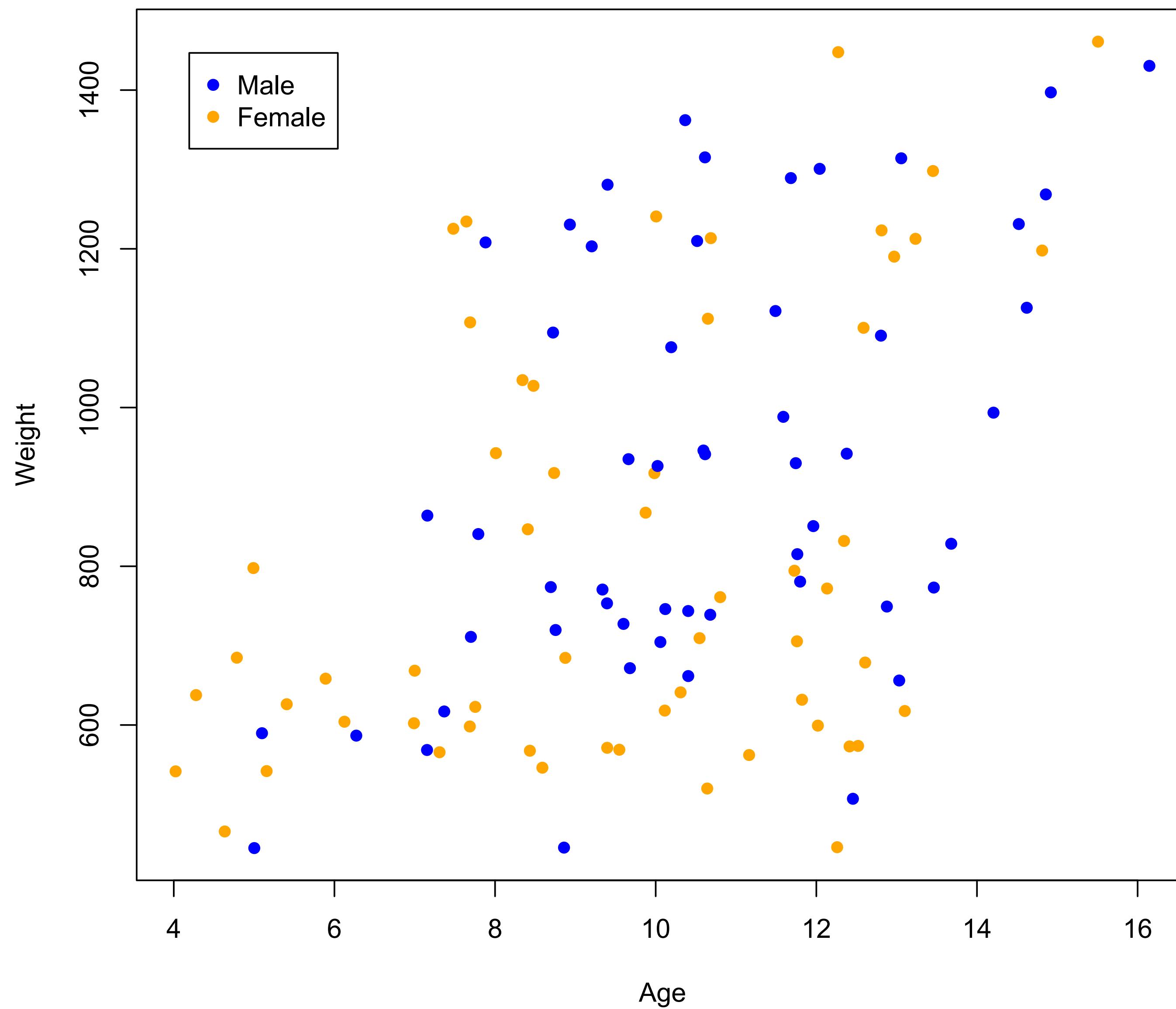
Meerkat Weight vs Age



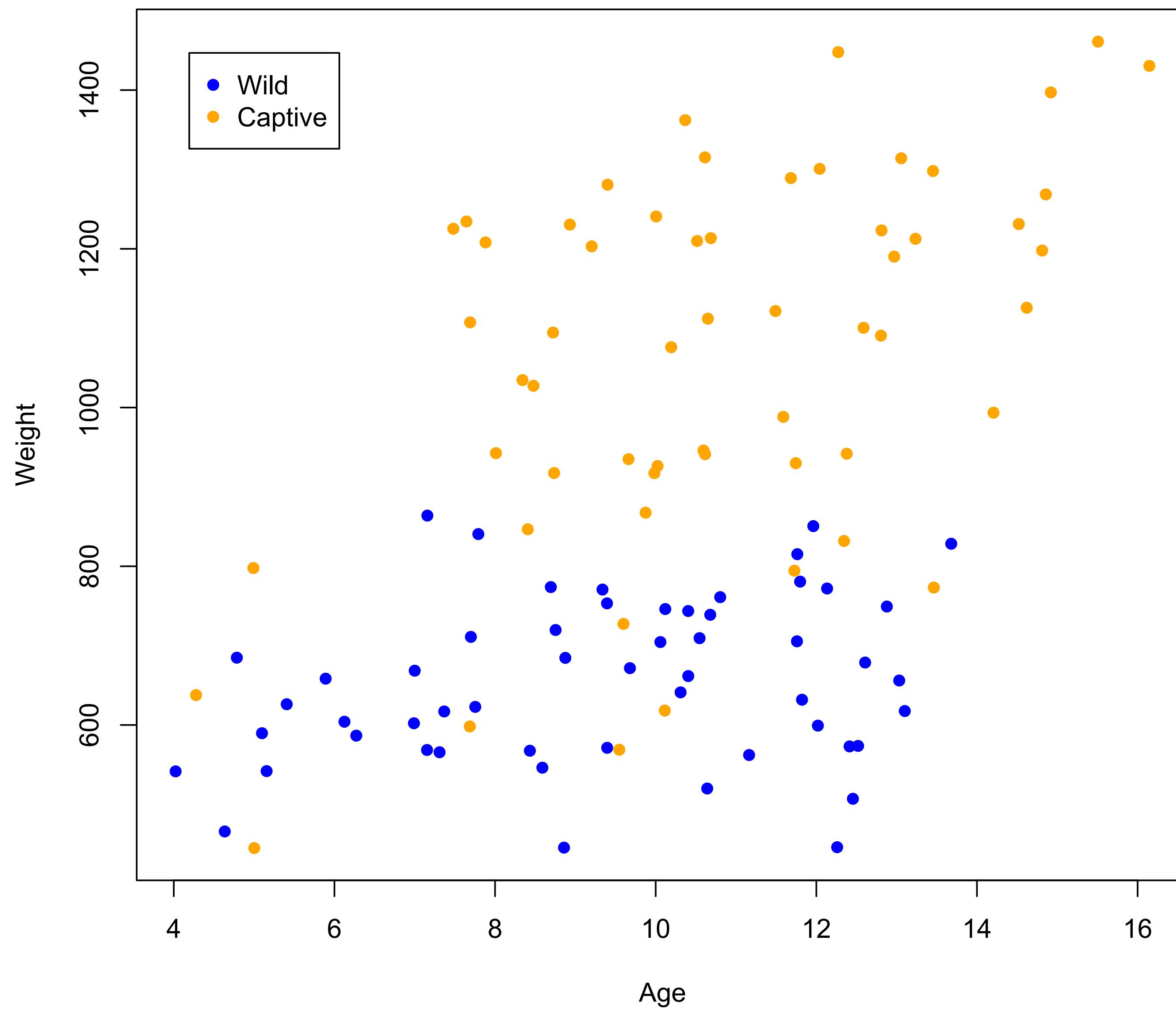
Meerkat Weight vs Age



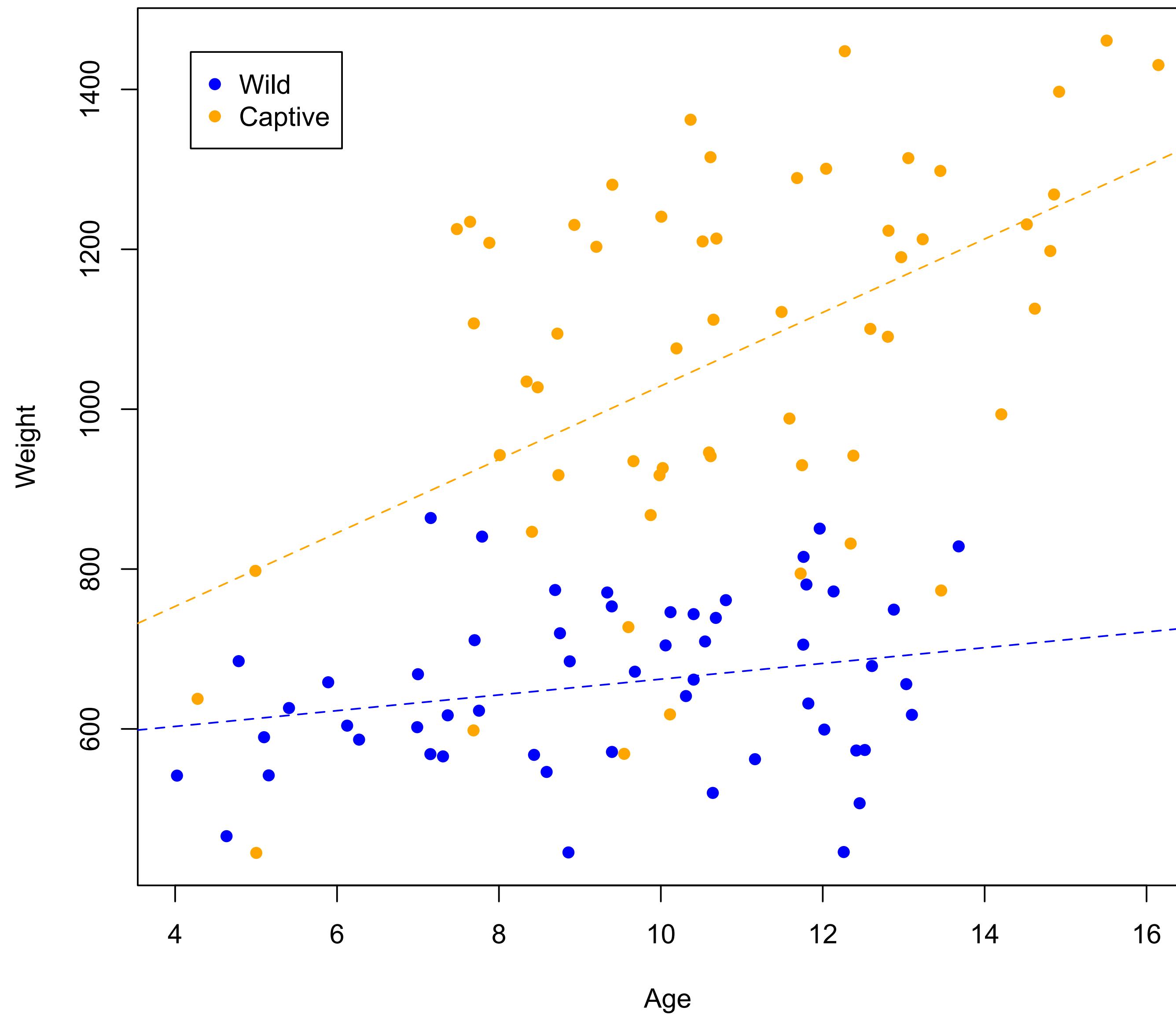
Meerkat Weight vs Age



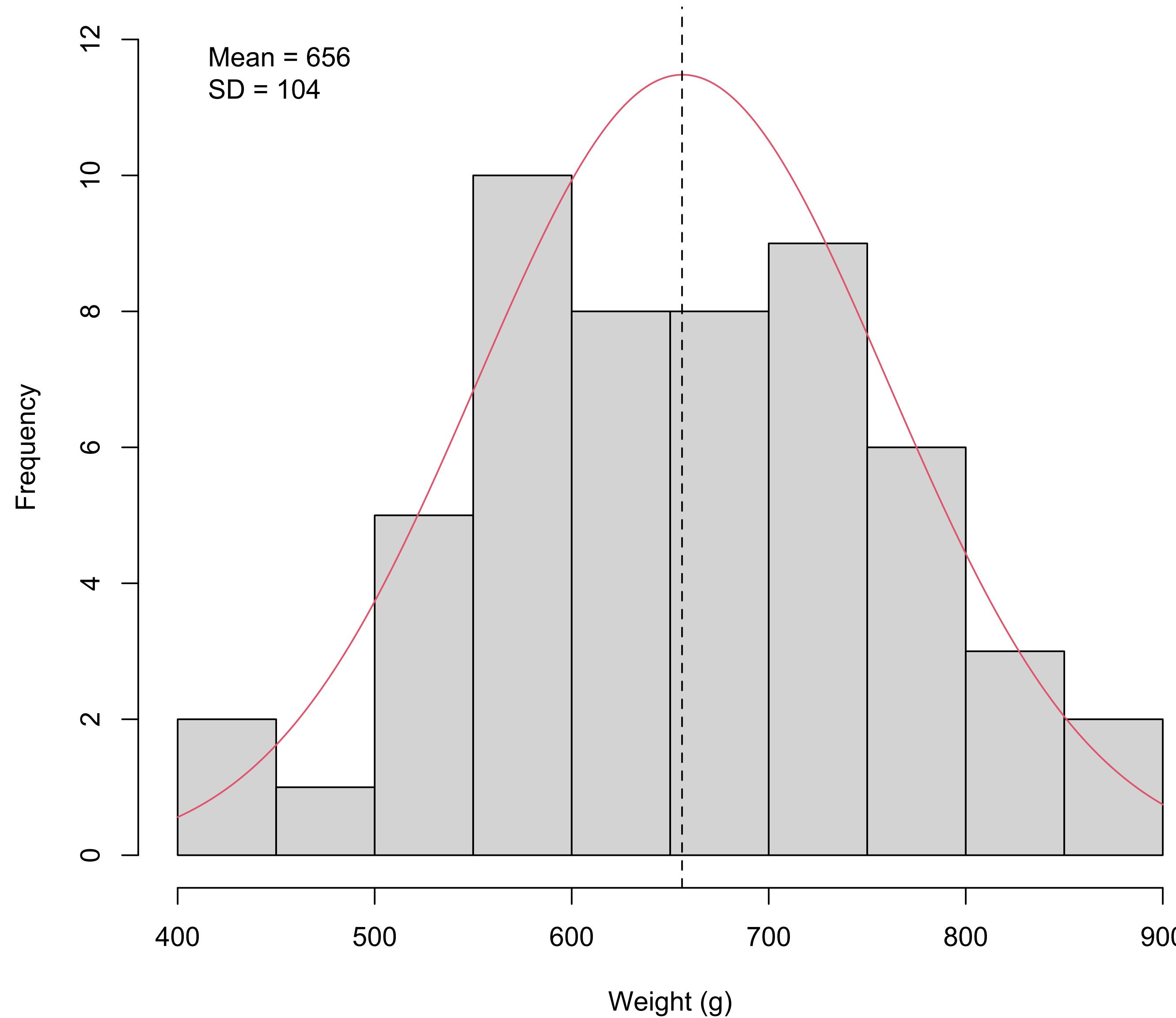
Meerkat Weight vs Age

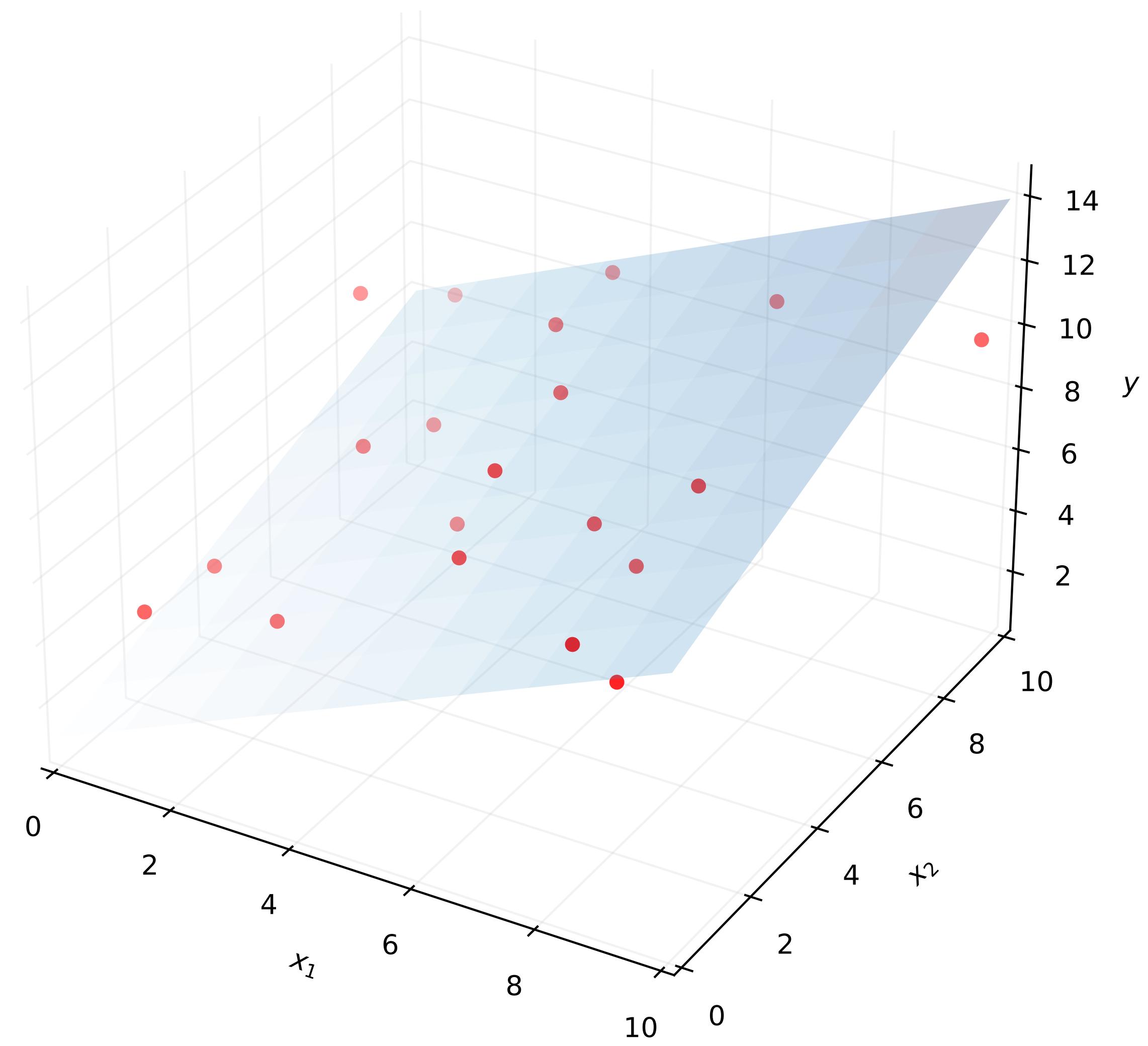
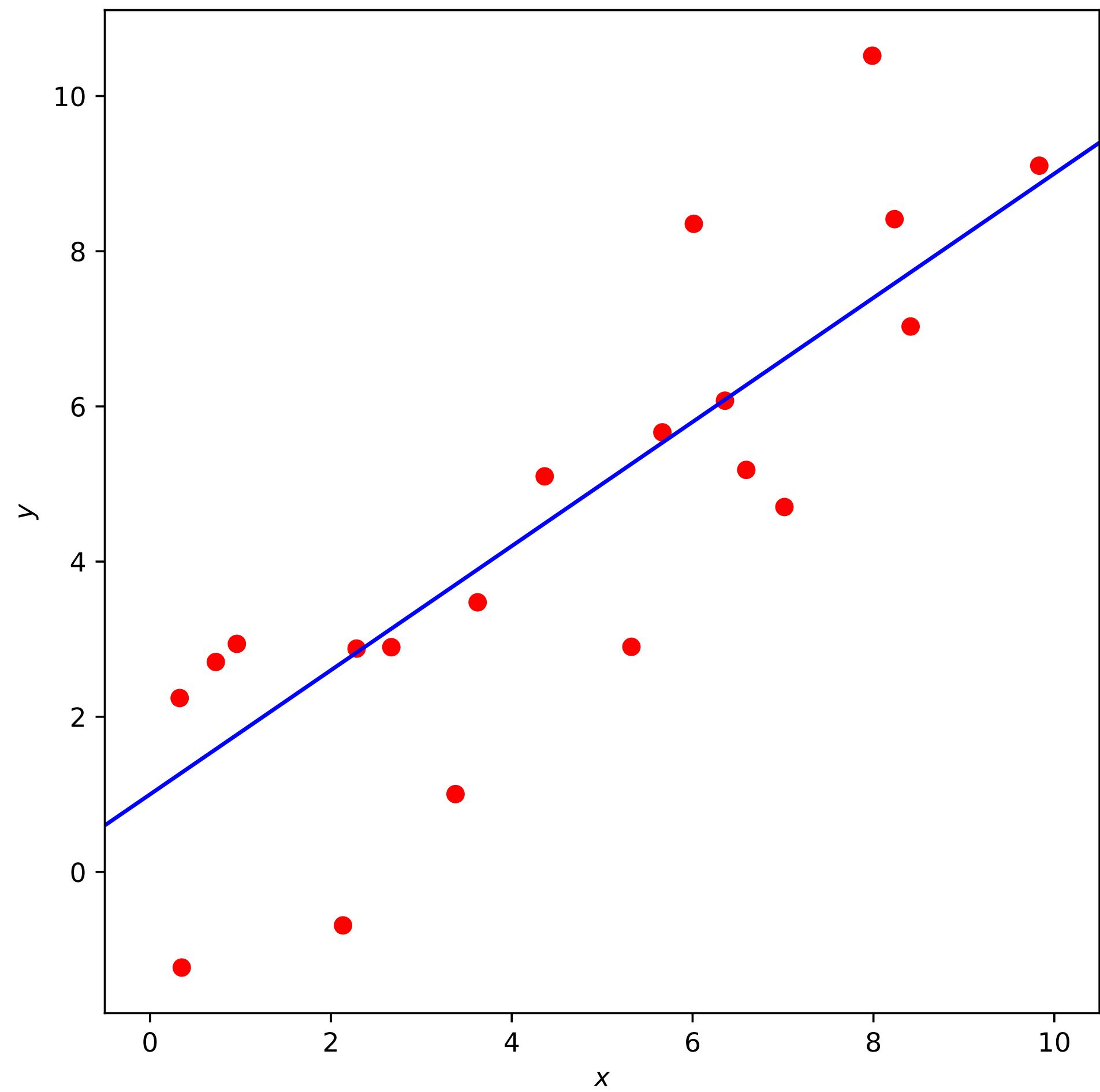


Meerkat Weight vs Age

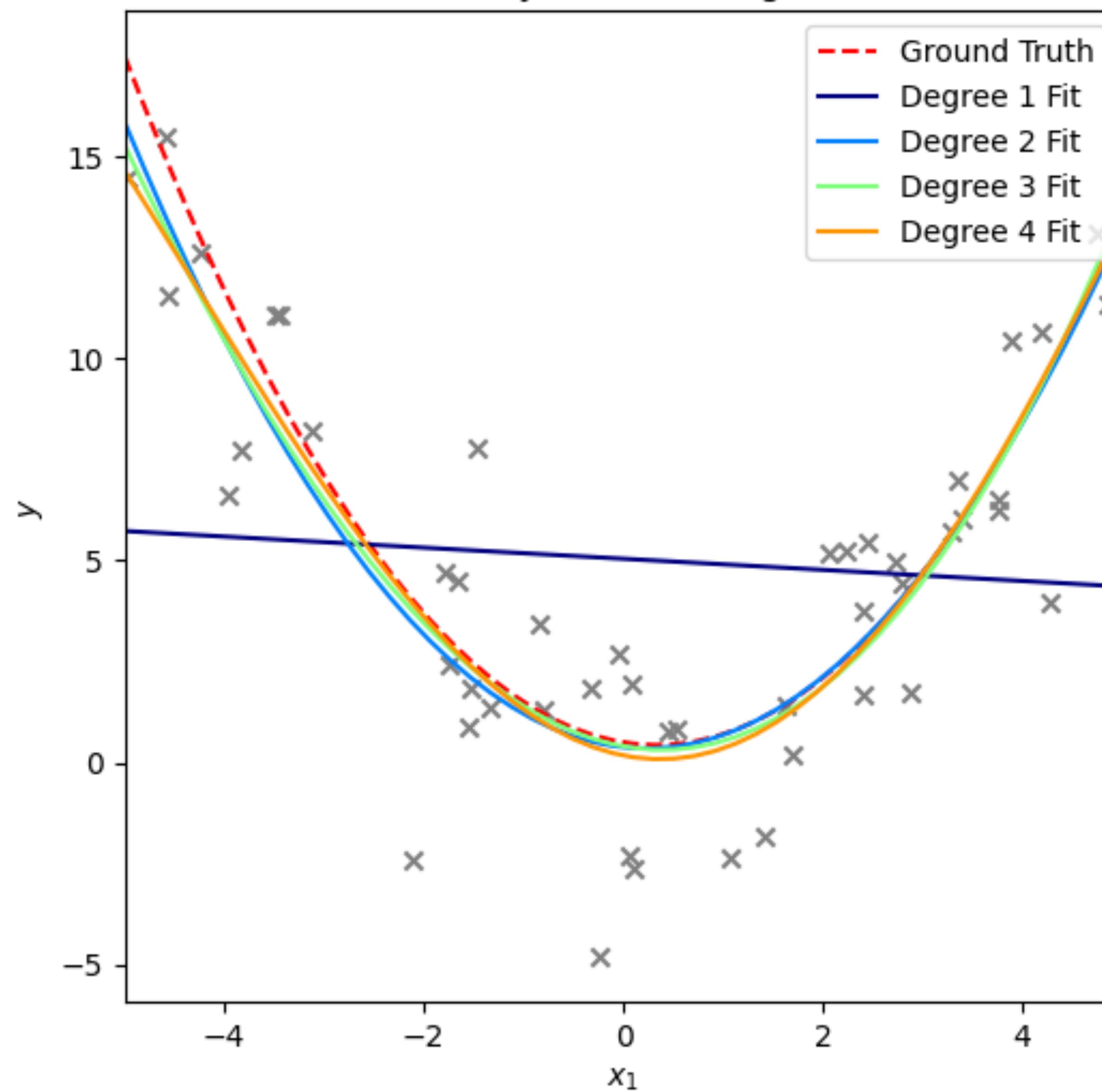


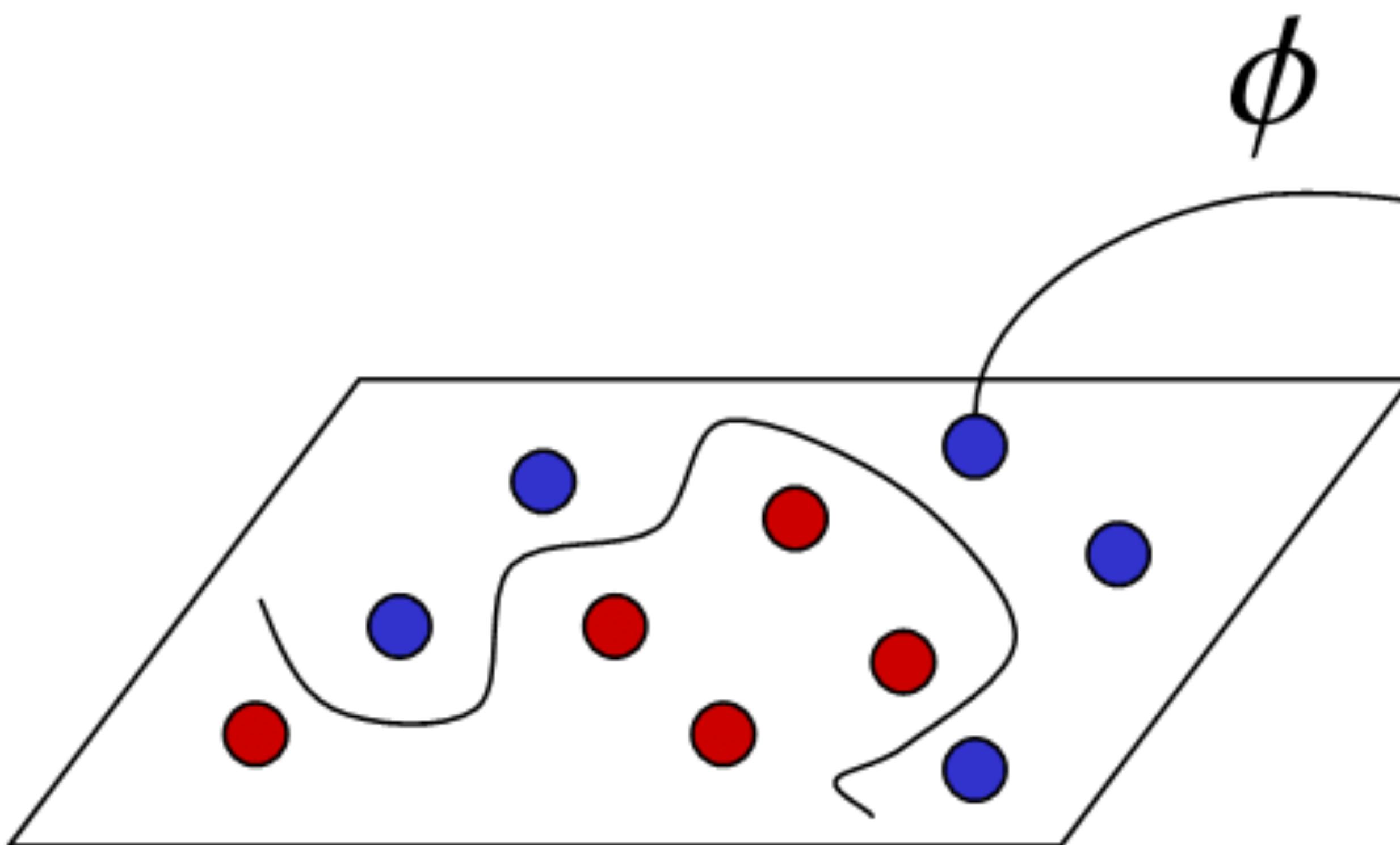
Wild Meerkat Weight Distribution



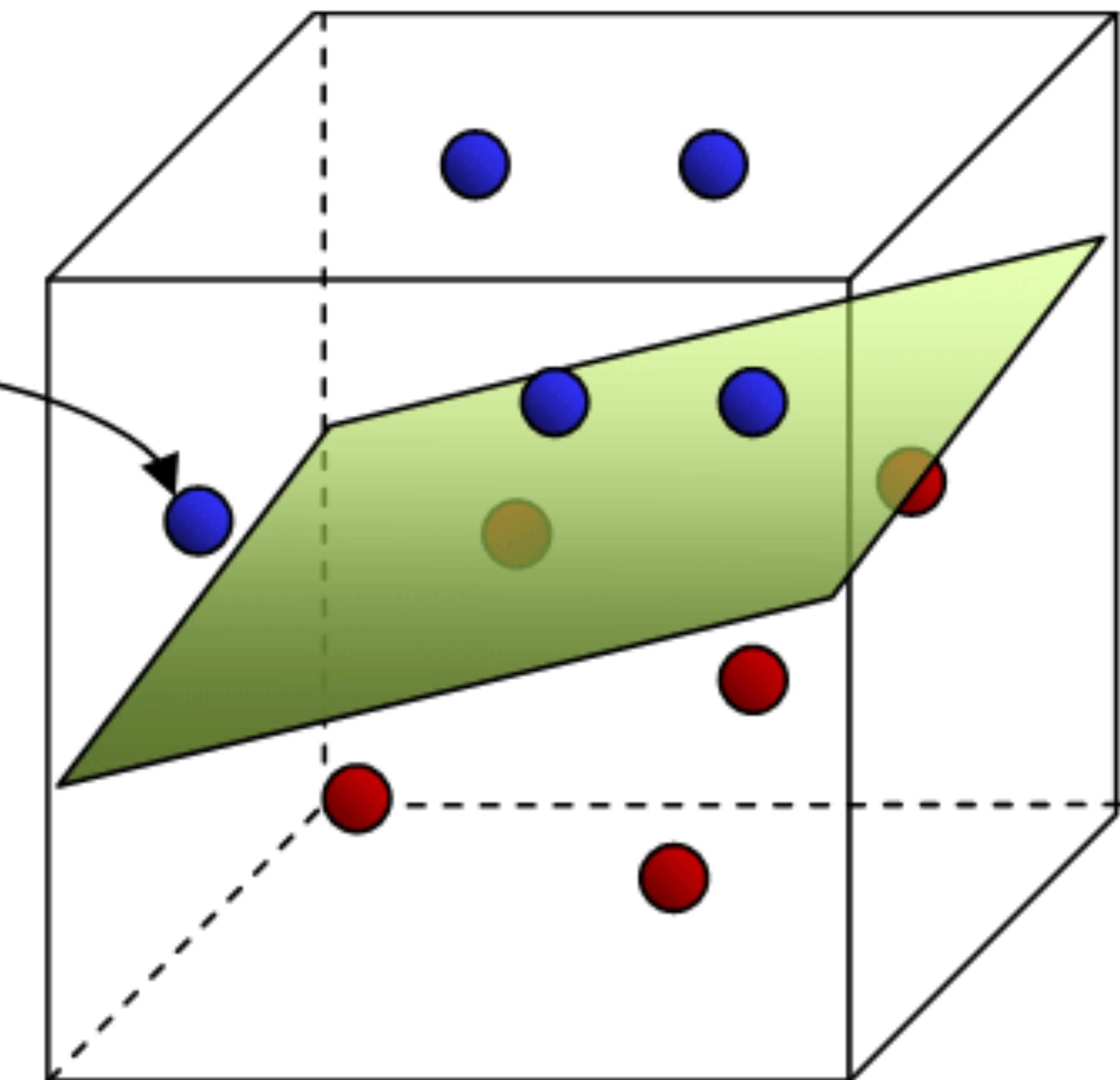


Polynomial Fitting

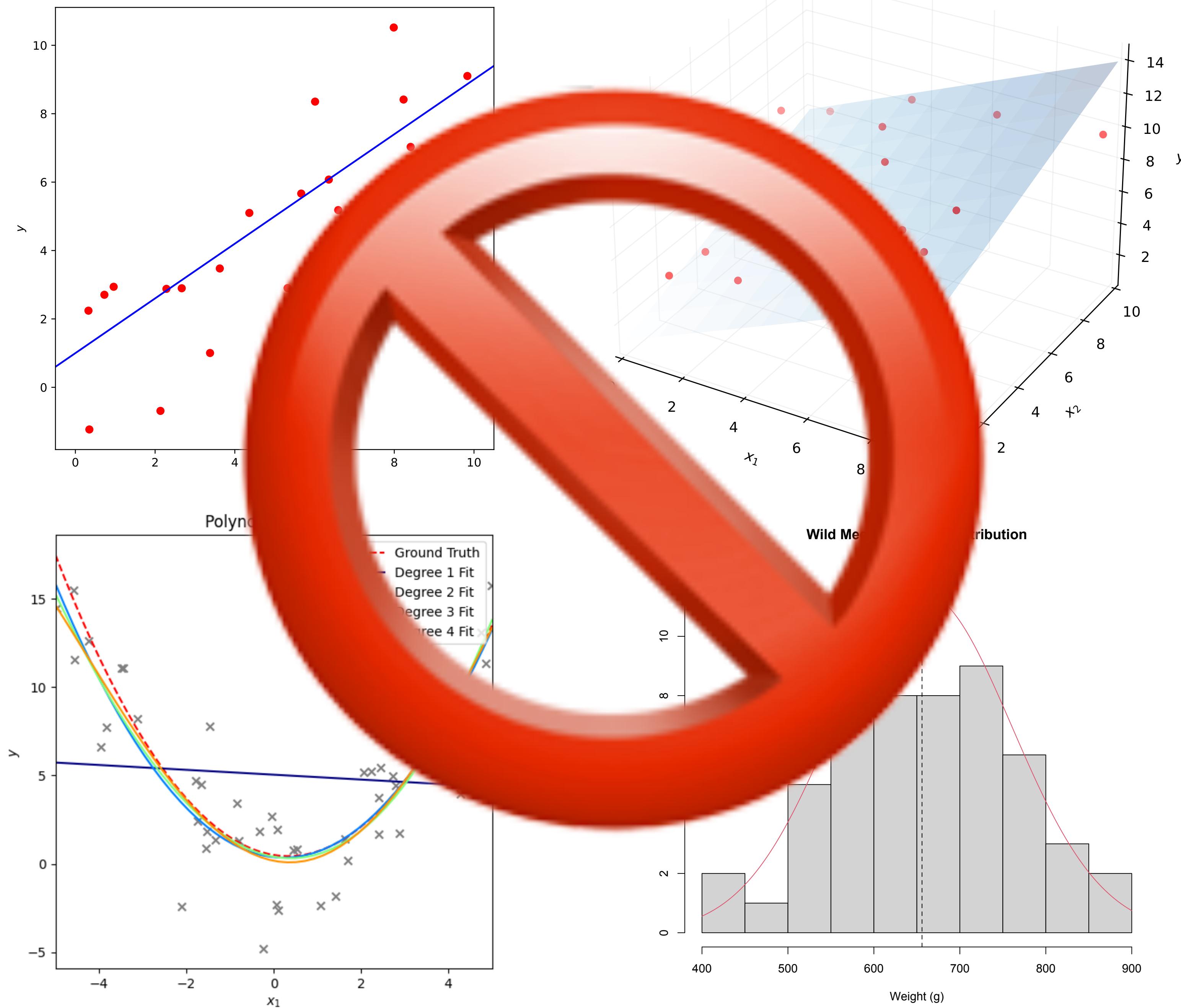




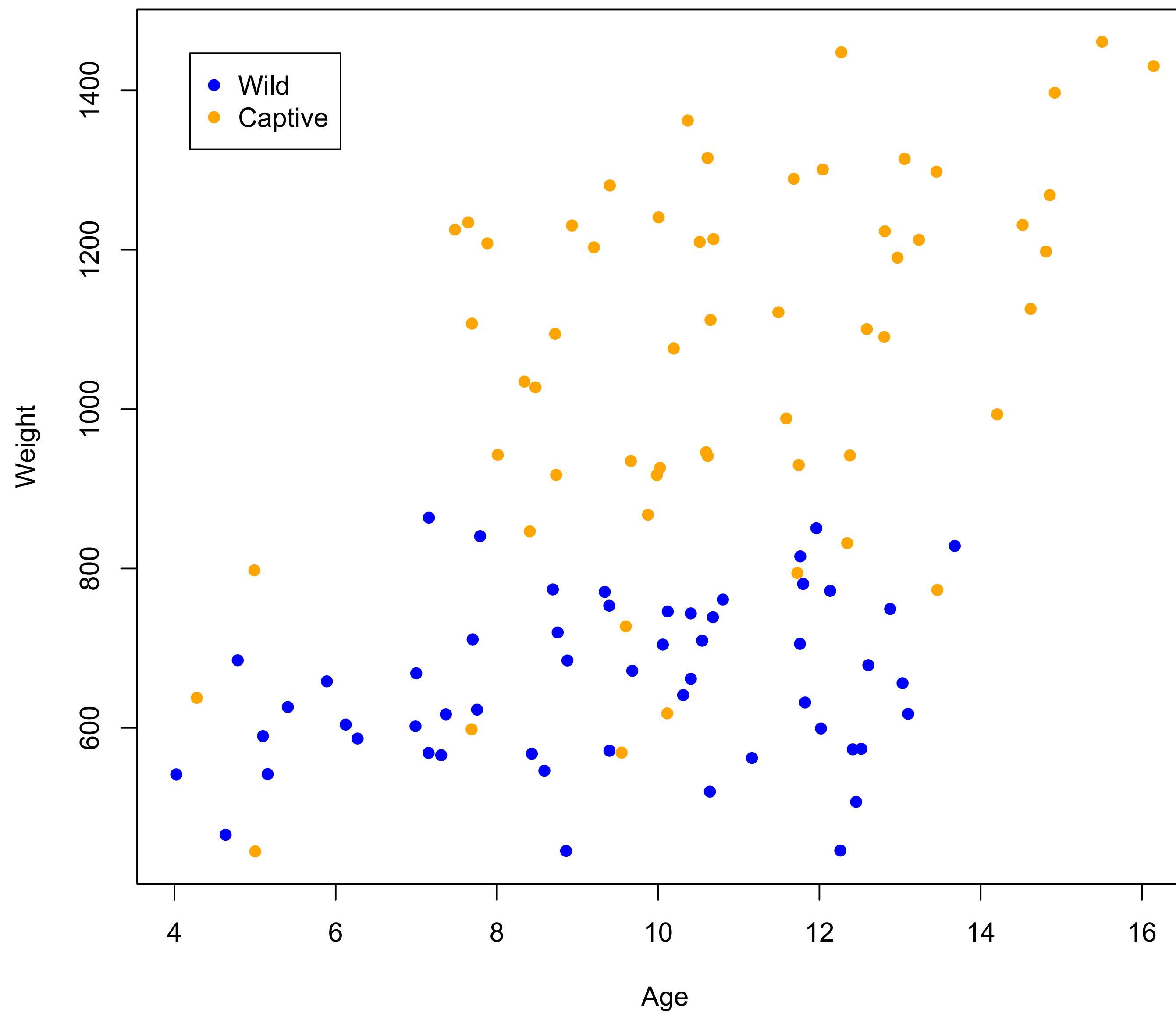
a) Input Space



b) Feature Space



Meerkat Weight vs Age

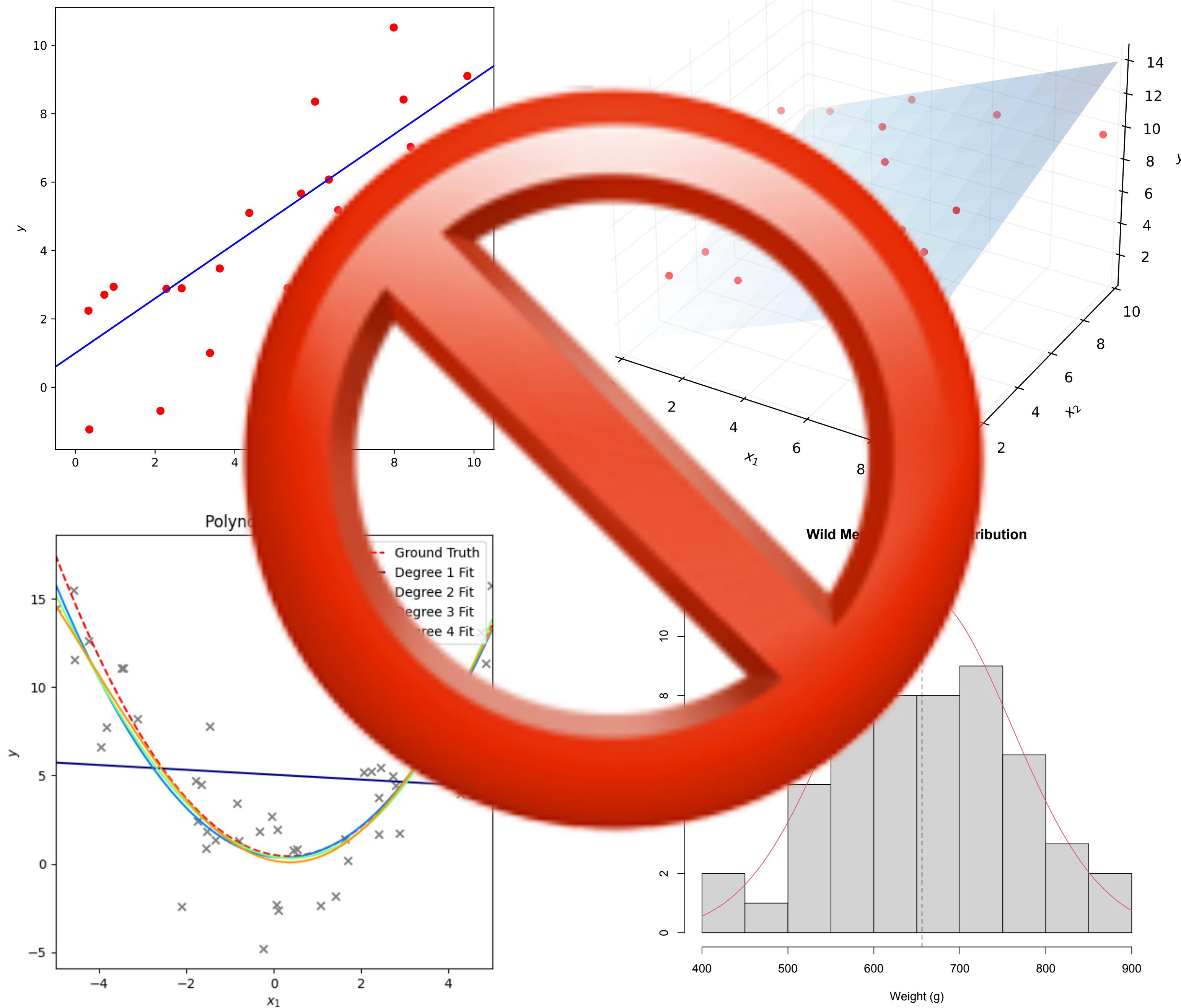




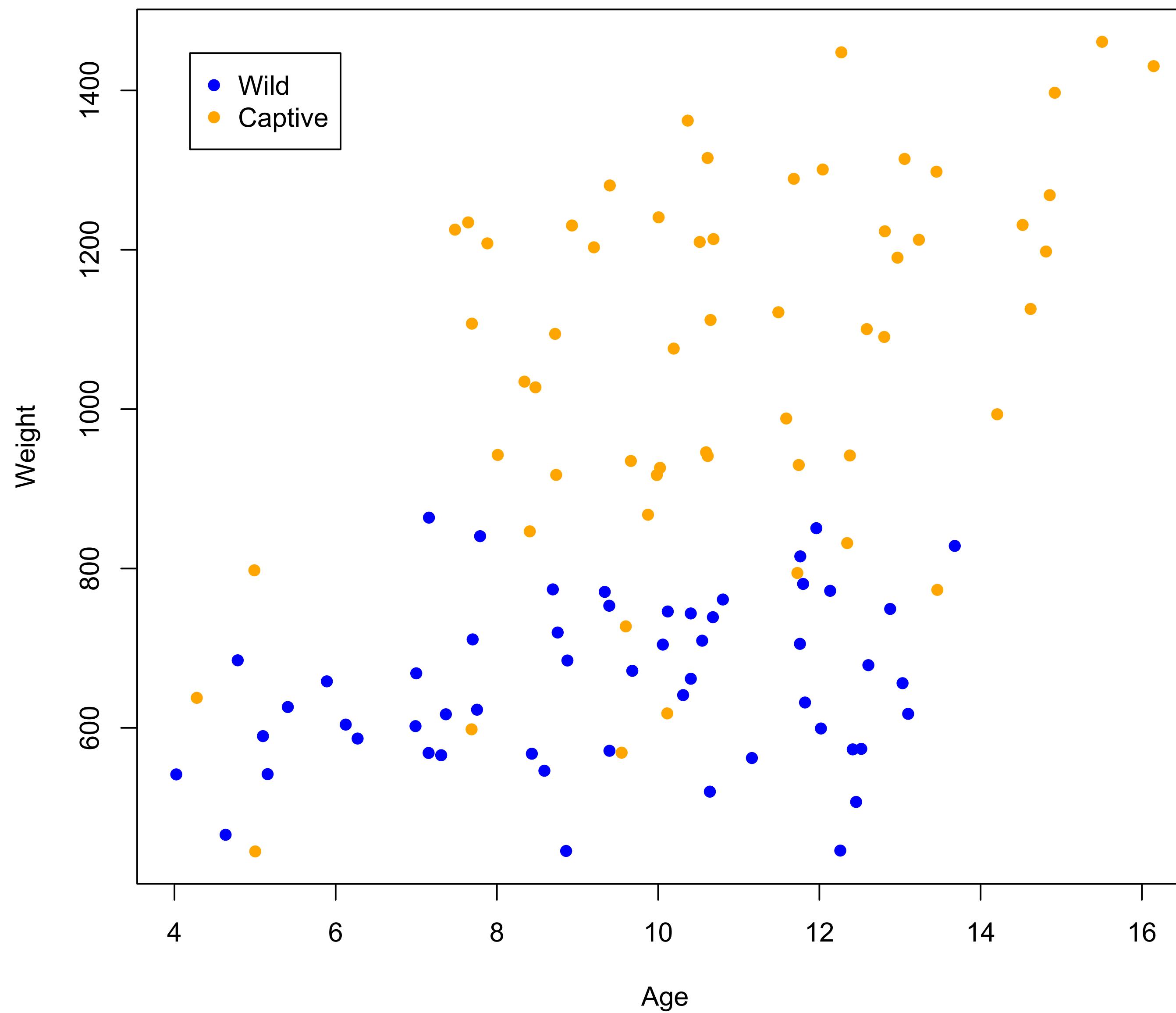
A close-up photograph of an older man with a beard and a woman with long hair, both looking intently at each other. They appear to be in a dimly lit, possibly outdoor, setting with foliage in the background.

from a certain point of view

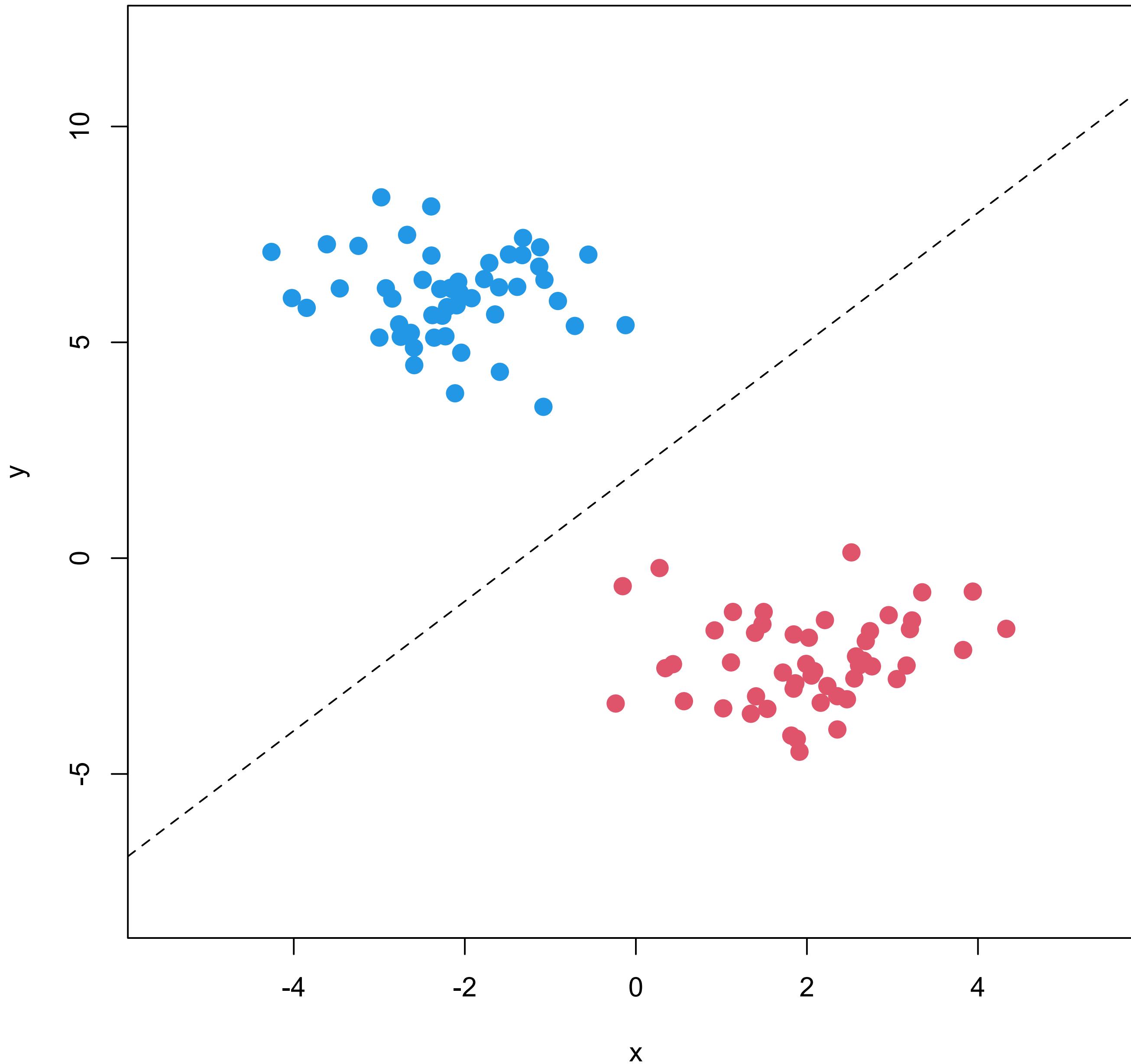
$$L(\mathbf{X}, \mathbf{Y}, \theta) = ??$$



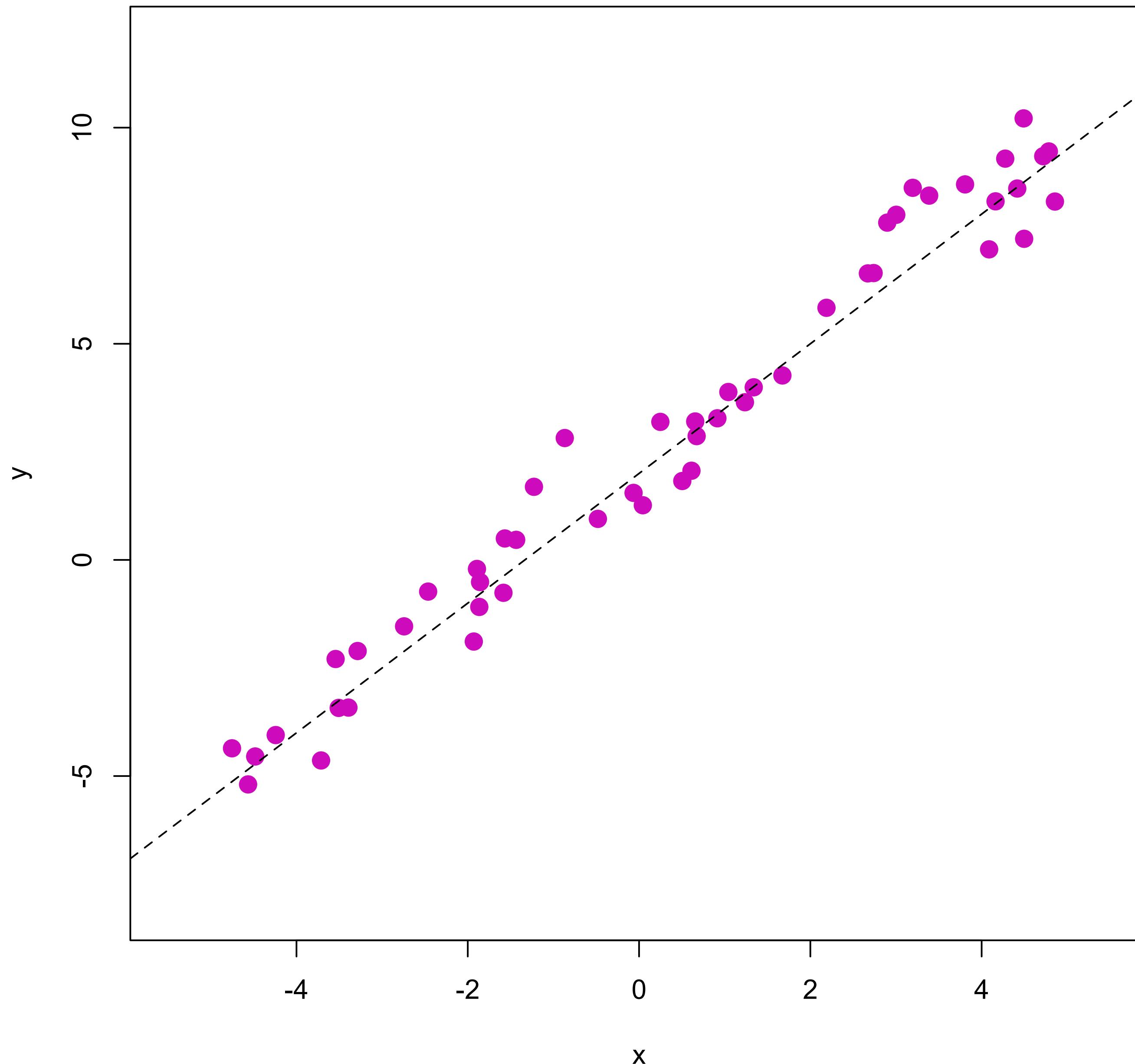
Meerkat Weight vs Age



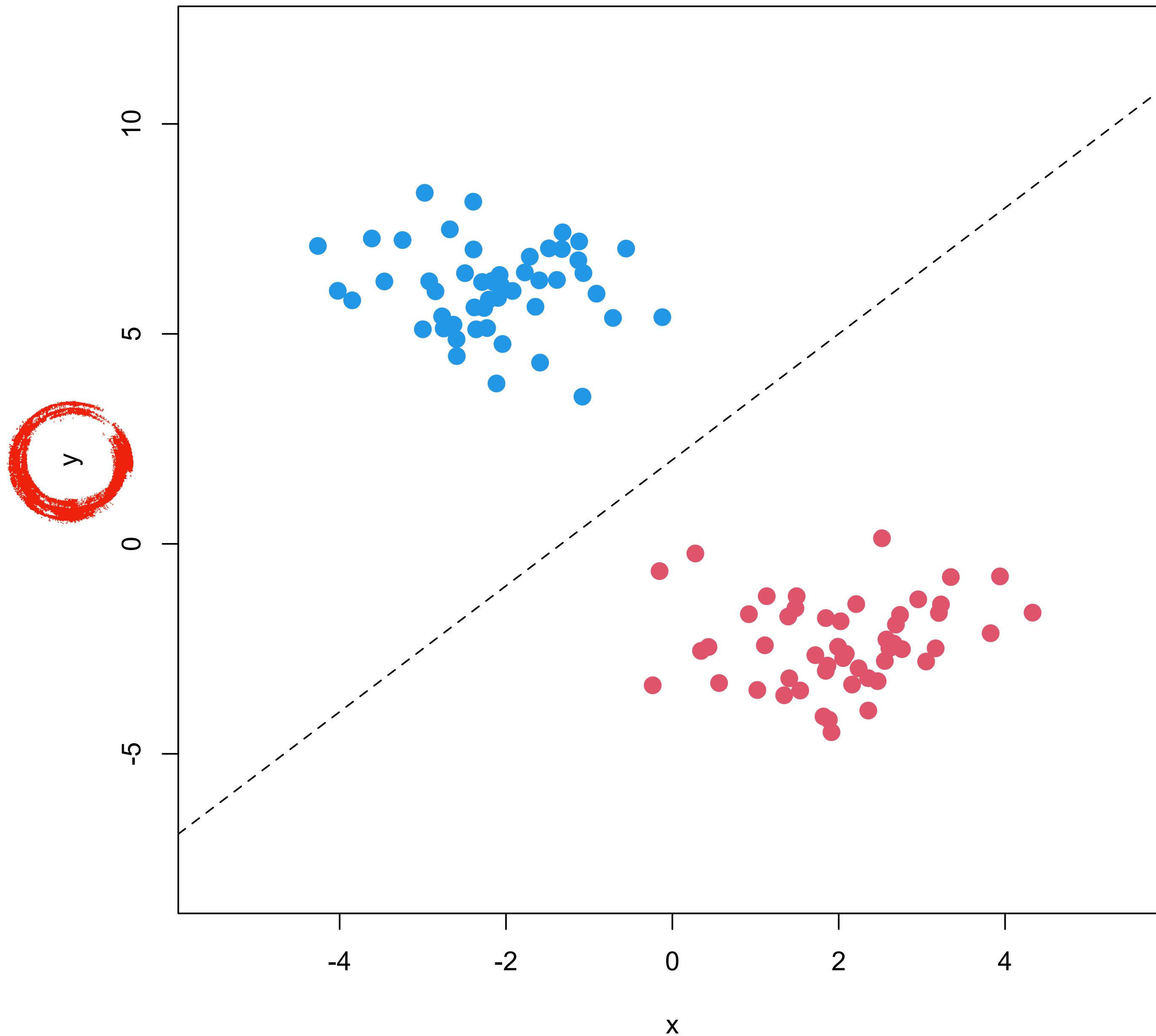
Classification

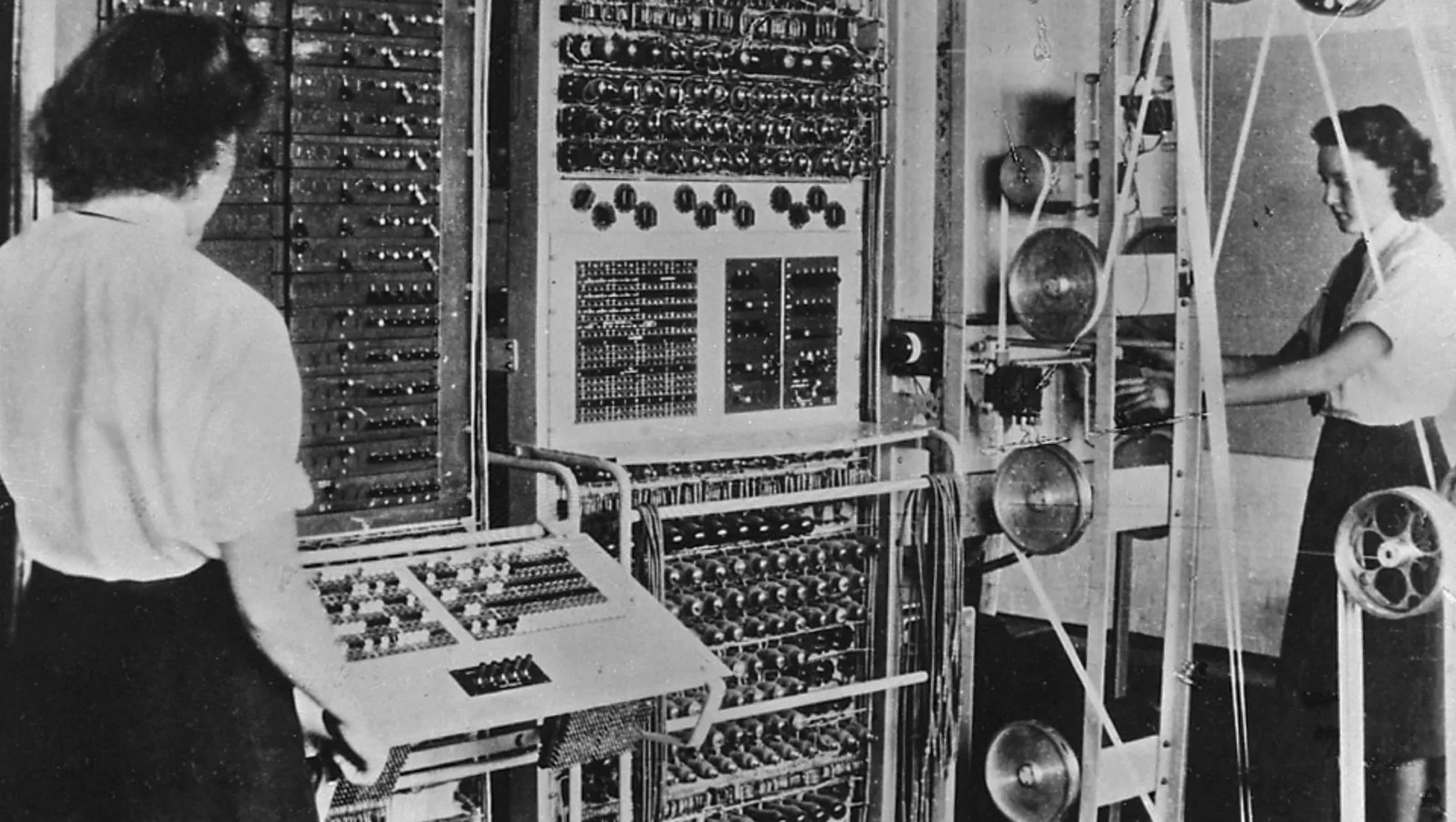


Regression

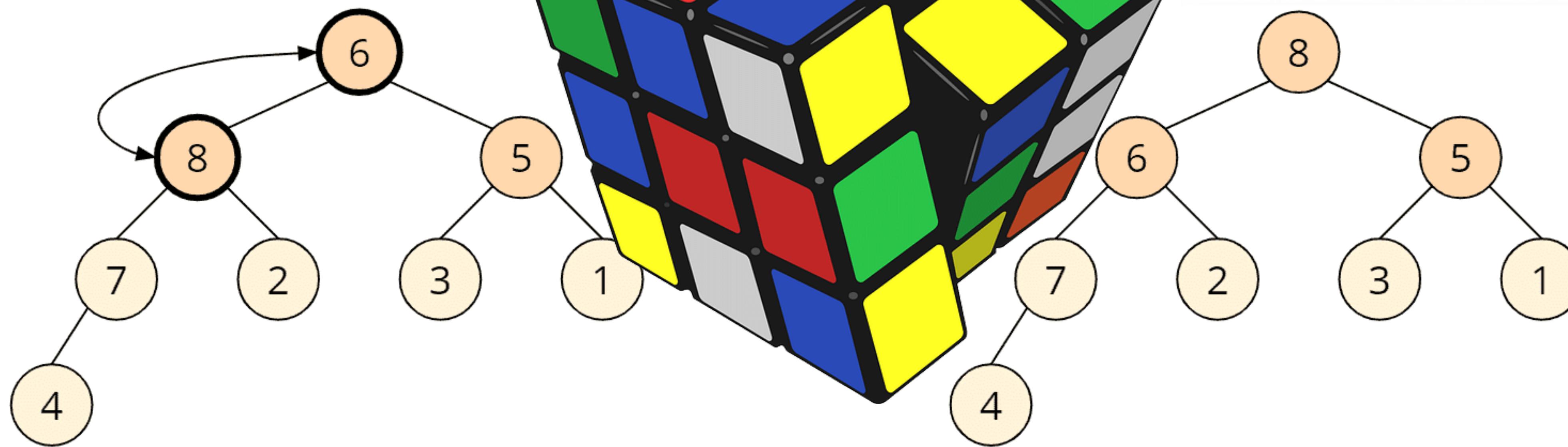
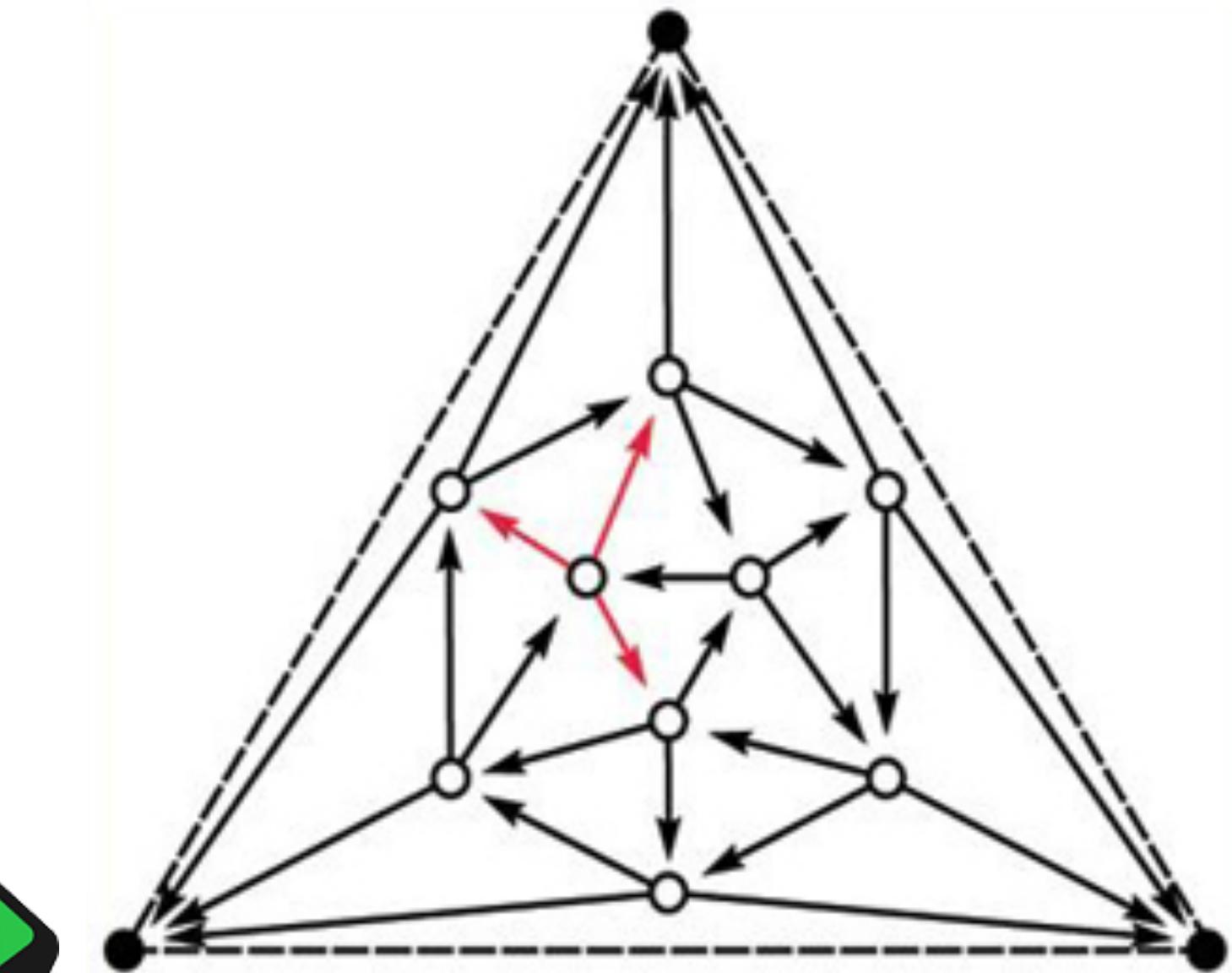
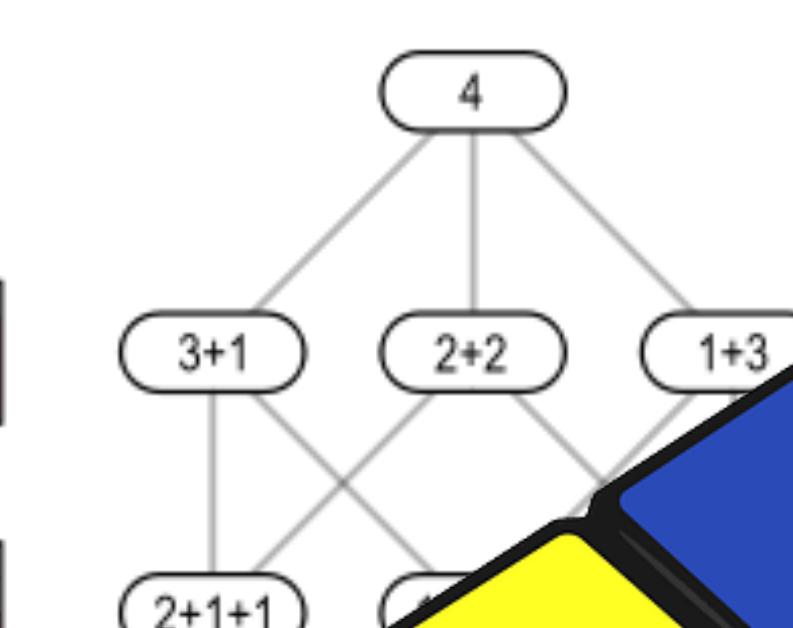
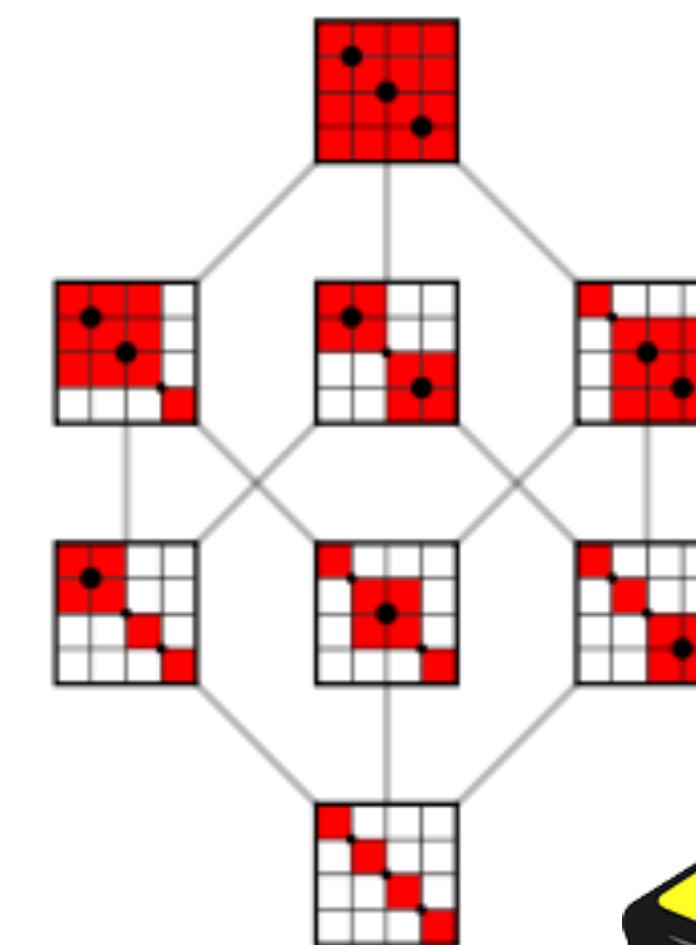
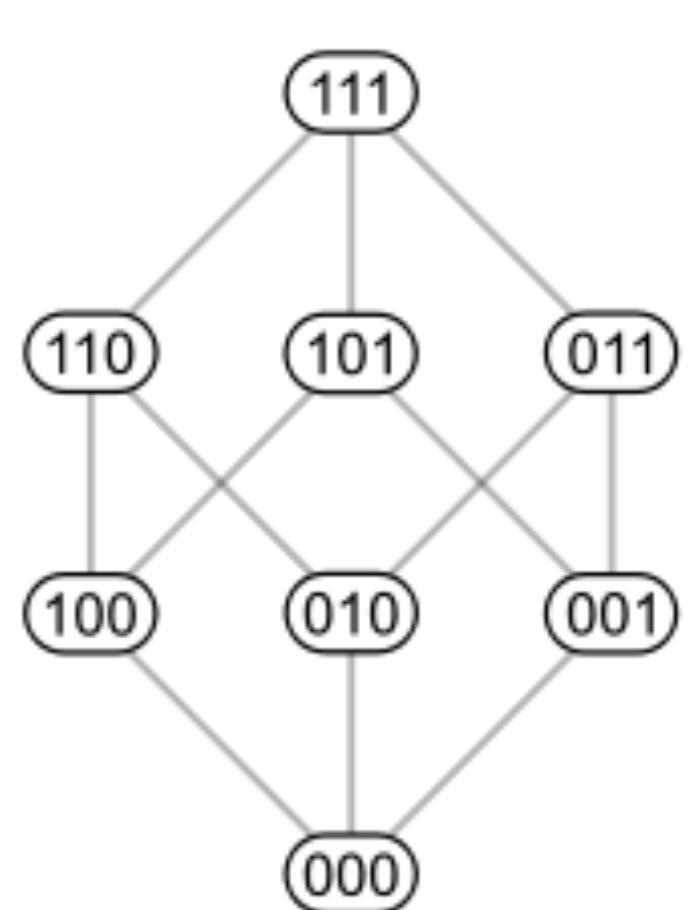


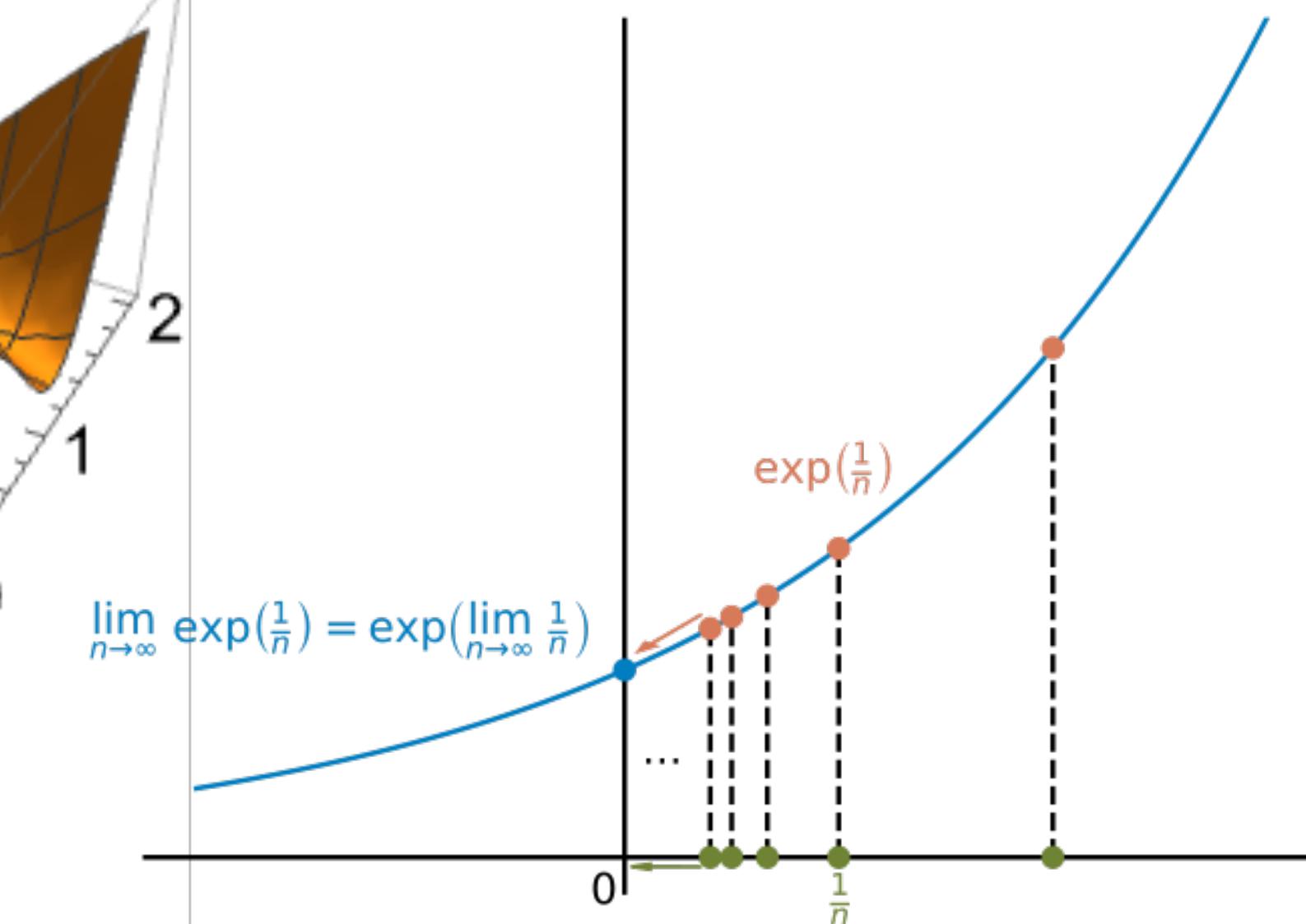
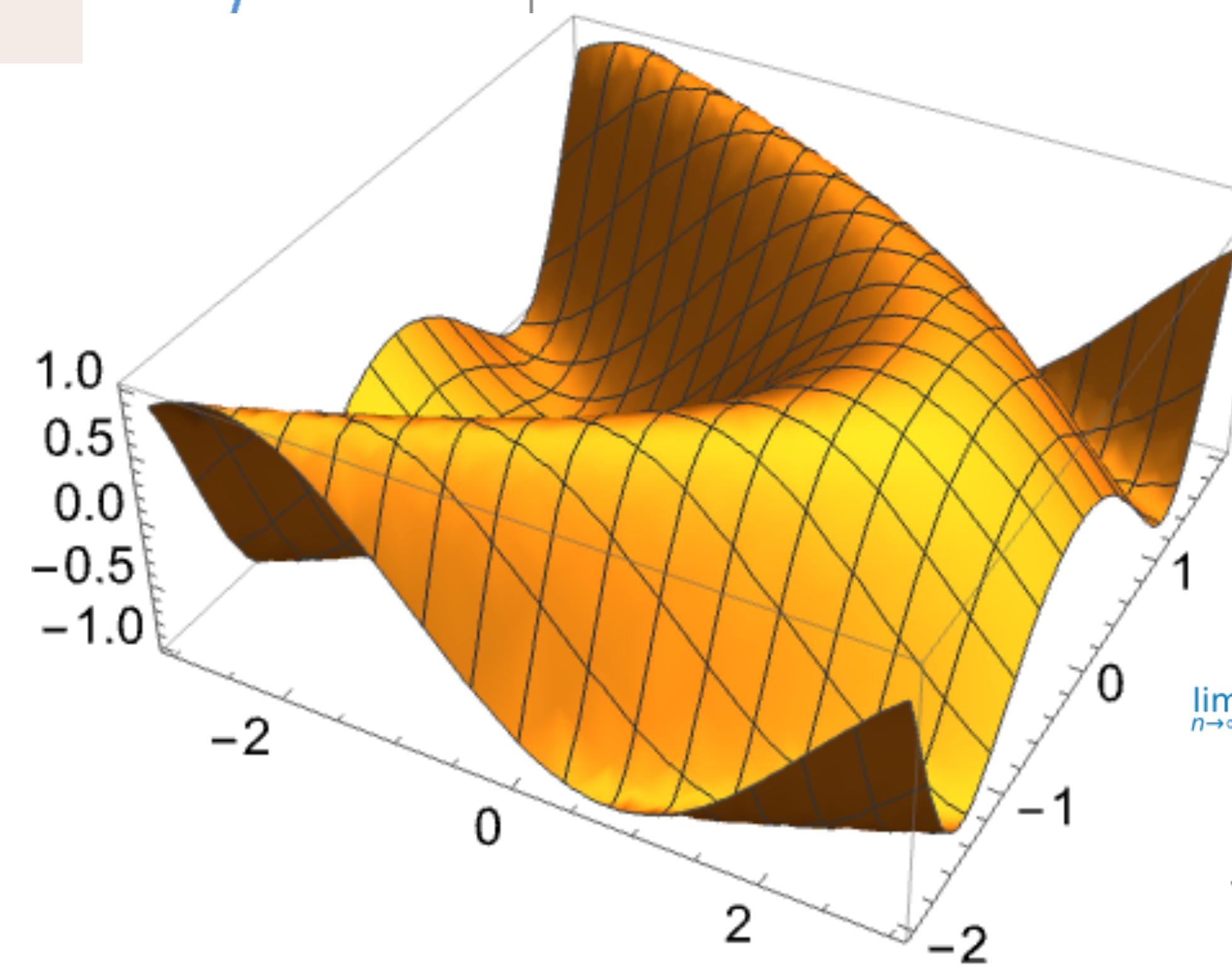
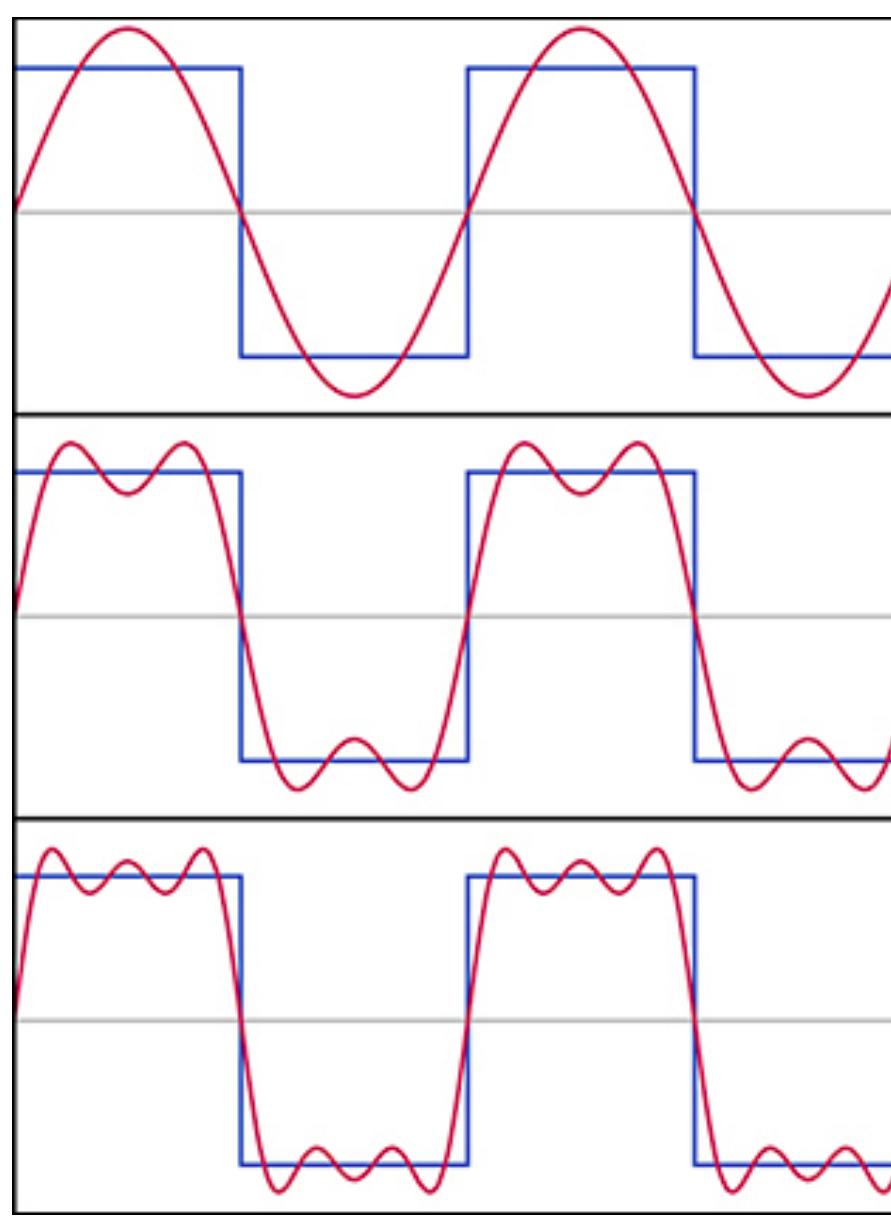
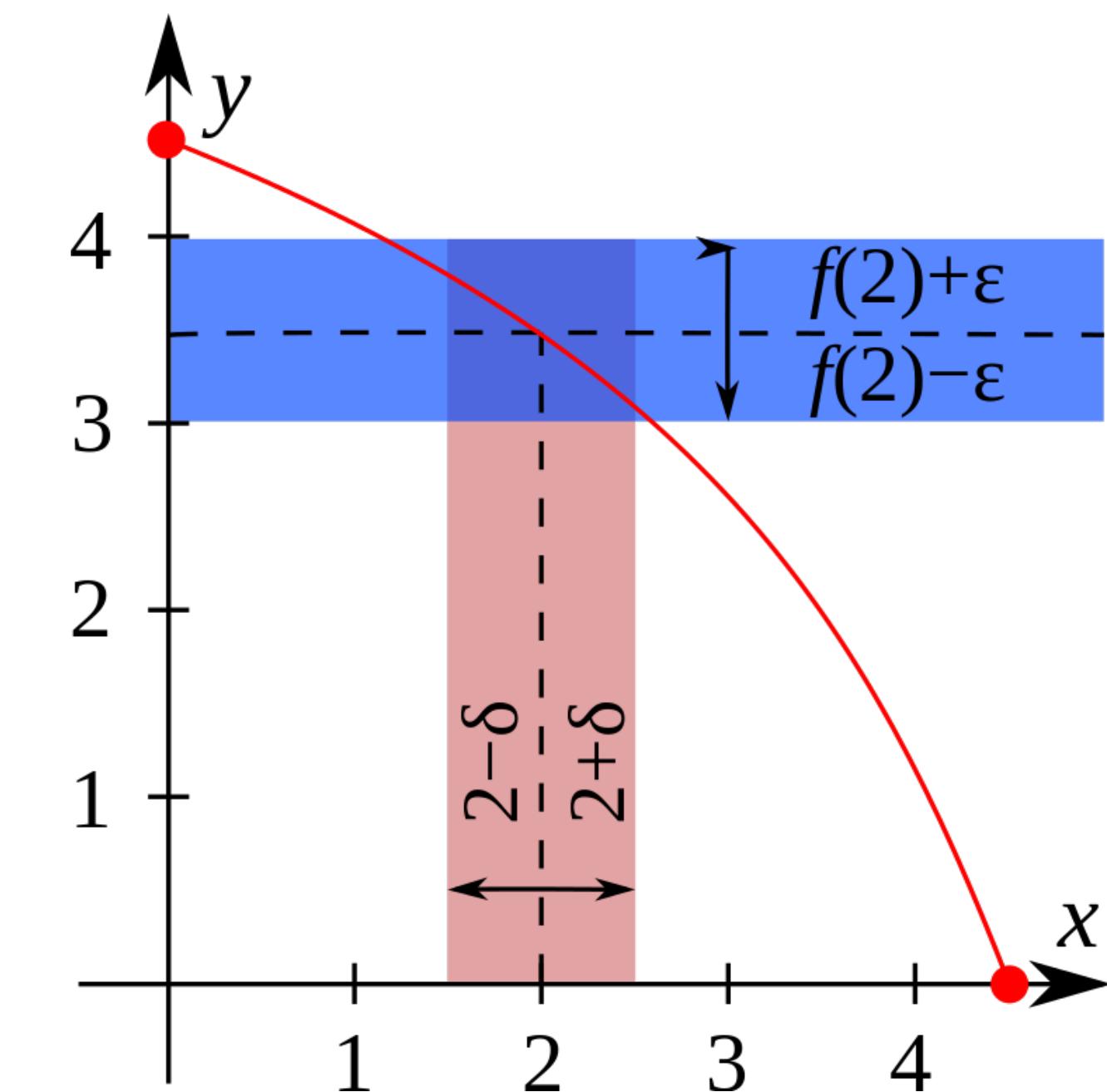
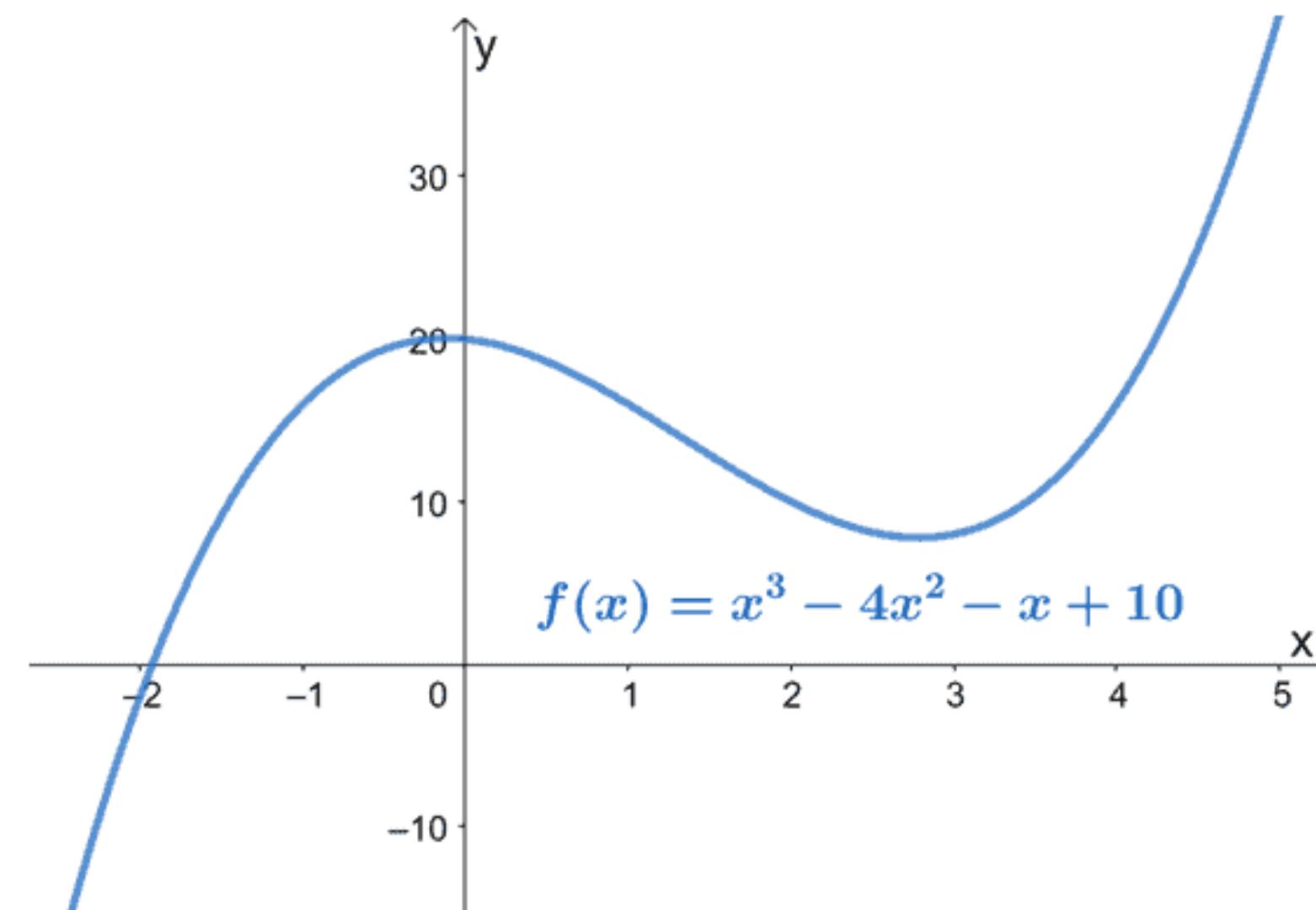
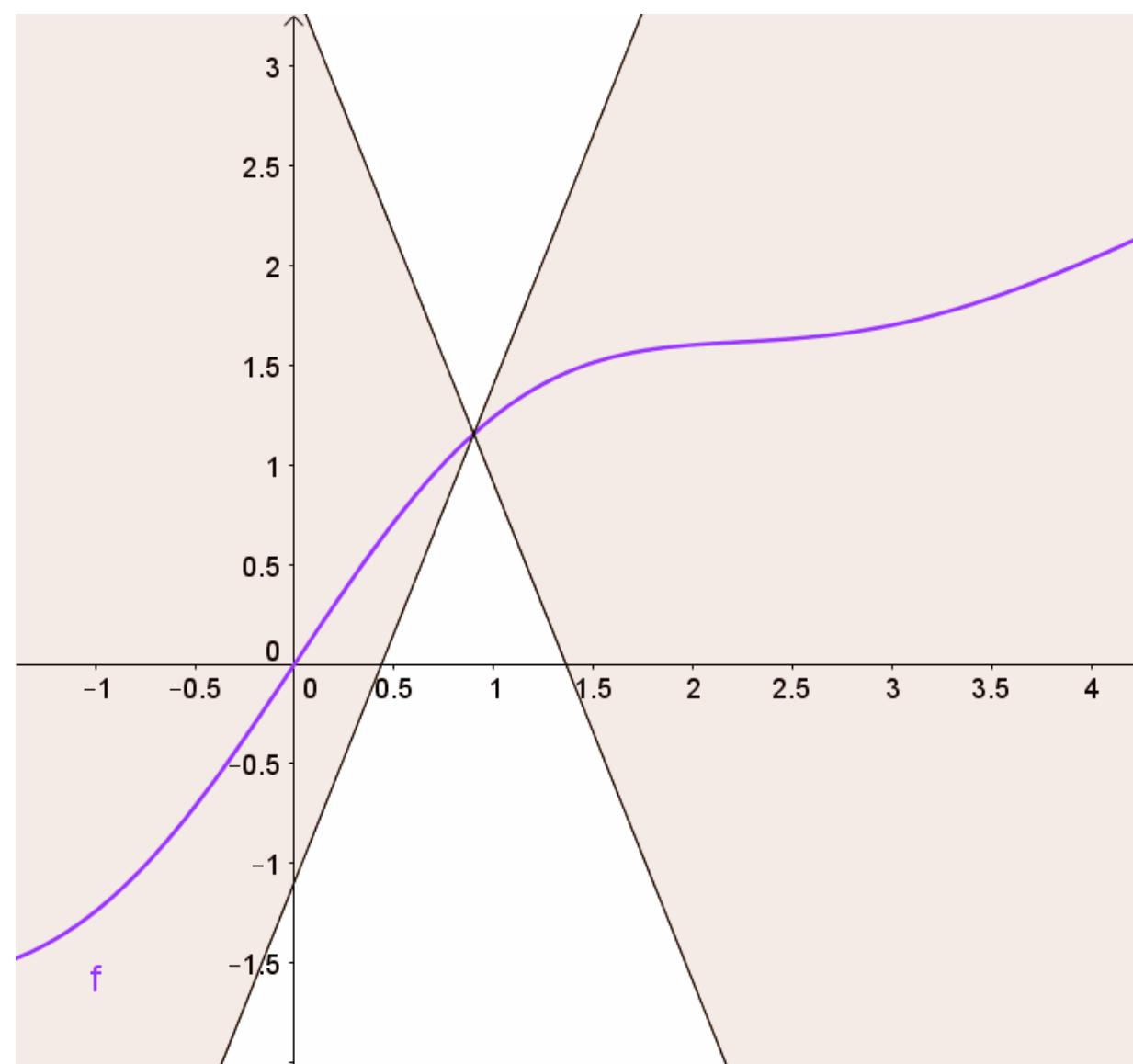
Classification



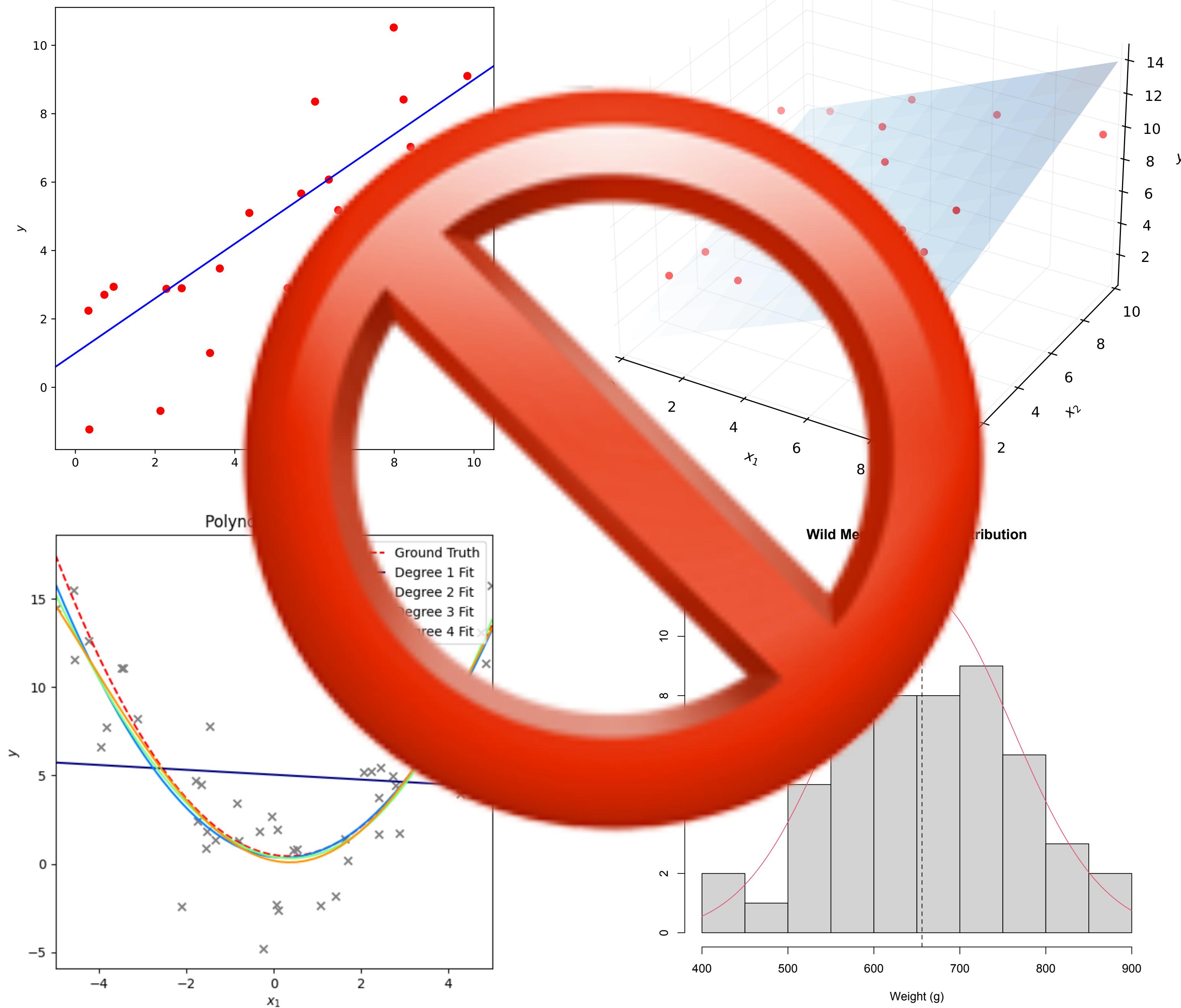


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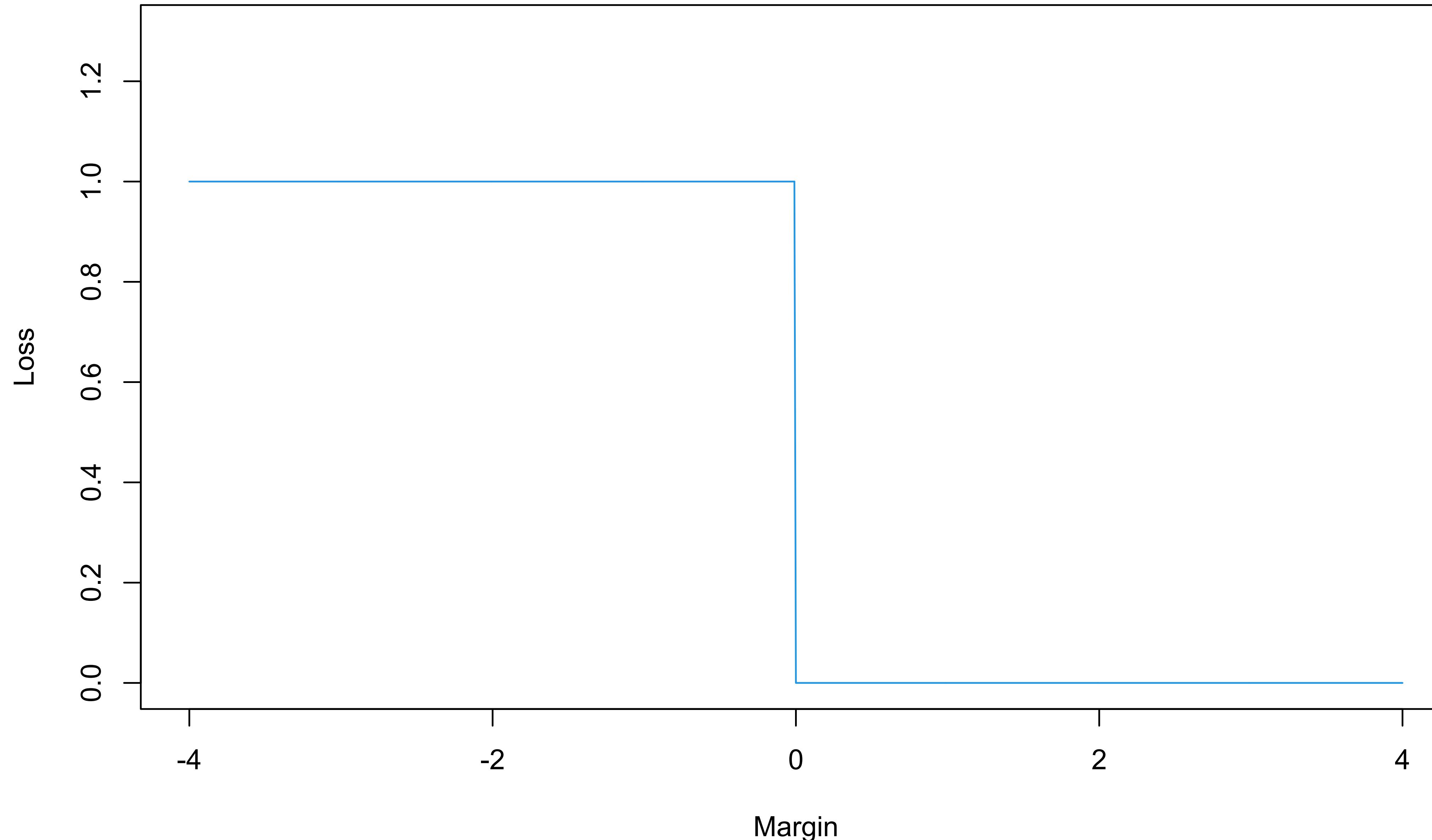


$$\frac{\partial x}{\partial y} = WTAF?$$

$$L(\mathbf{X}, \mathbf{Y}, \theta) = ??$$

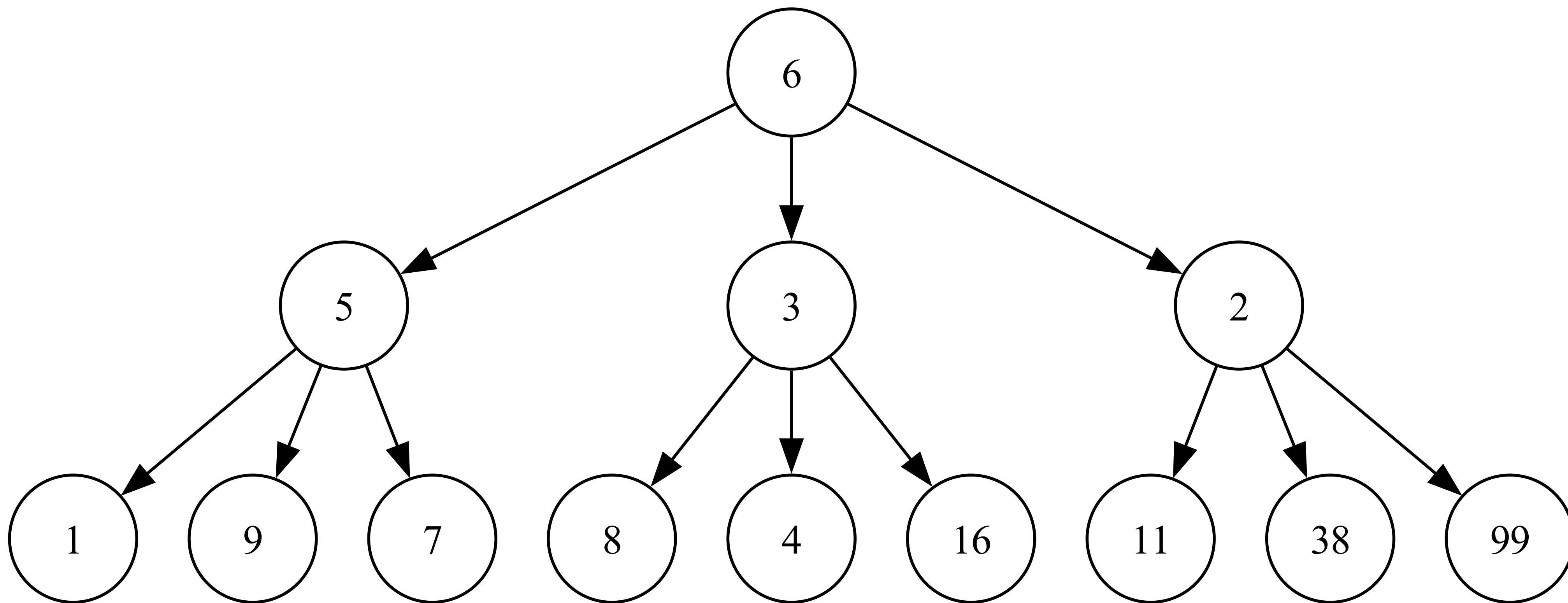
0-1 Loss

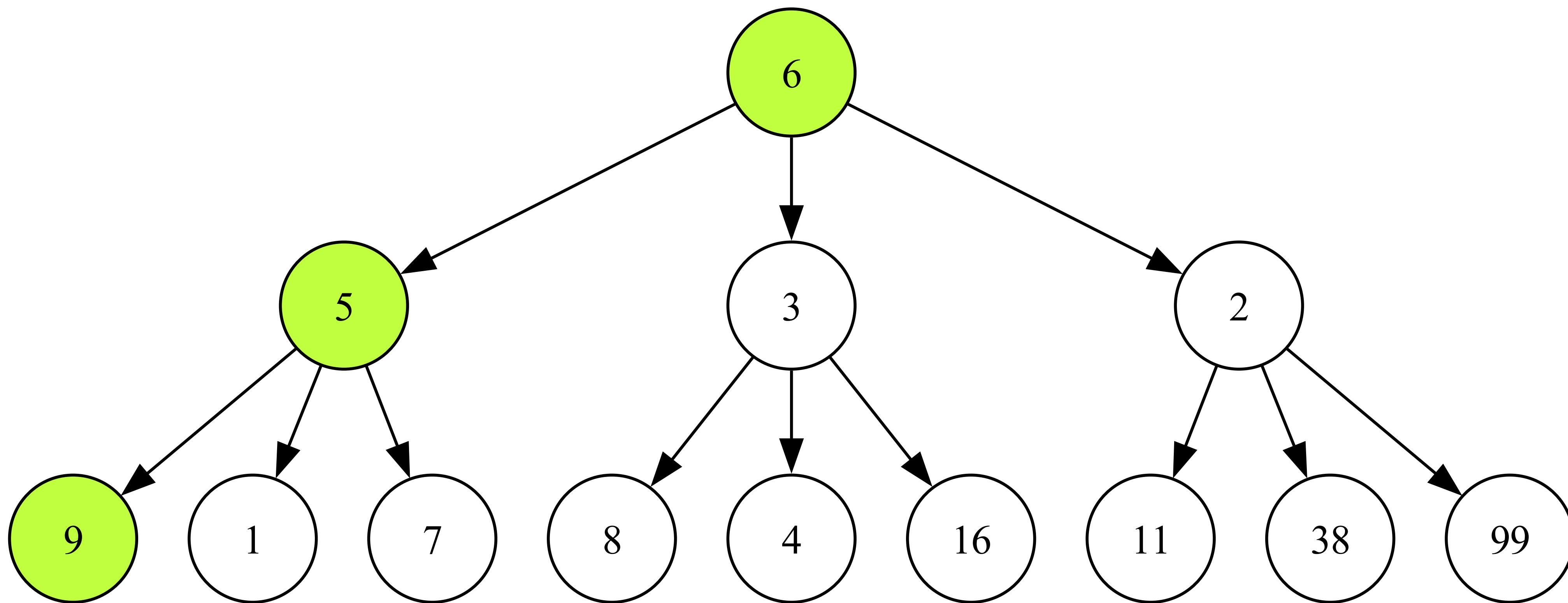


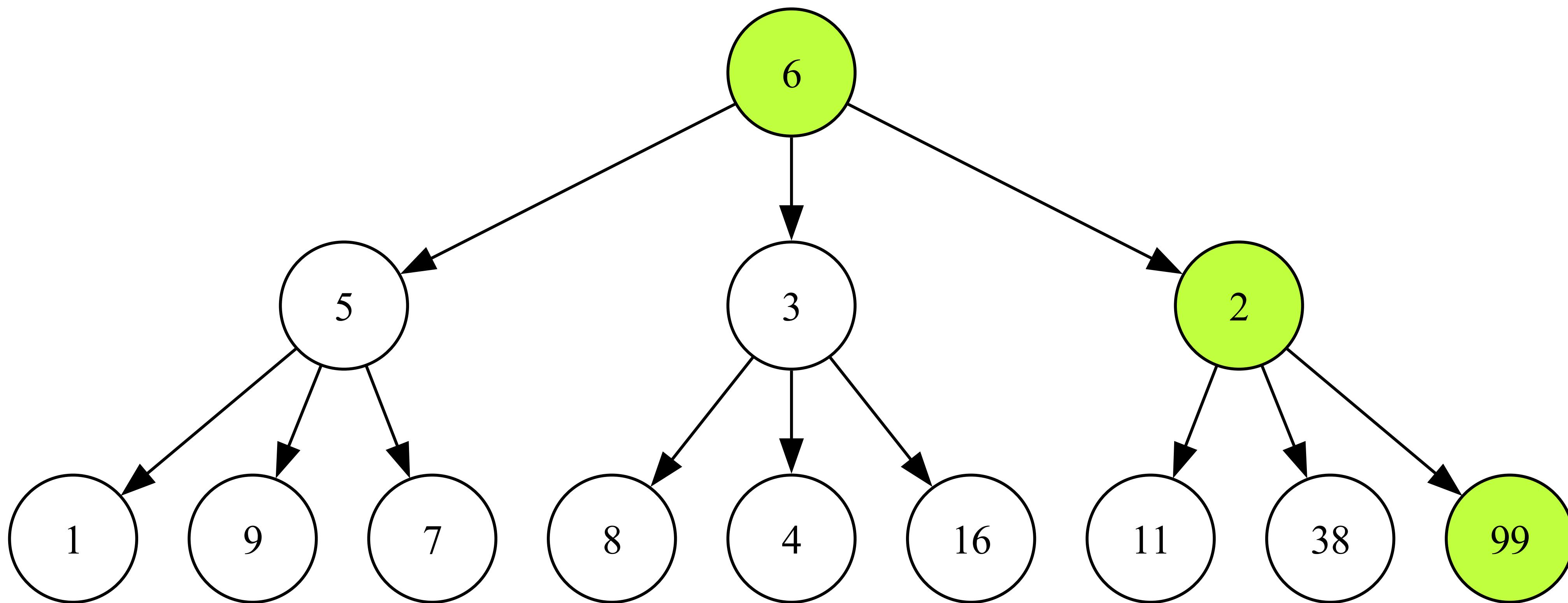
$$\nabla_{\theta} L(\mathbf{y}, \theta)$$

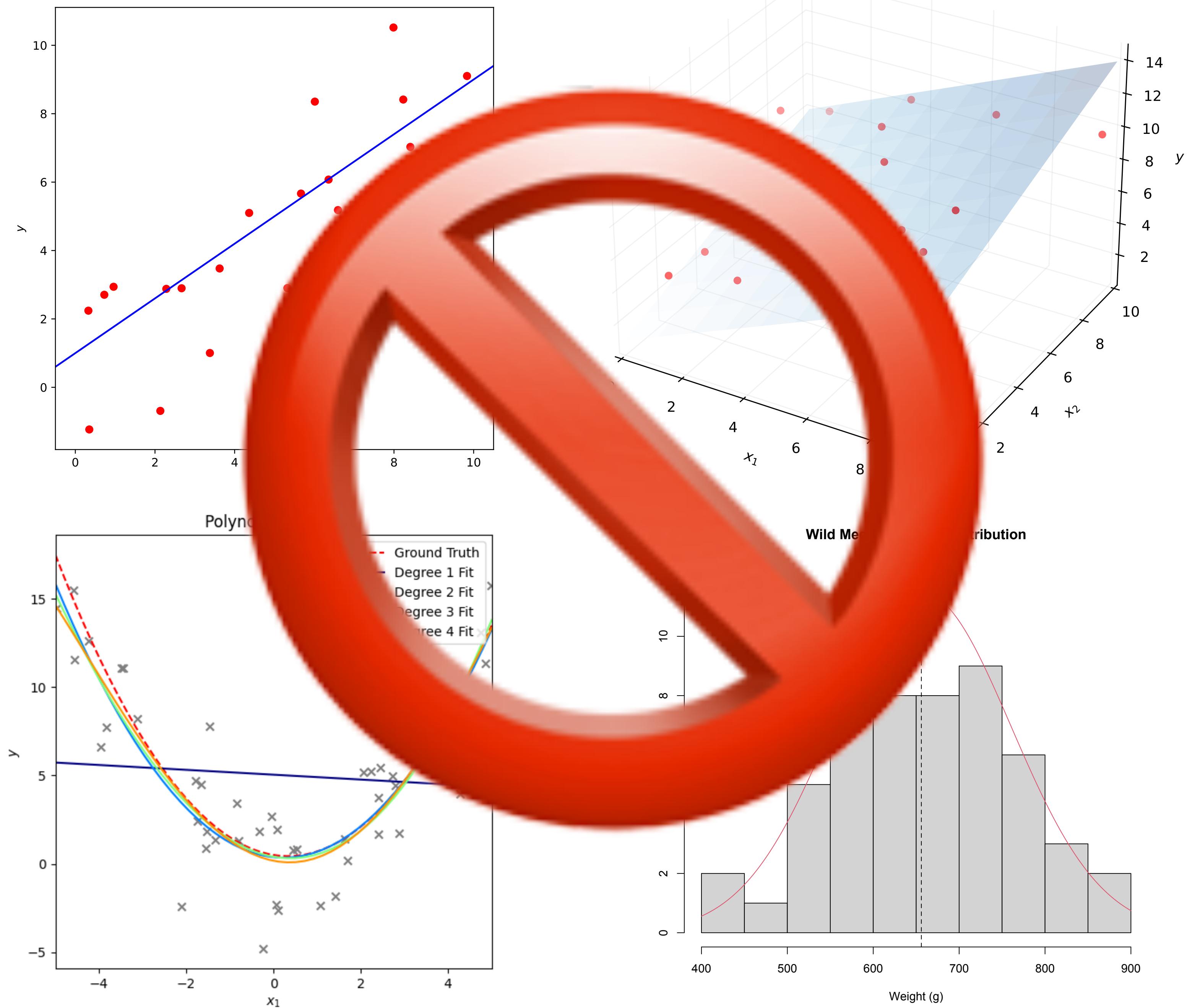



greed is good



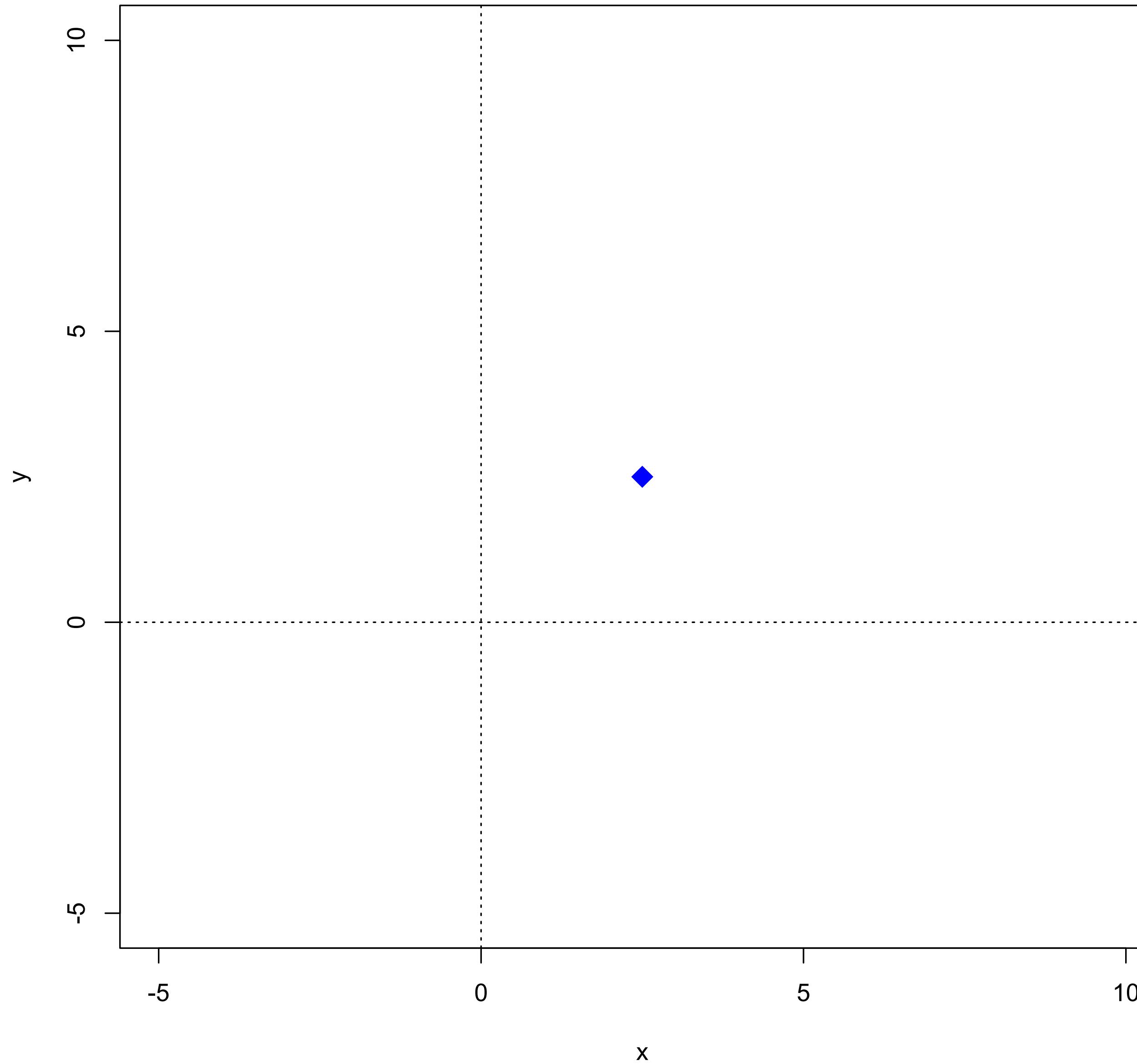




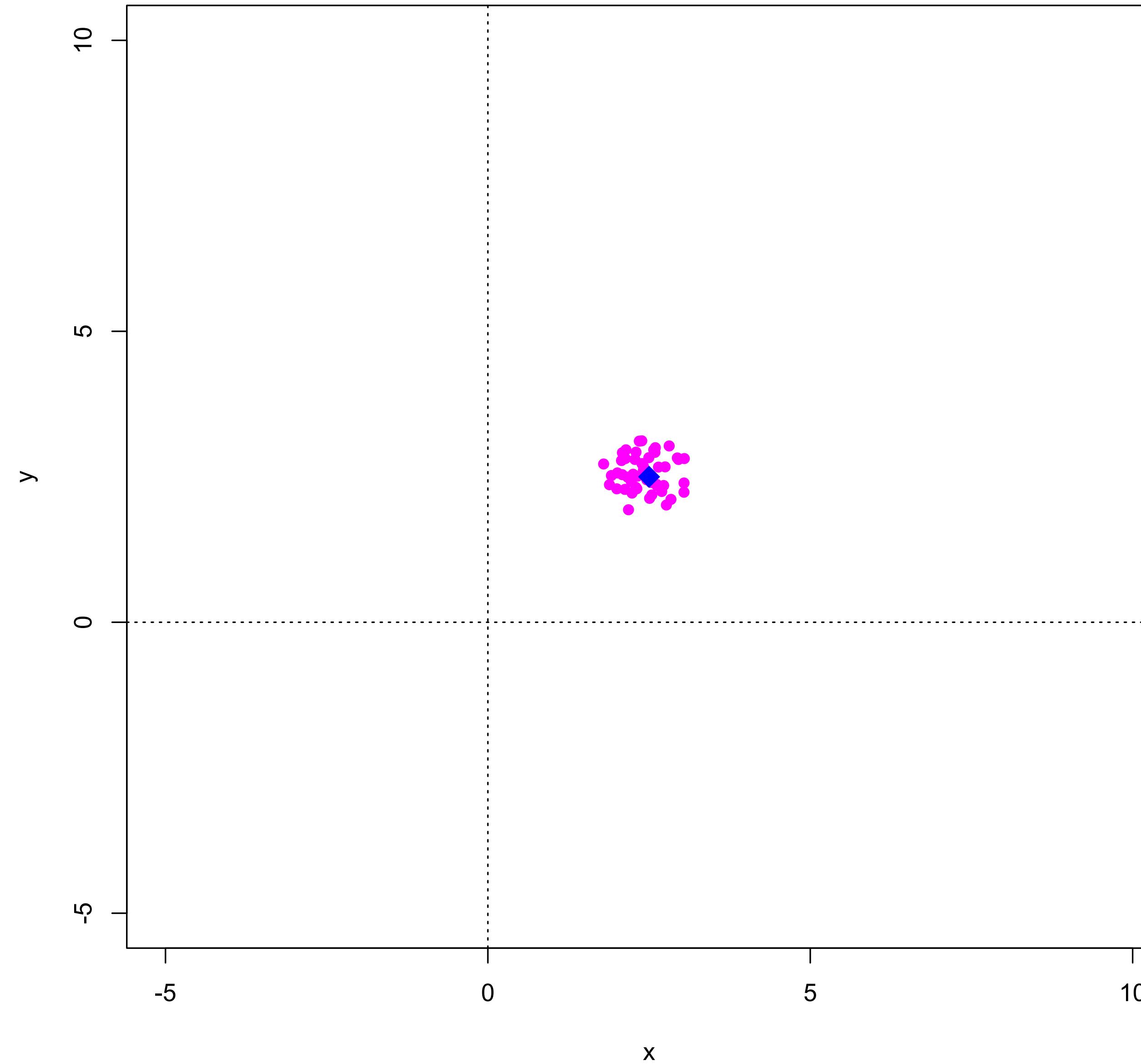


bias-variance tradeoff

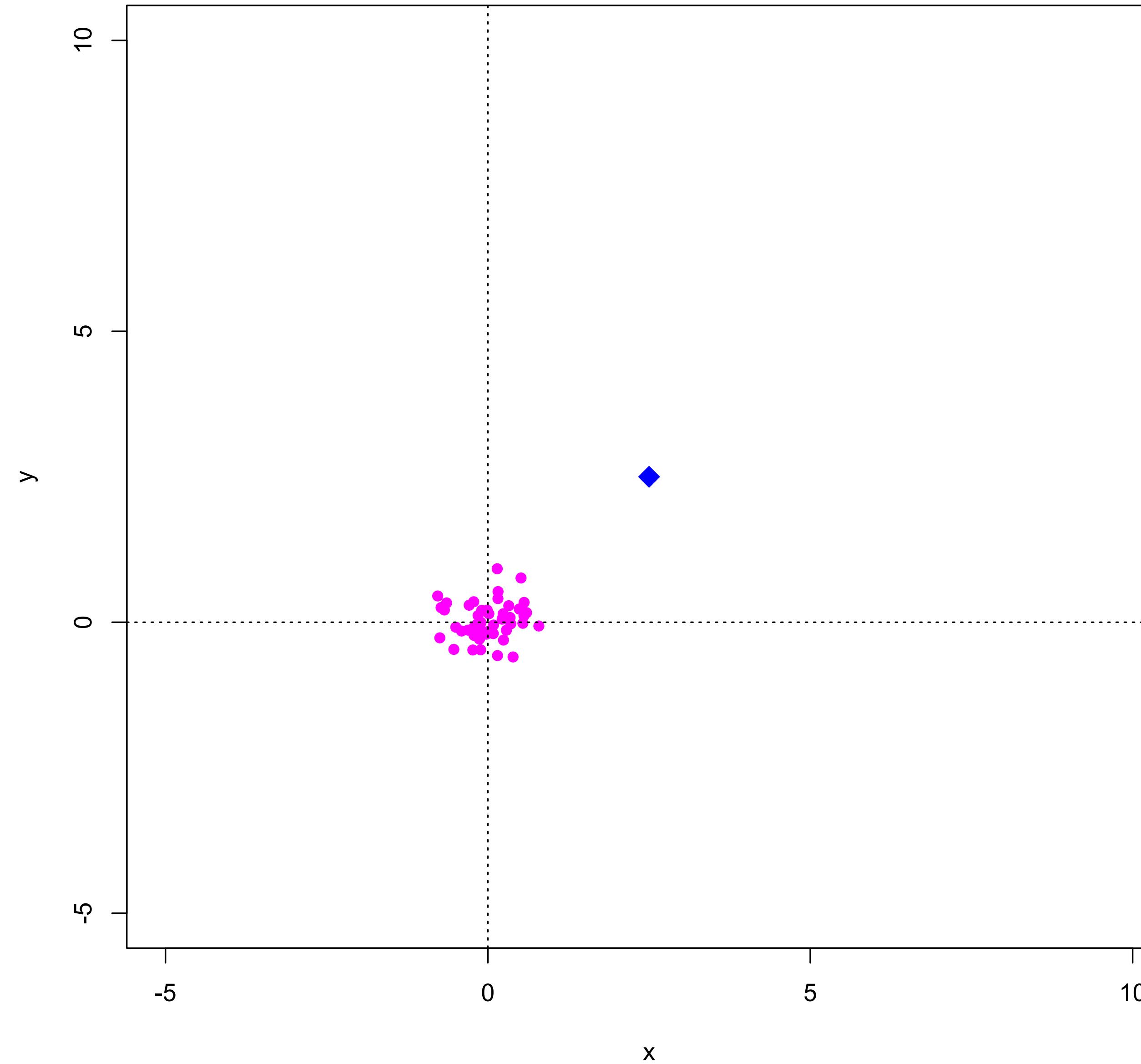
Ground Truth



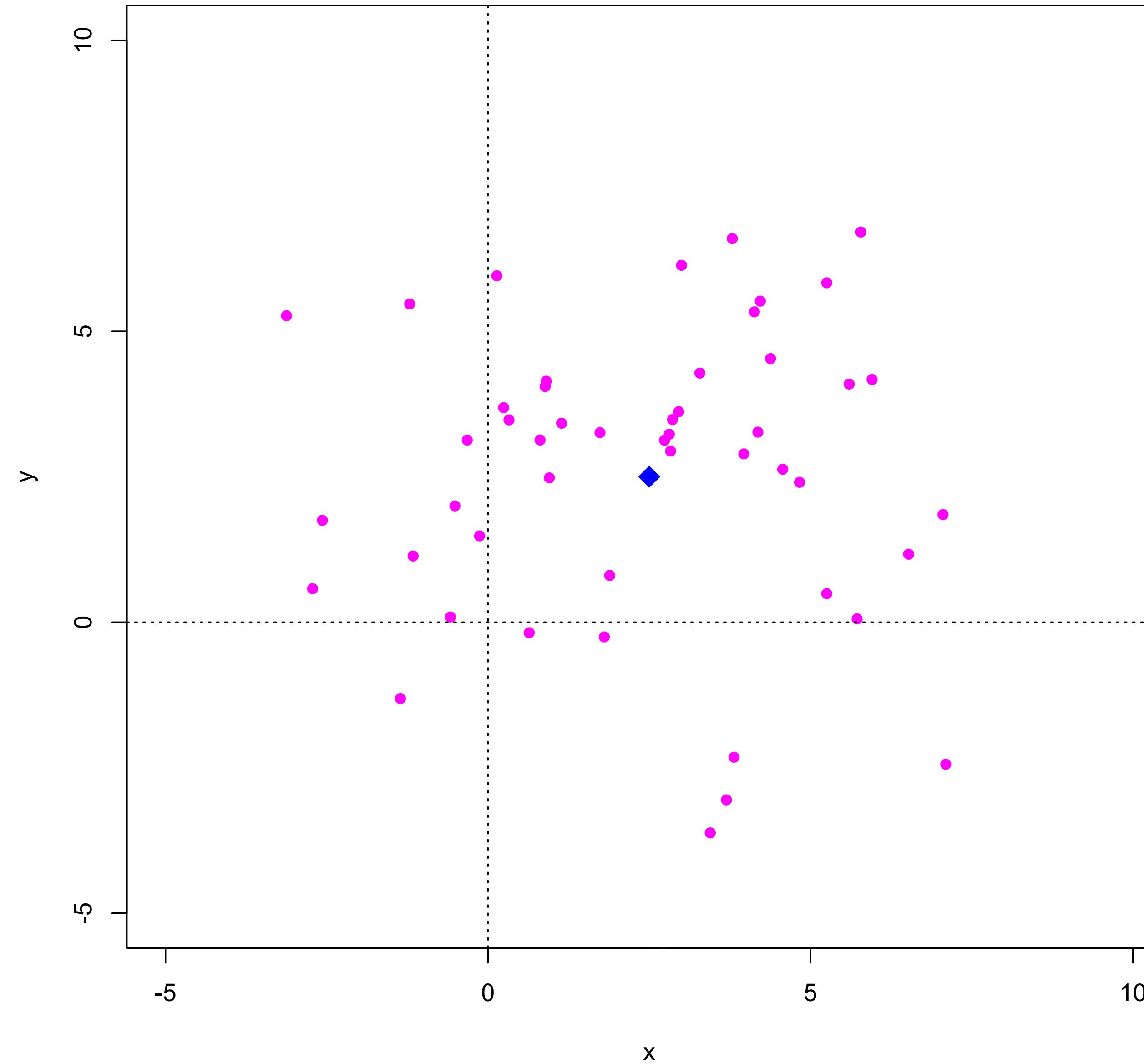
Low Variance, Low Bias



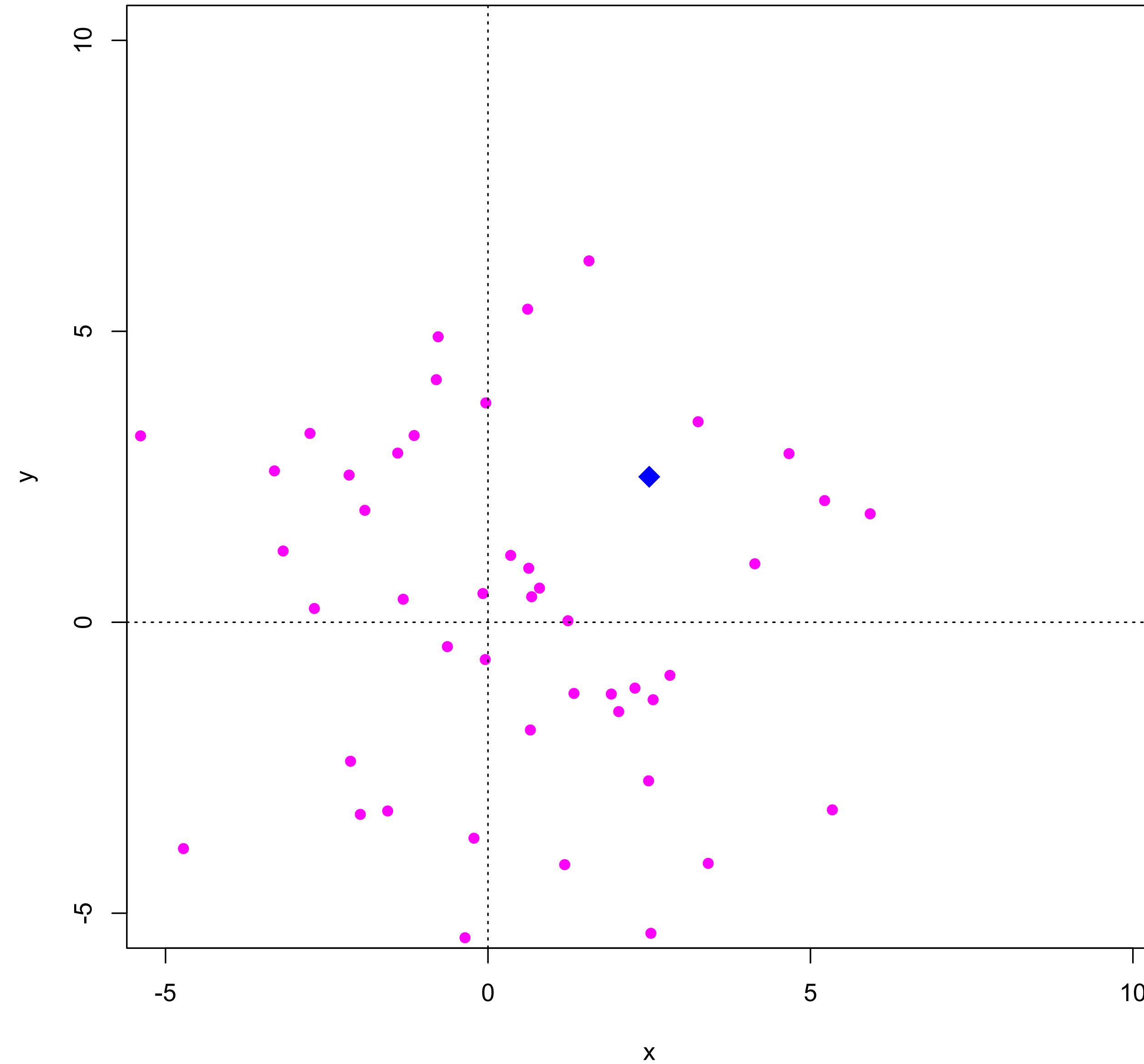
Low Variance, High Bias



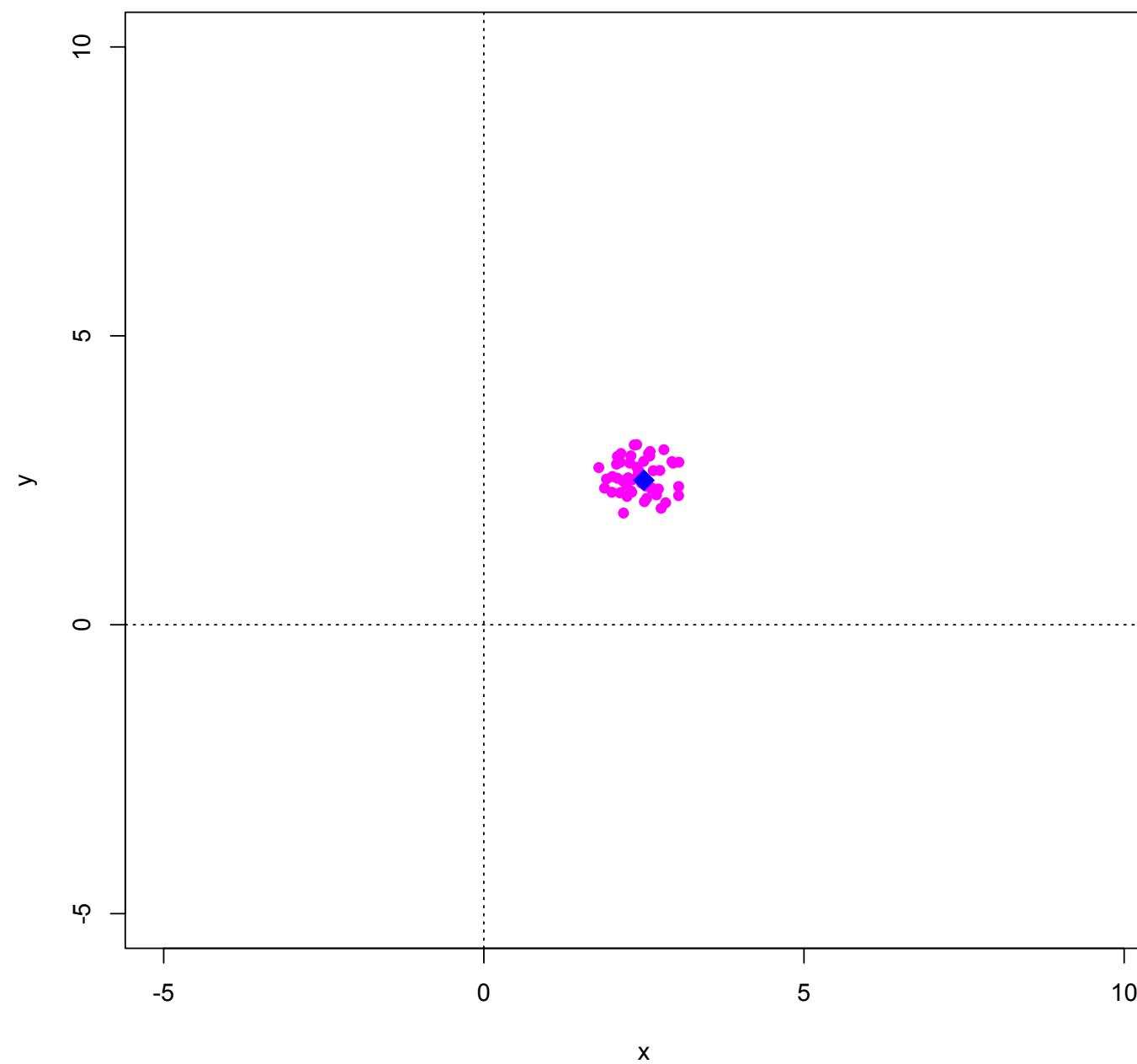
High Variance, Low Bias



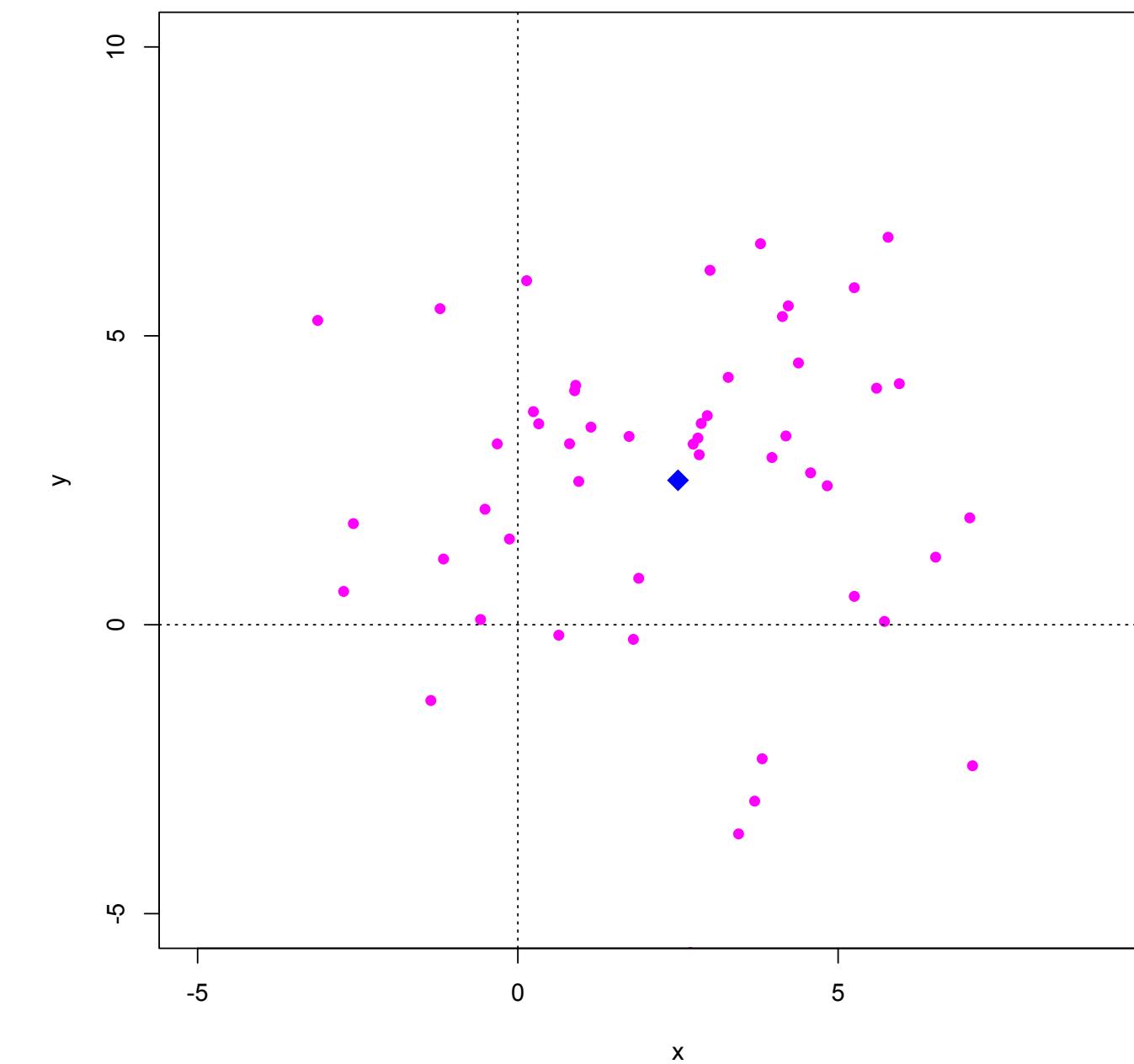
High Variance, High Bias



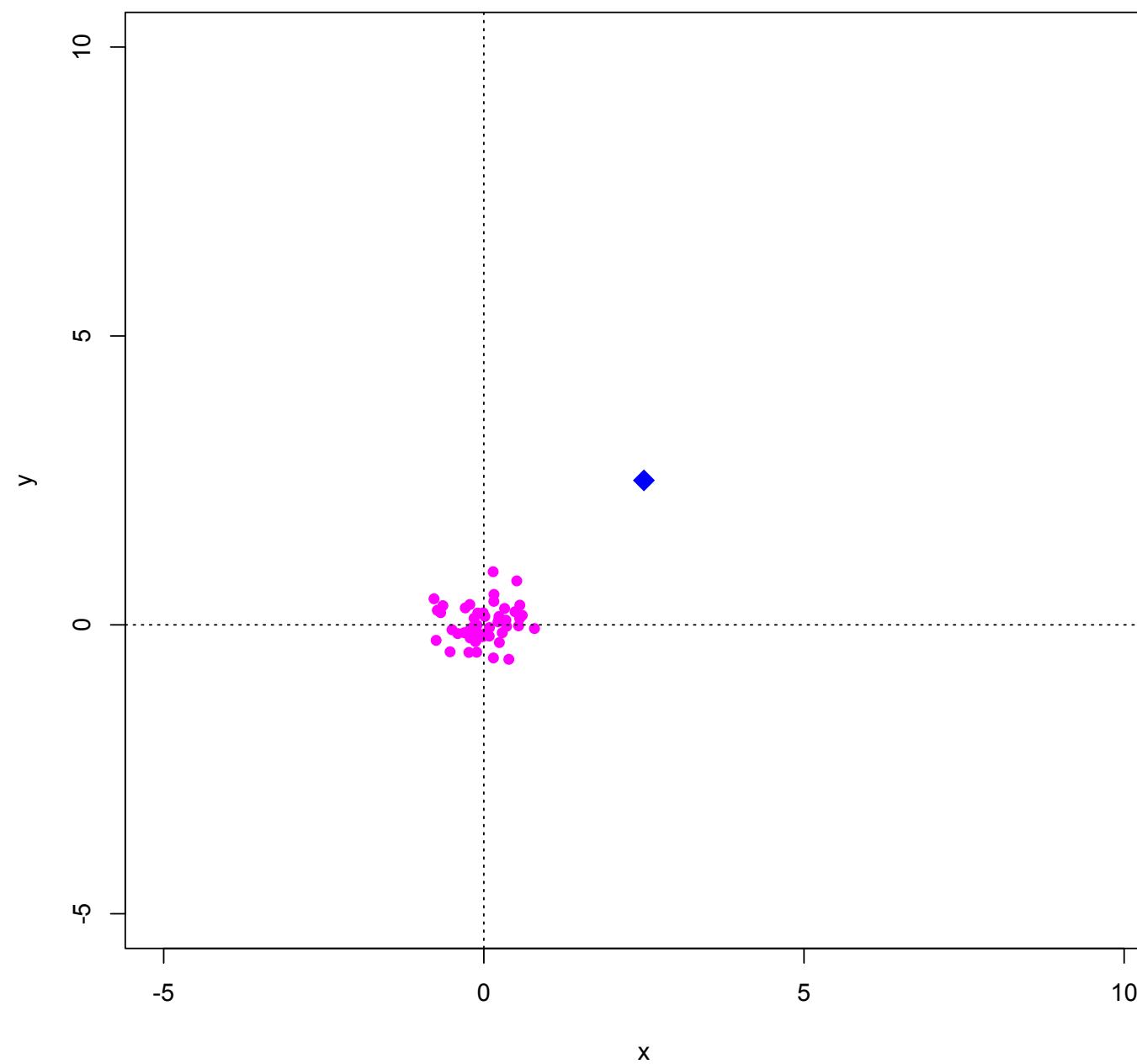
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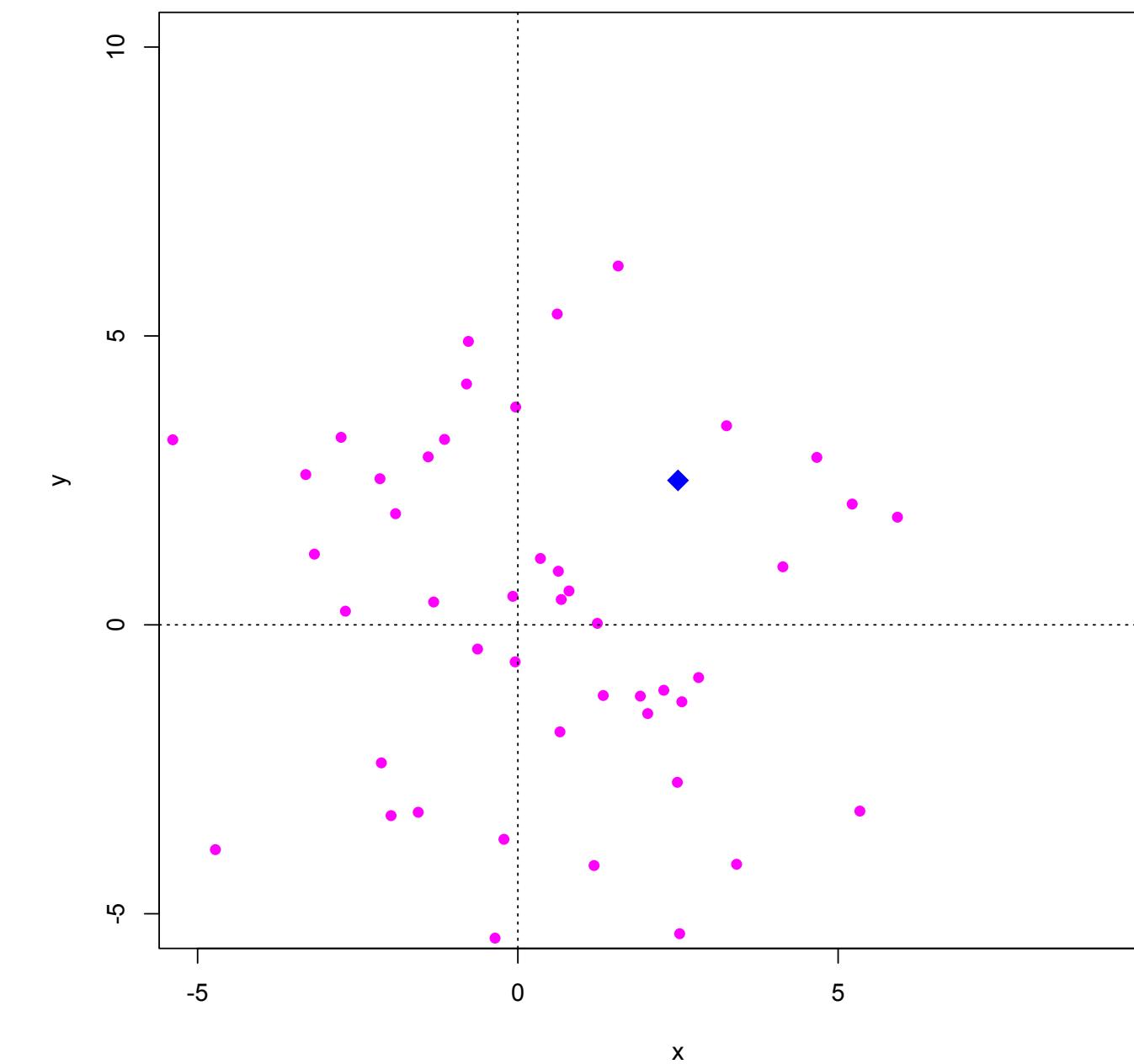
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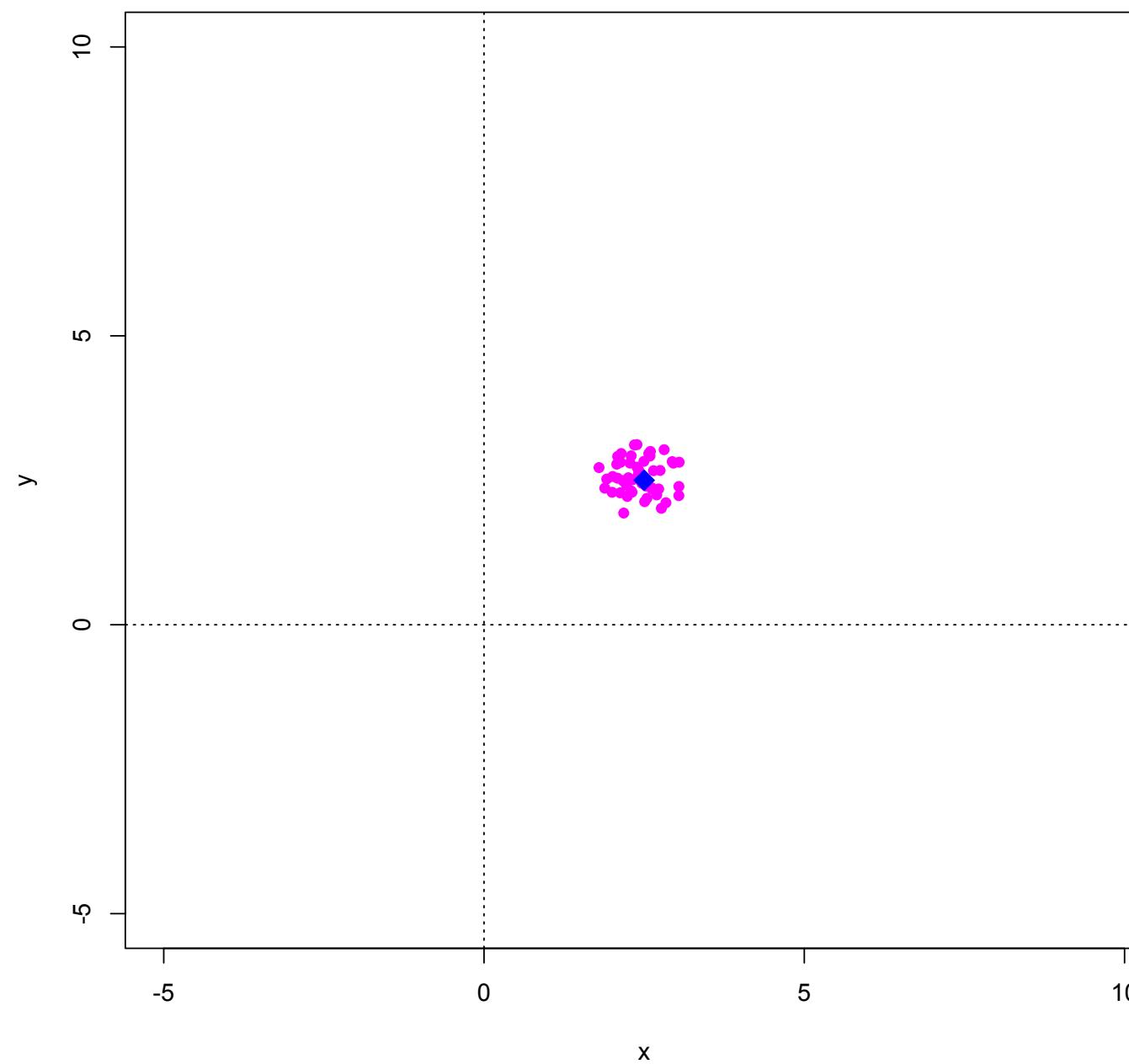
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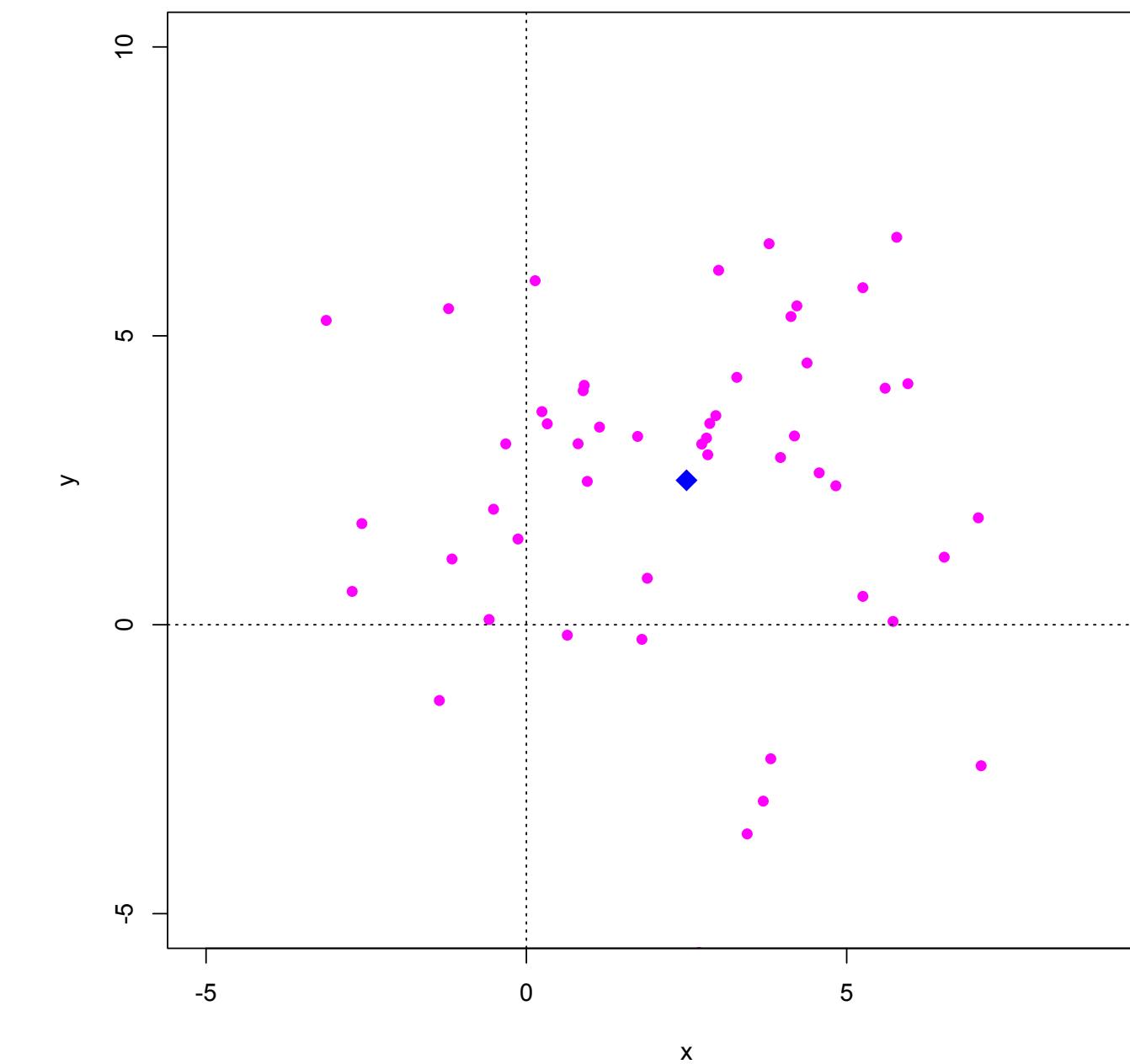
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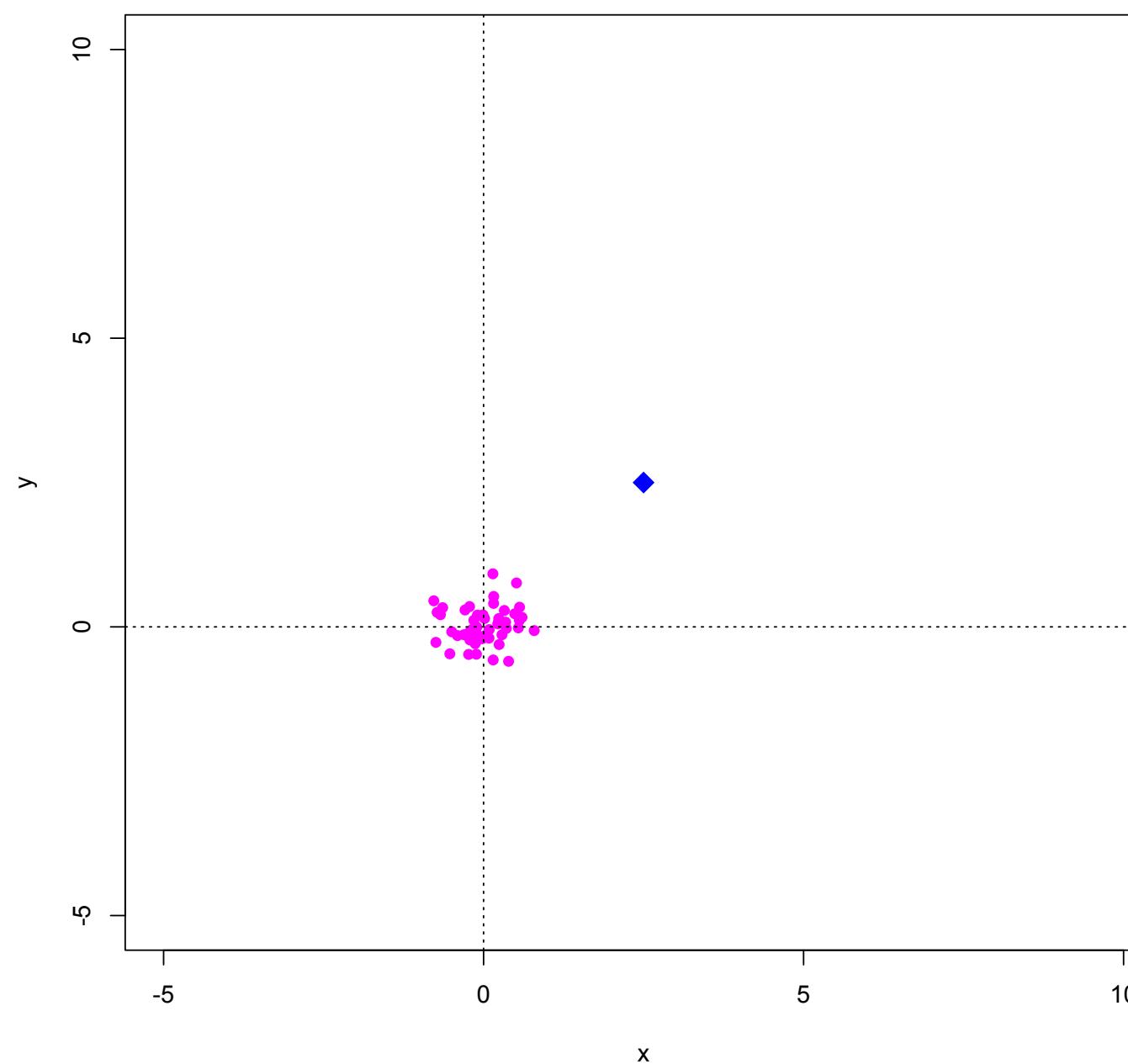
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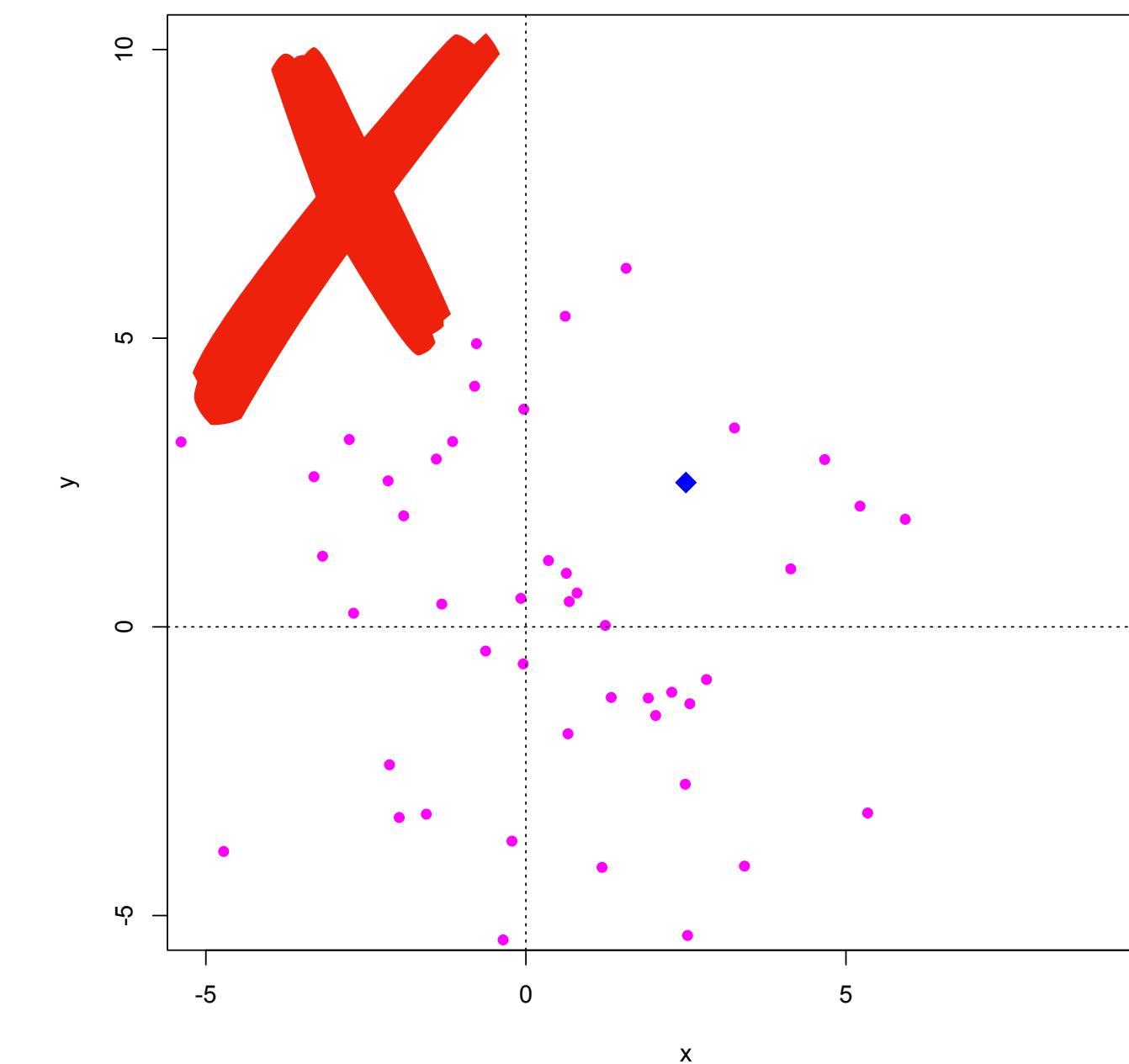
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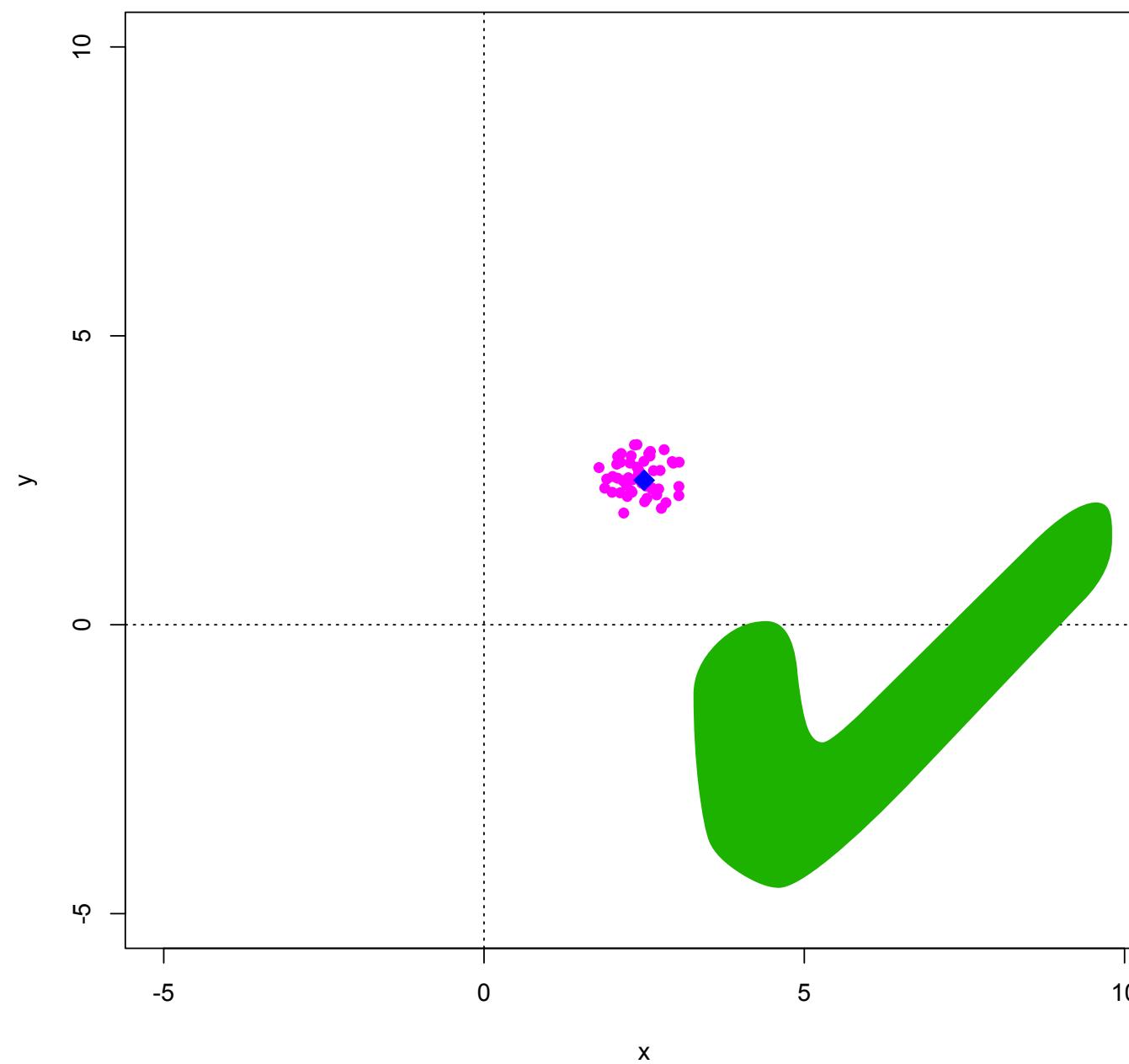
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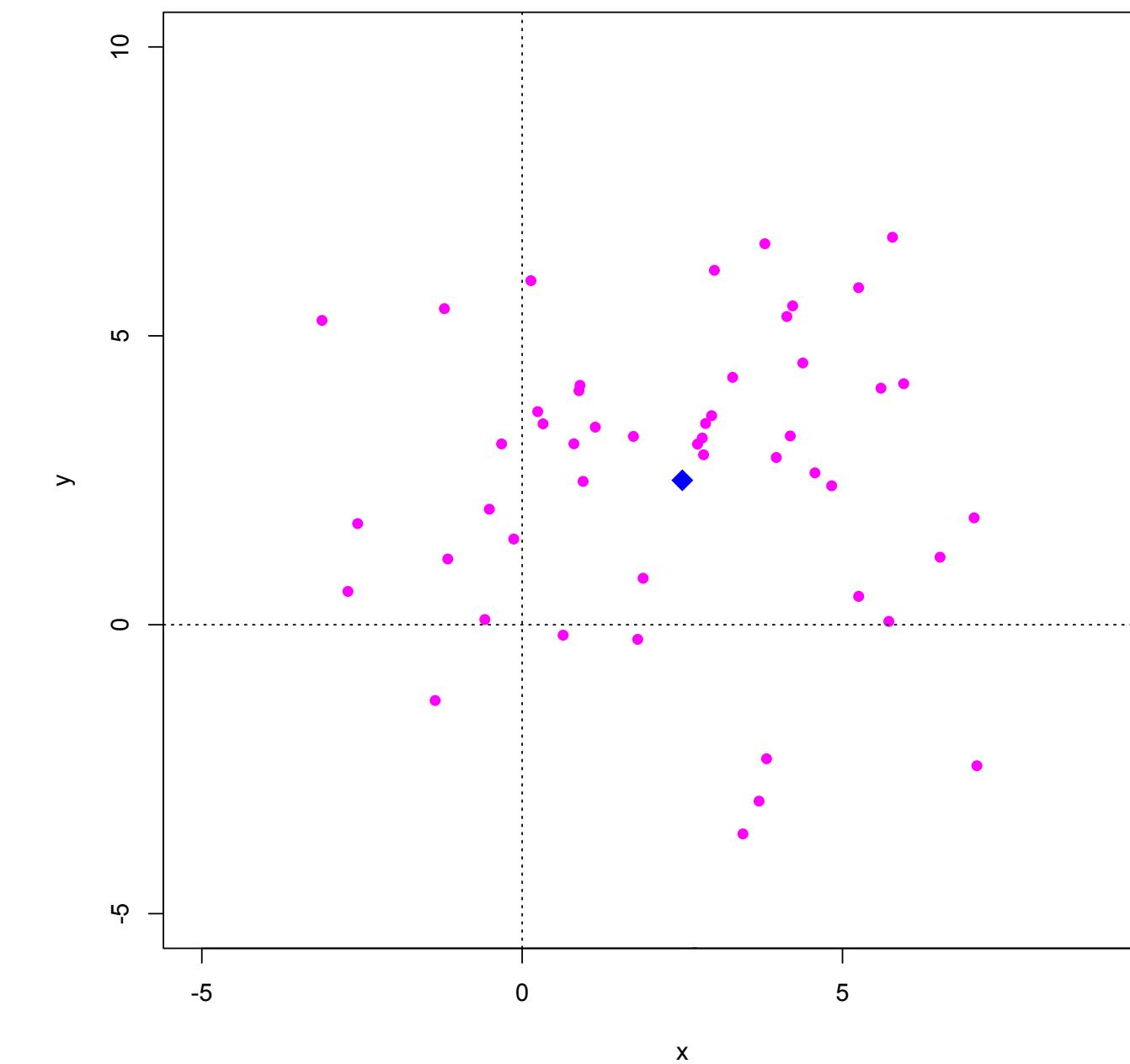
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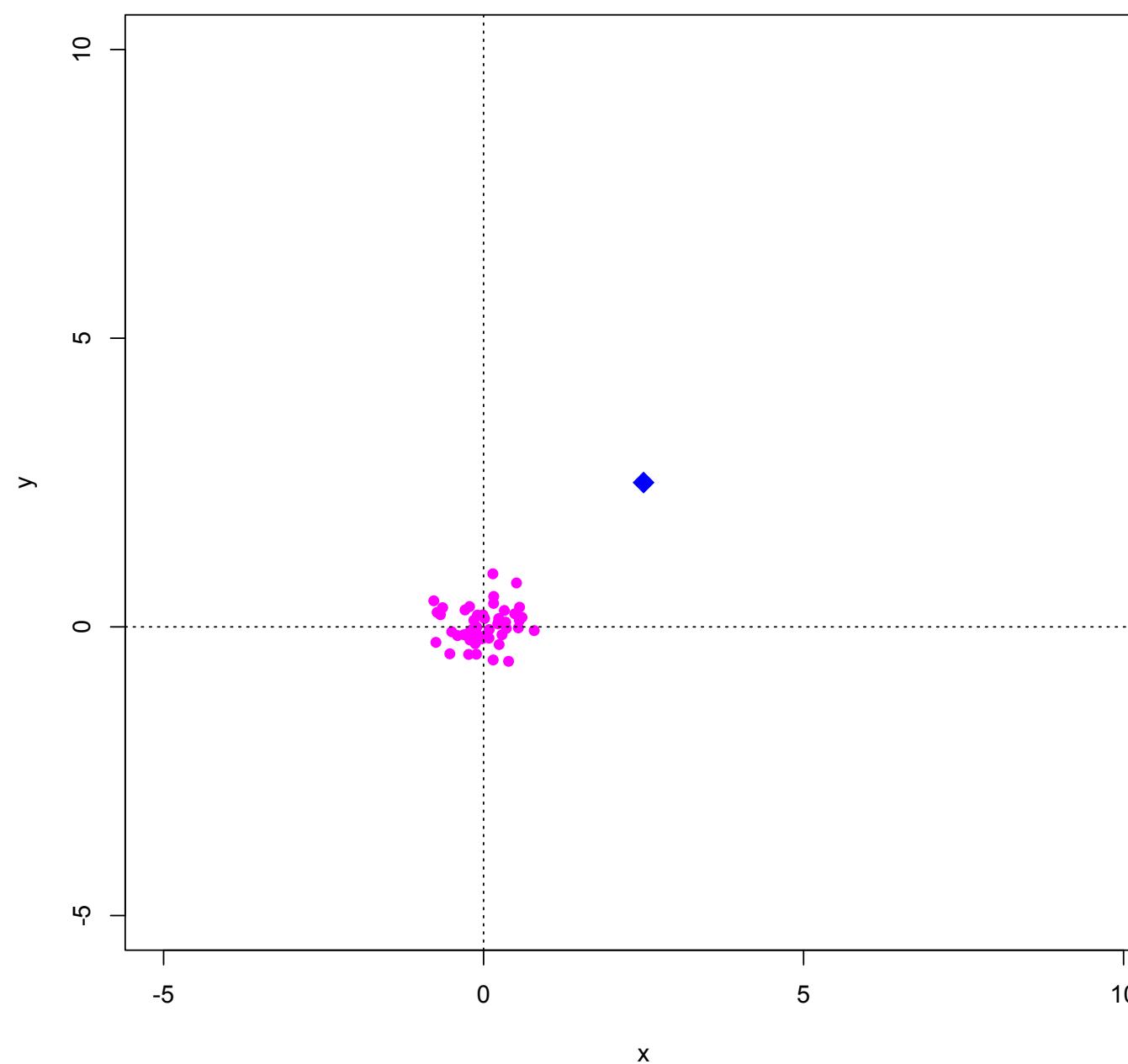
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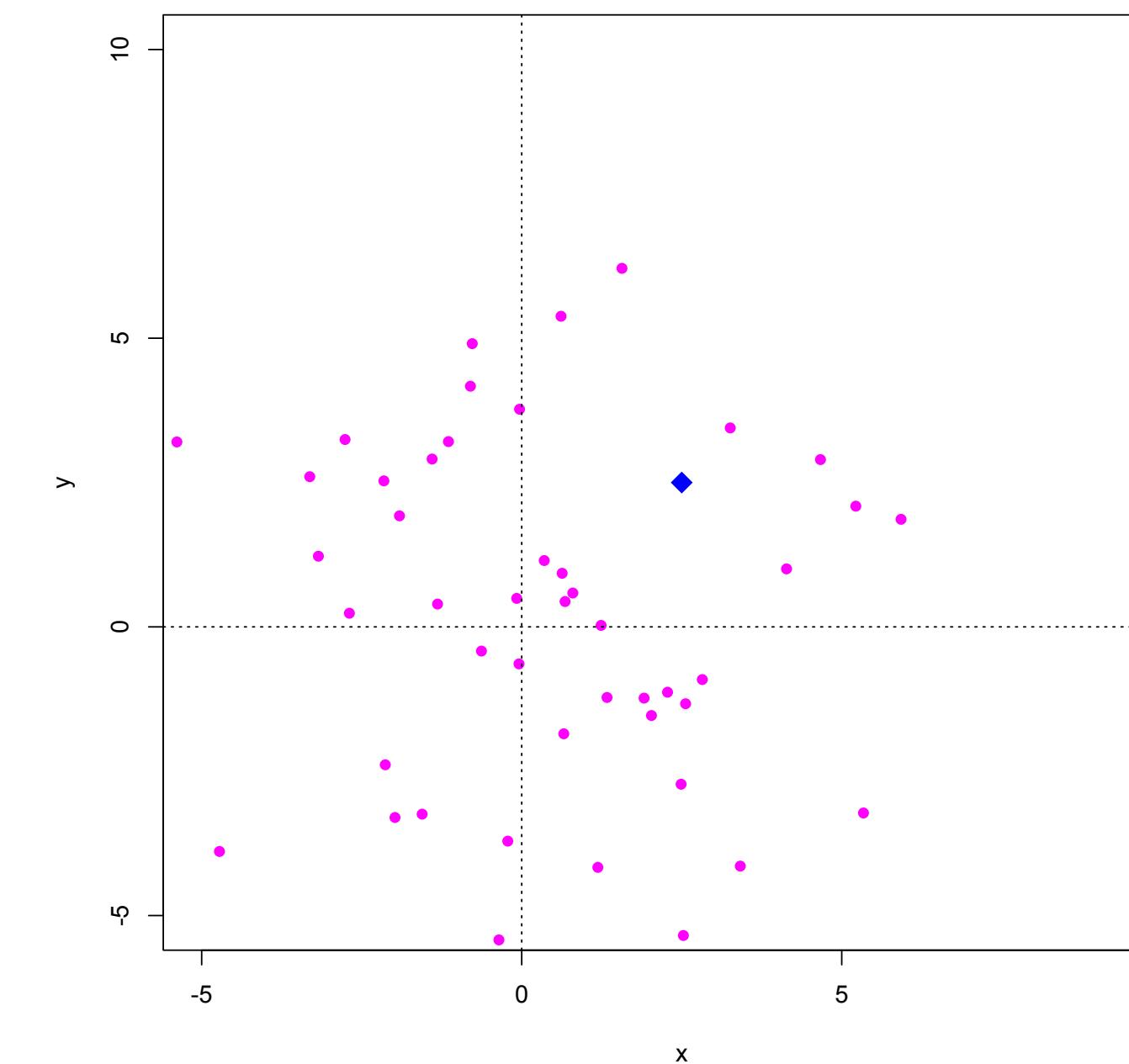
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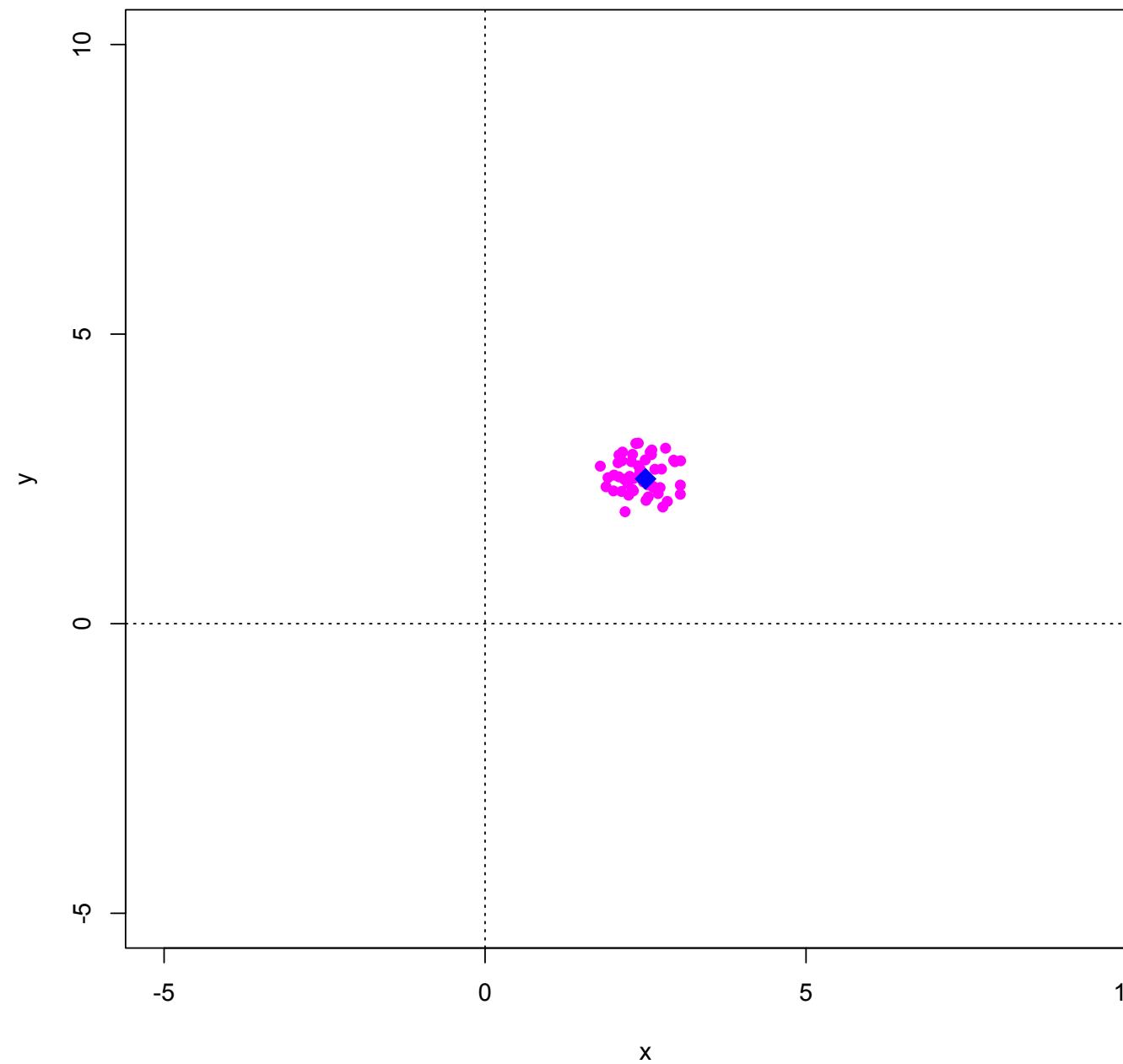
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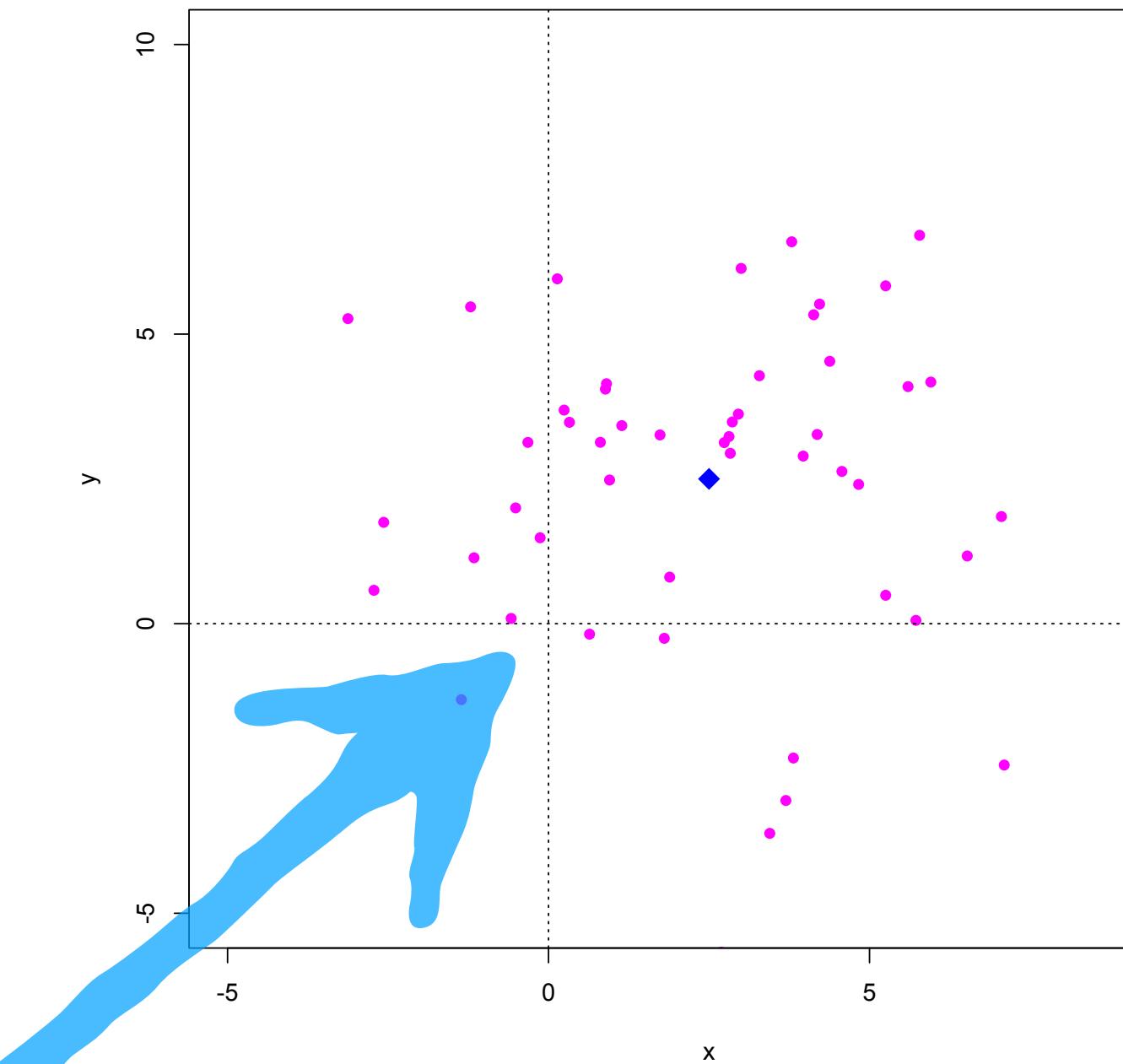
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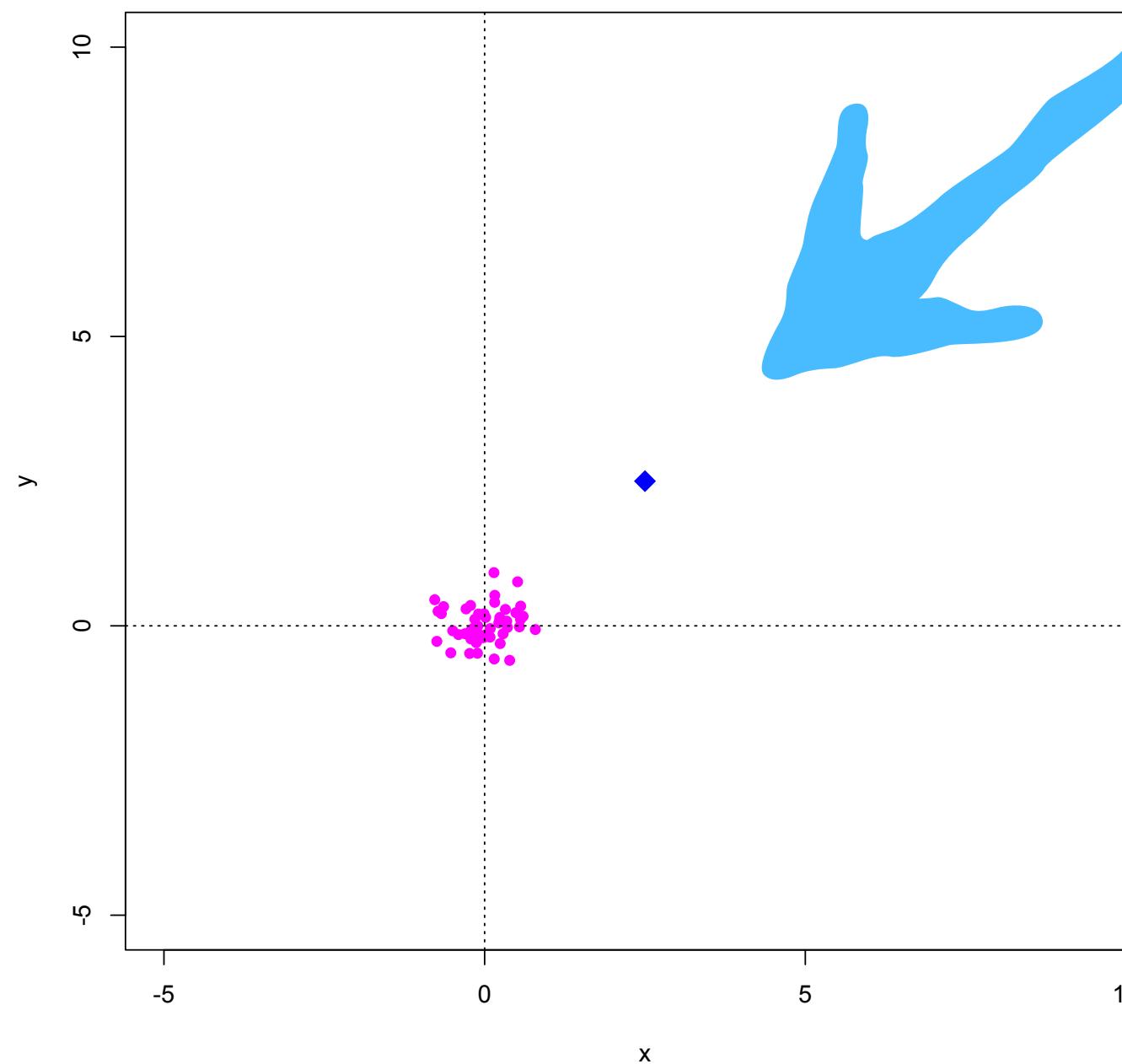
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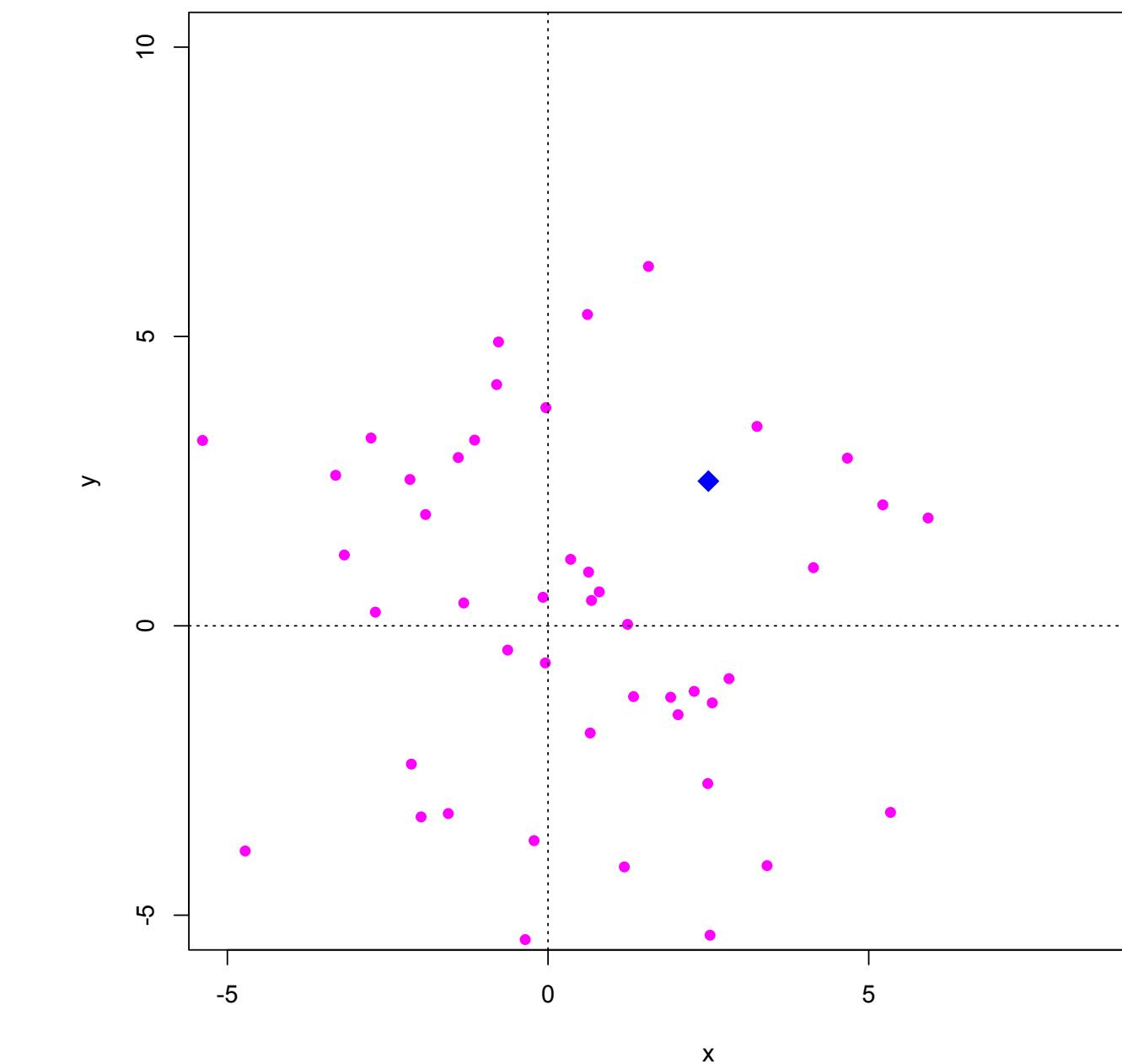
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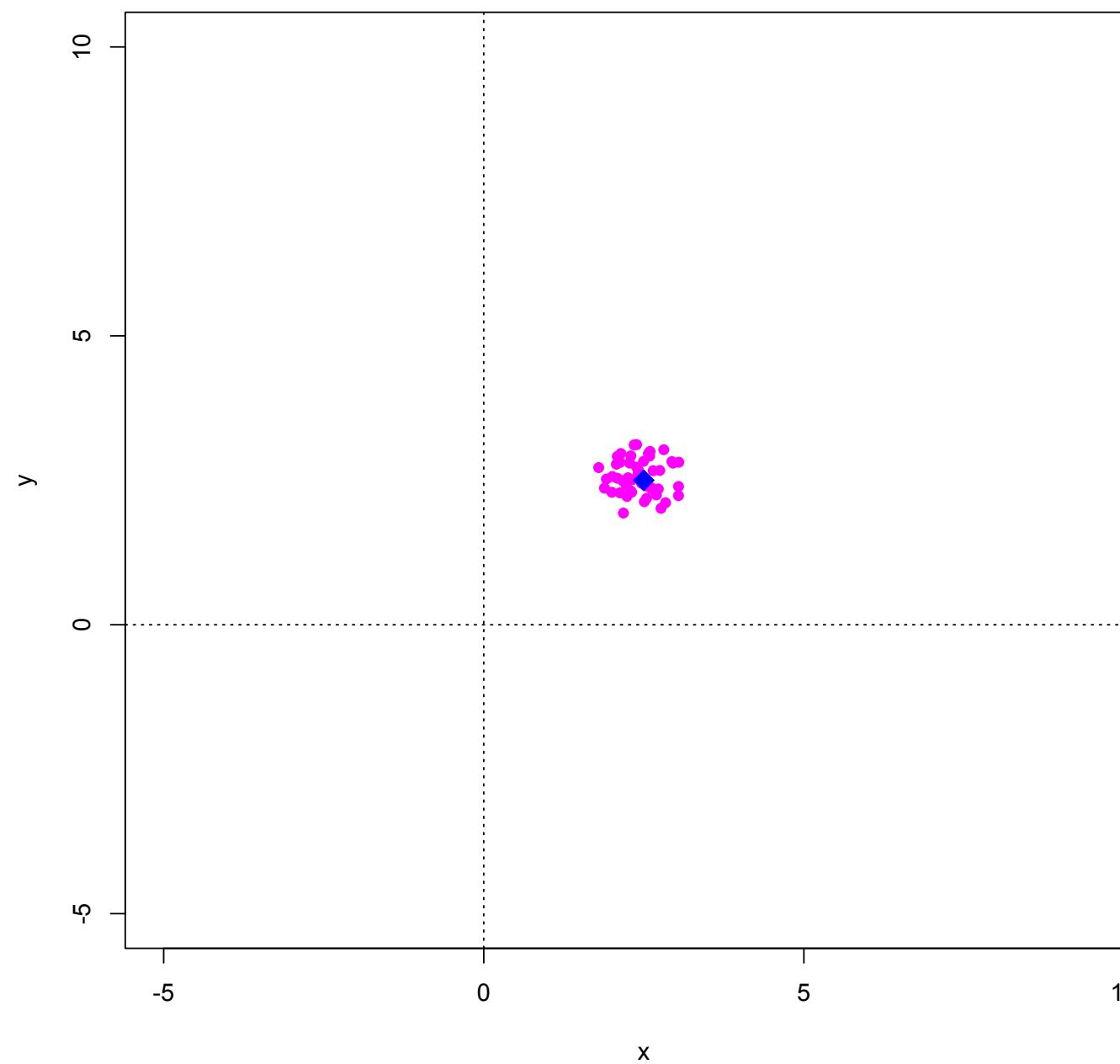
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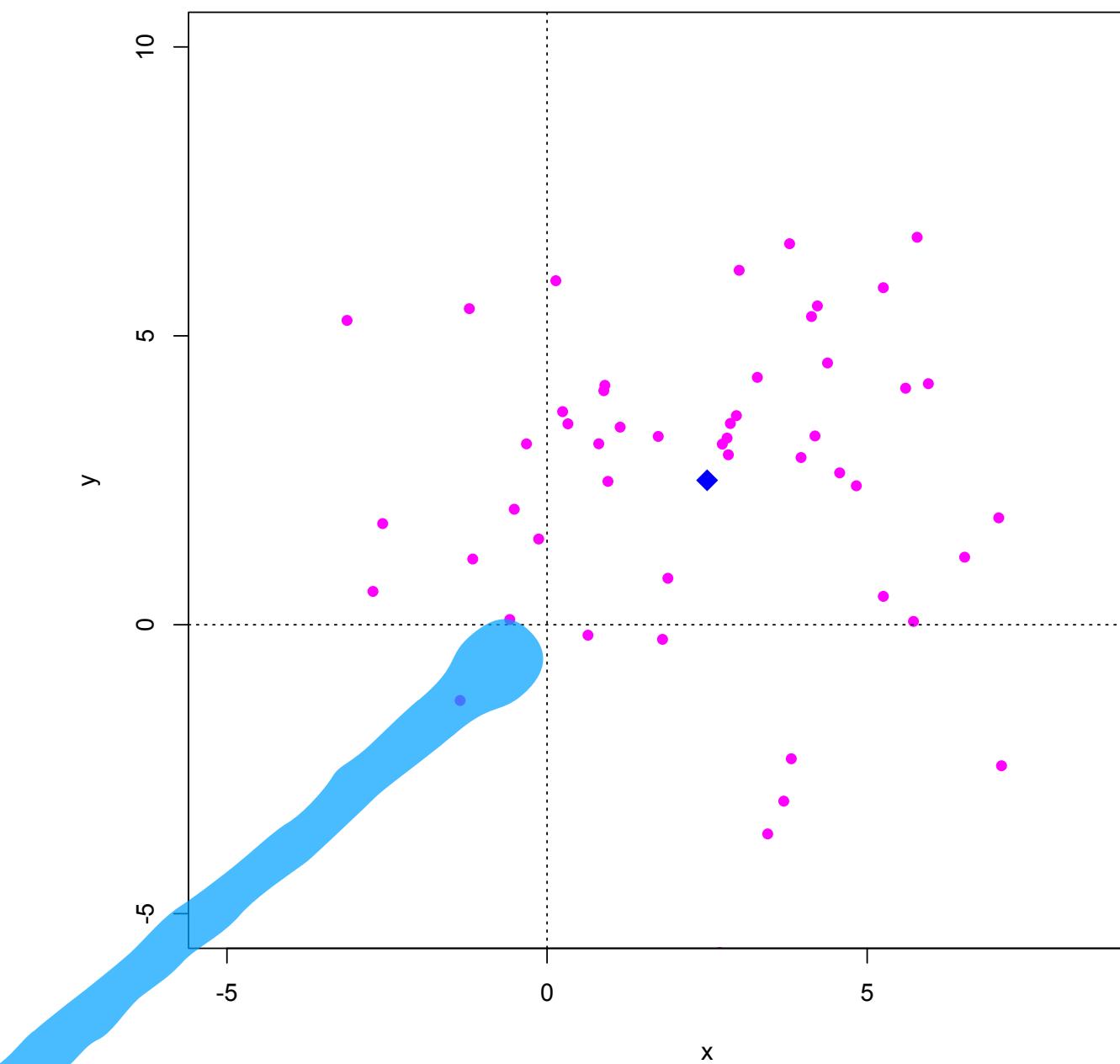
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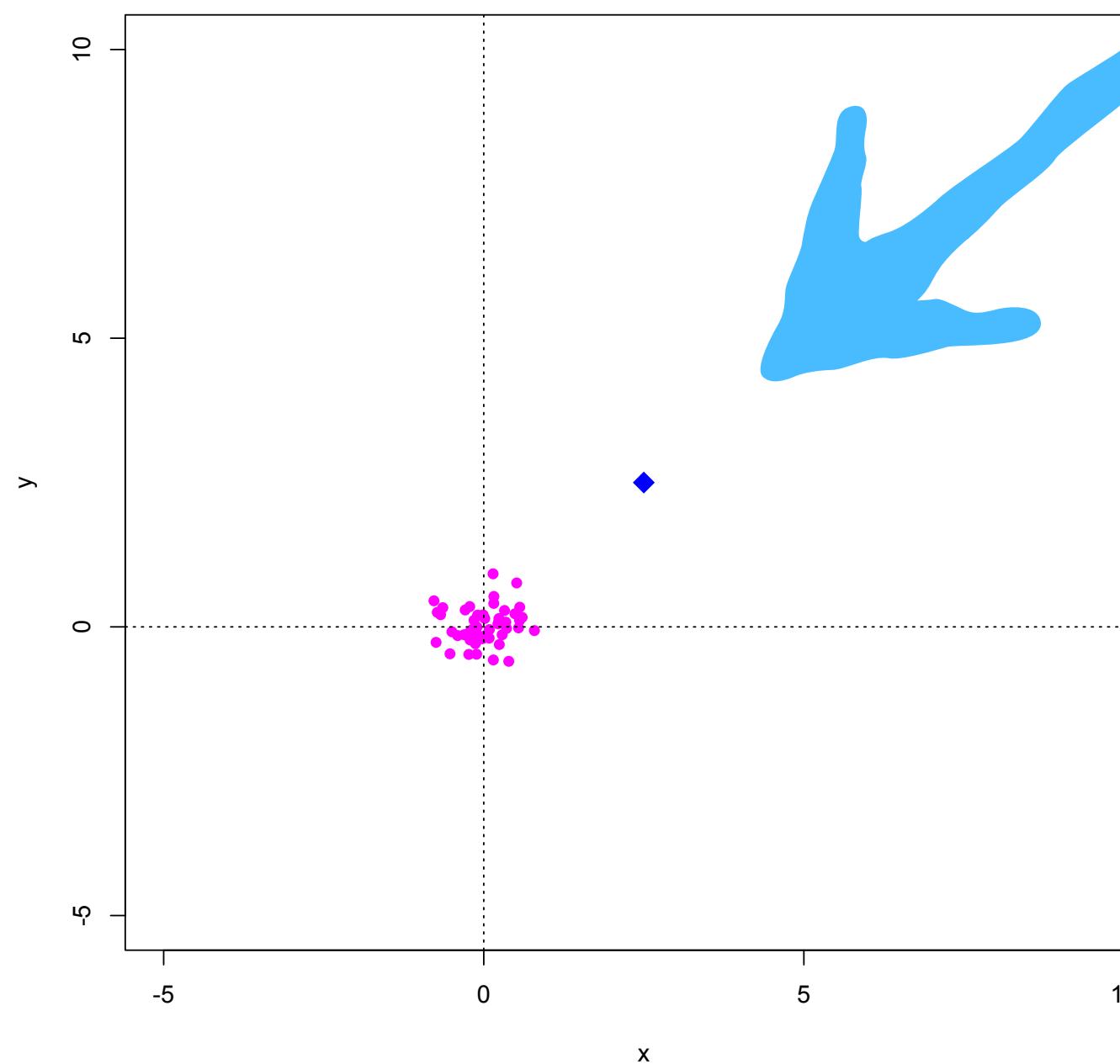
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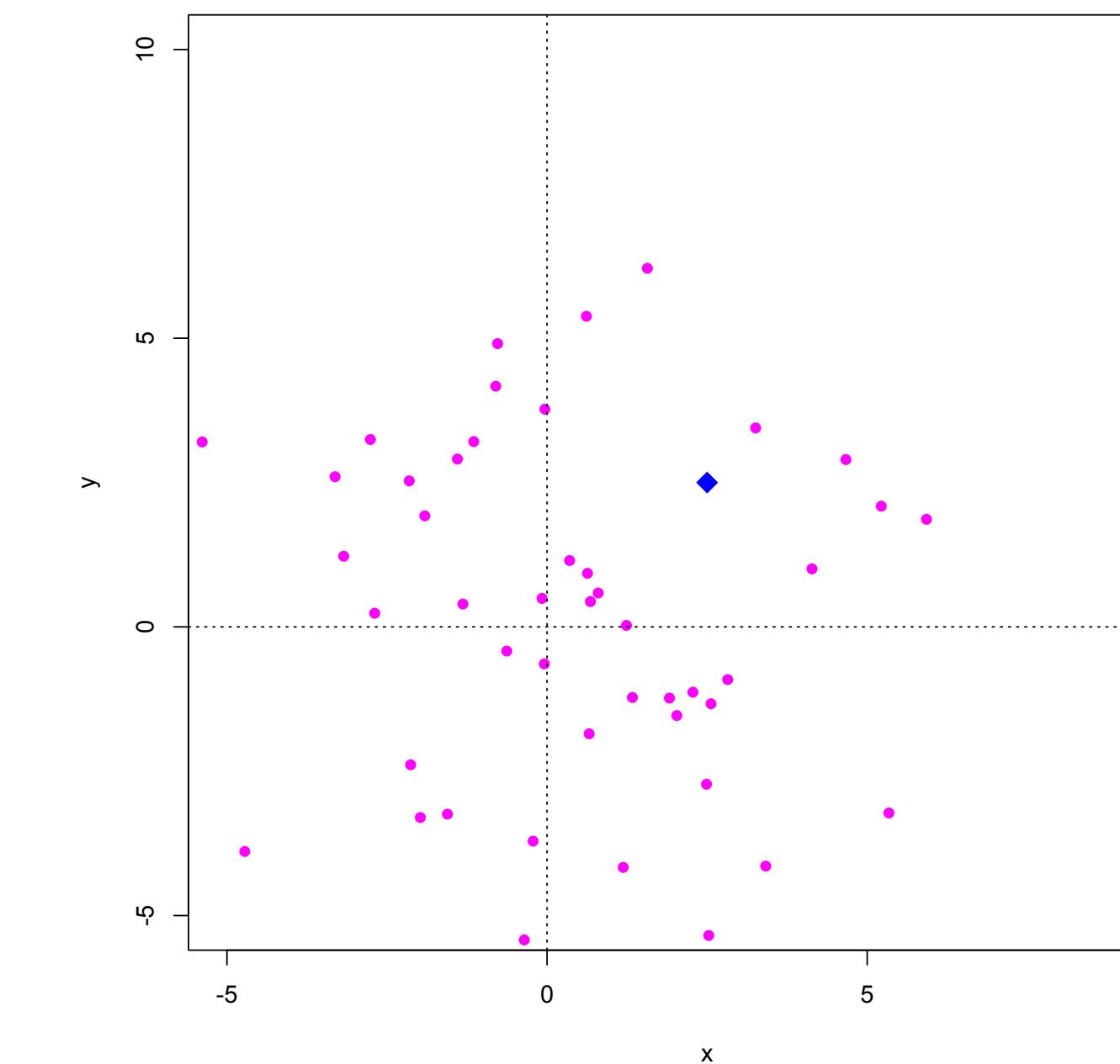
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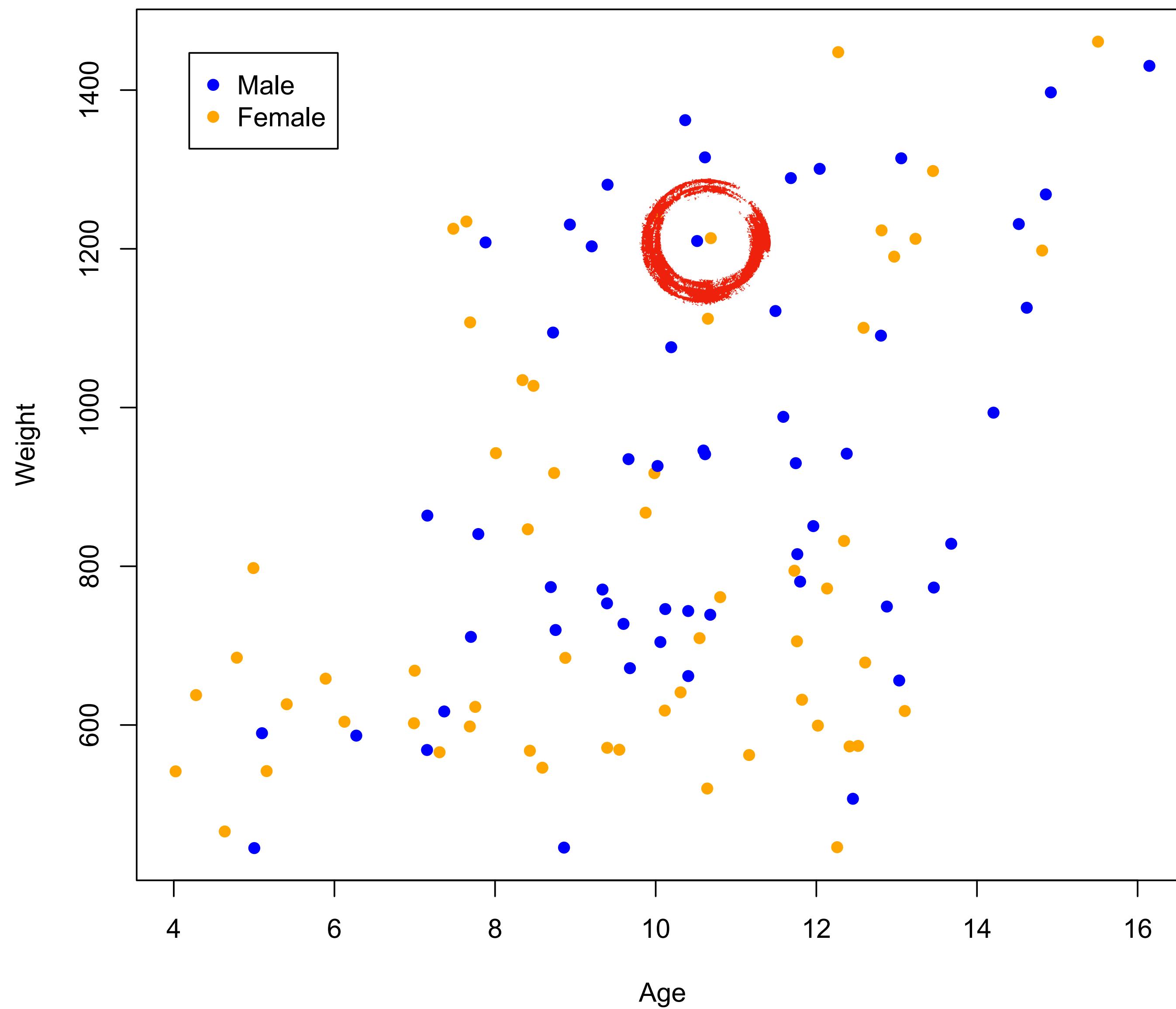
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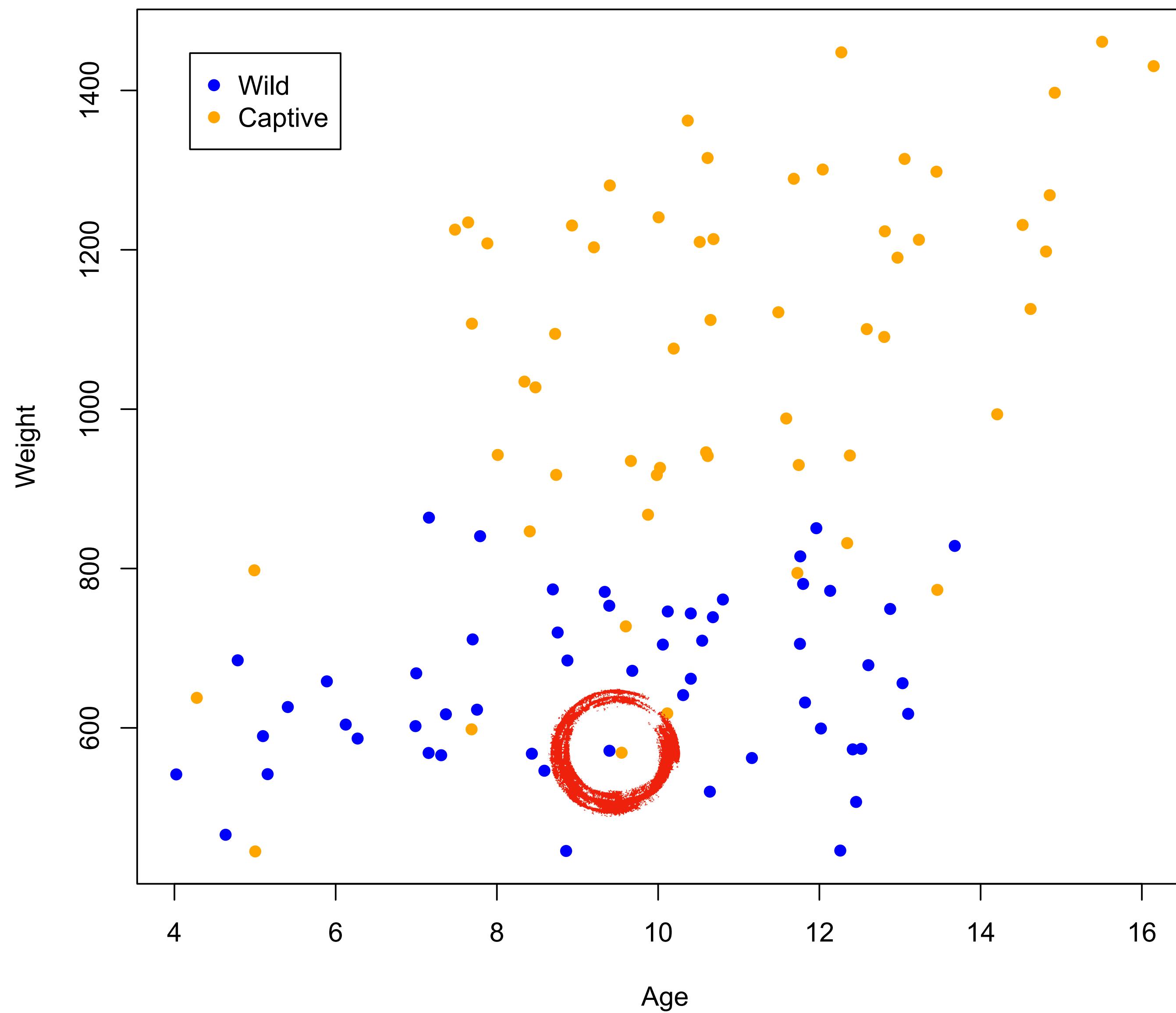


Neighbors

Meerkat Weight vs Age



Meerkat Weight vs Age



Meerkats

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Meerkats

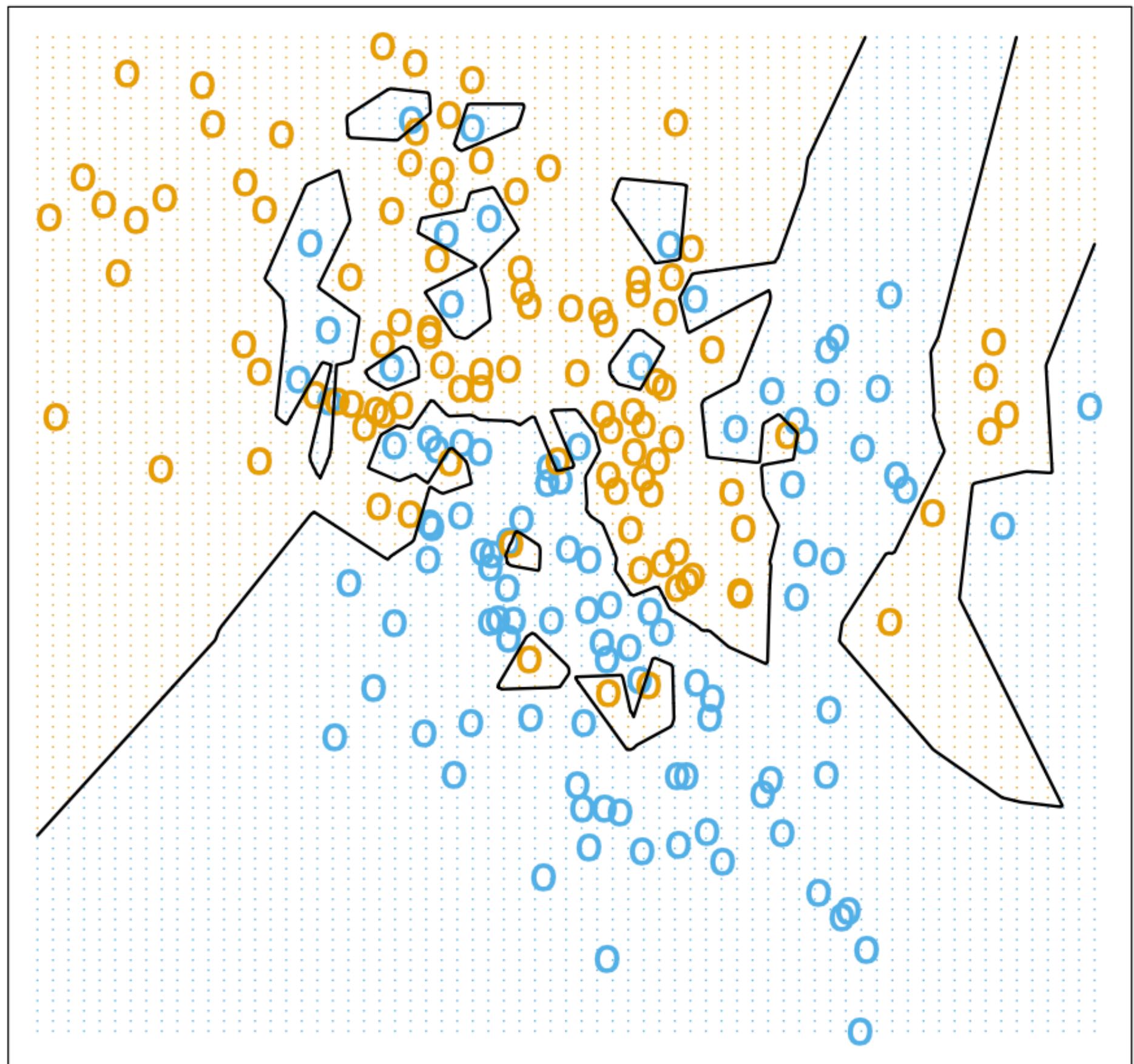
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Meerkats

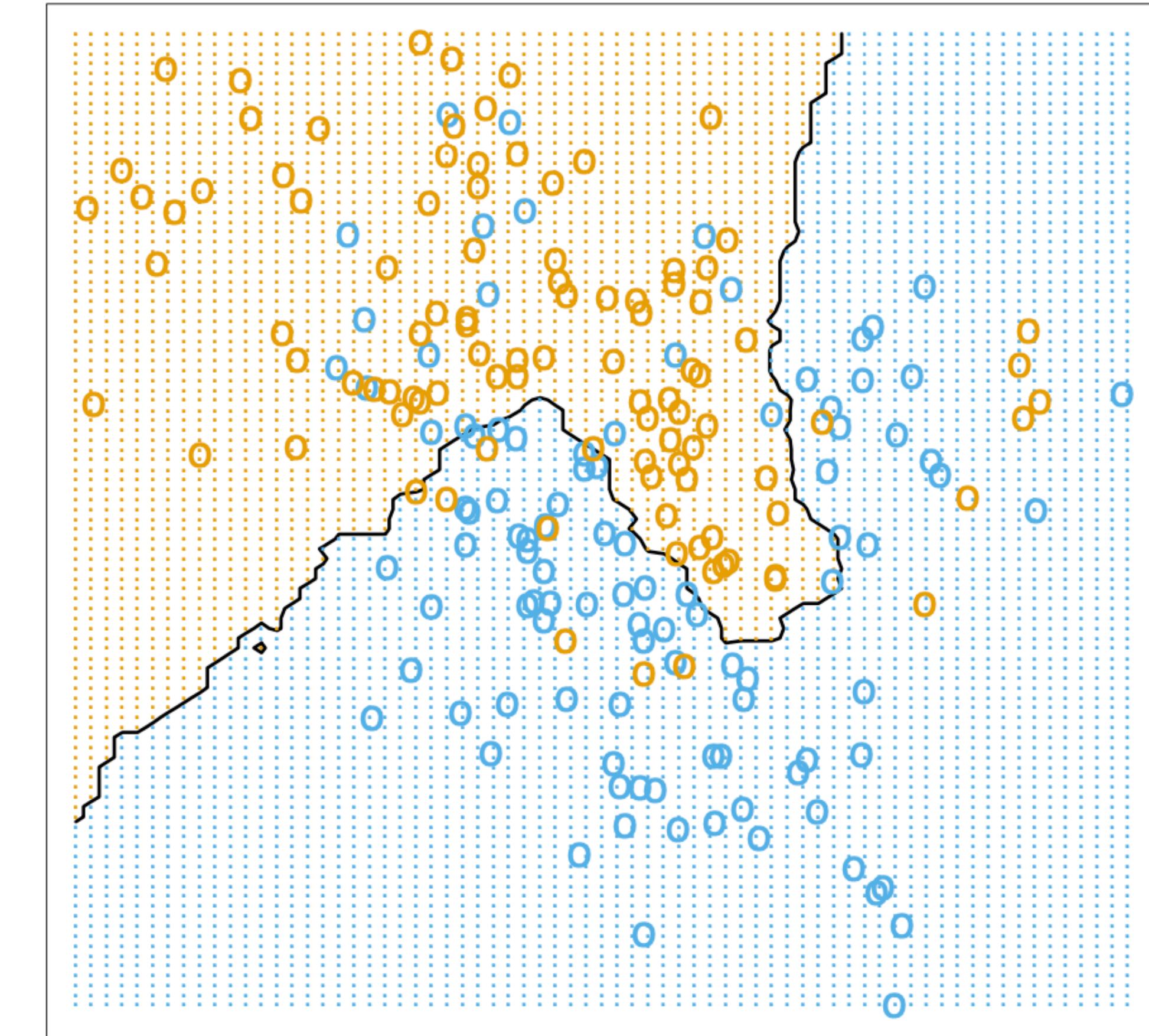
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Meerkats

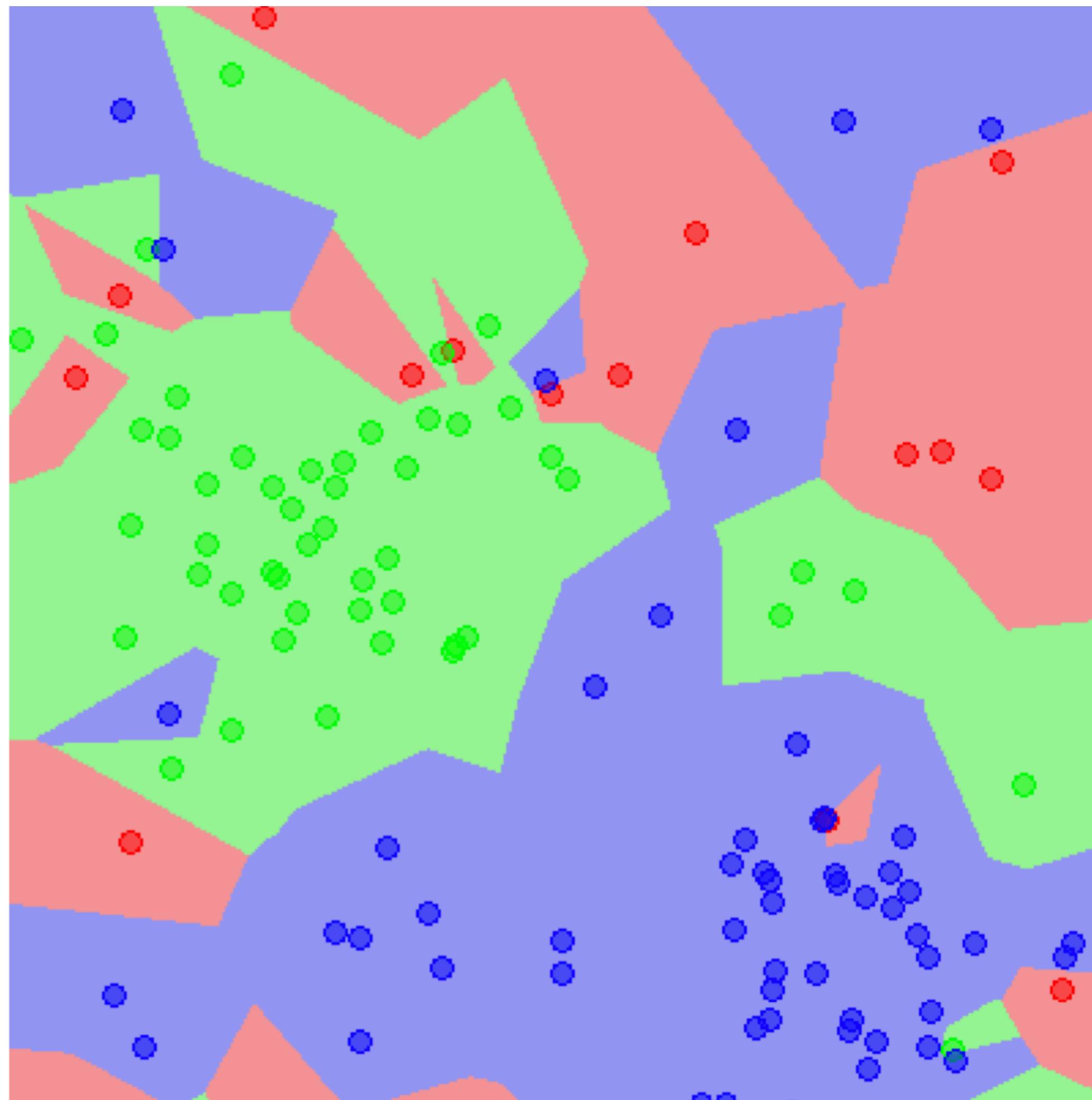
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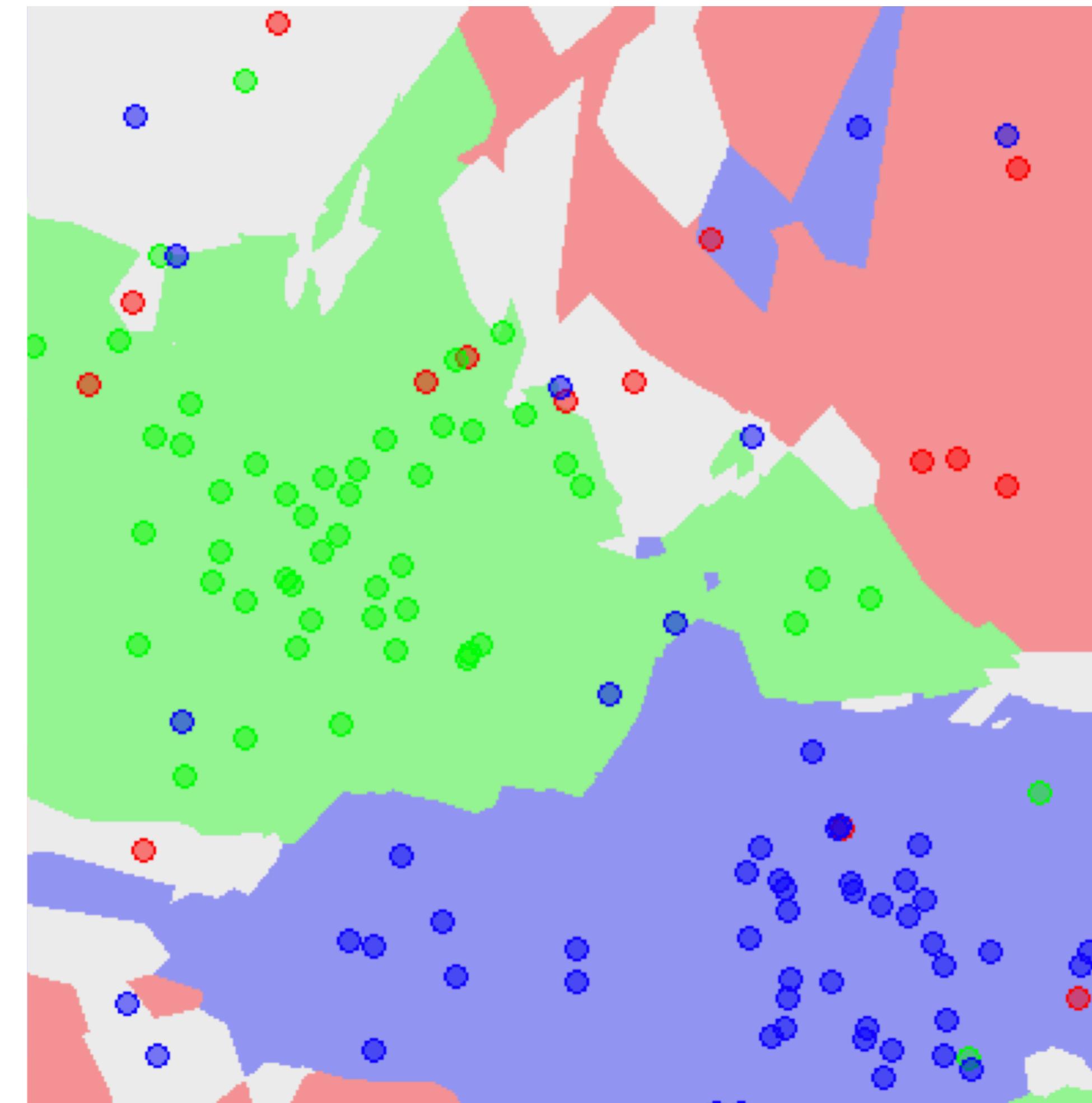
$k=1$



$k=15$



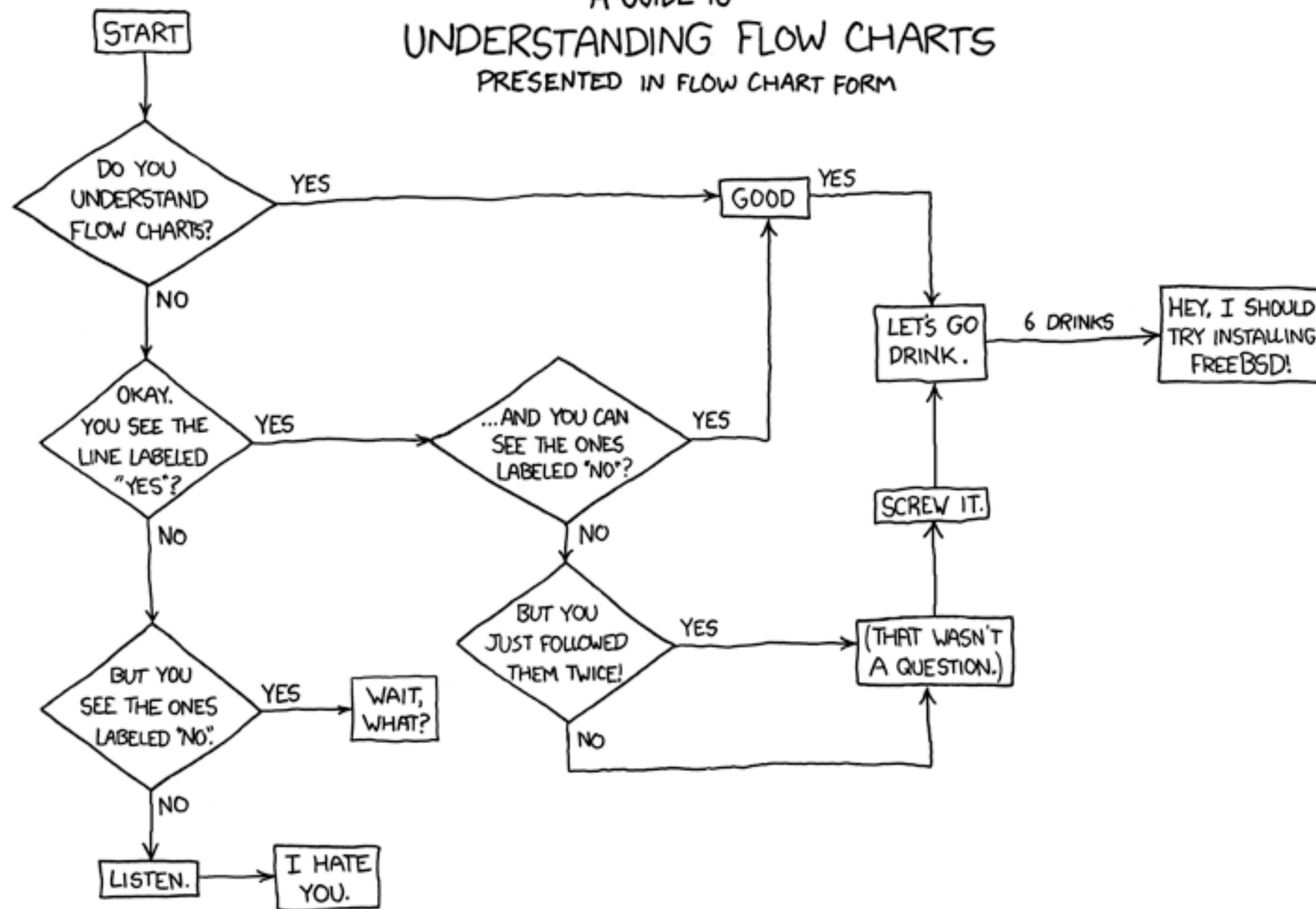
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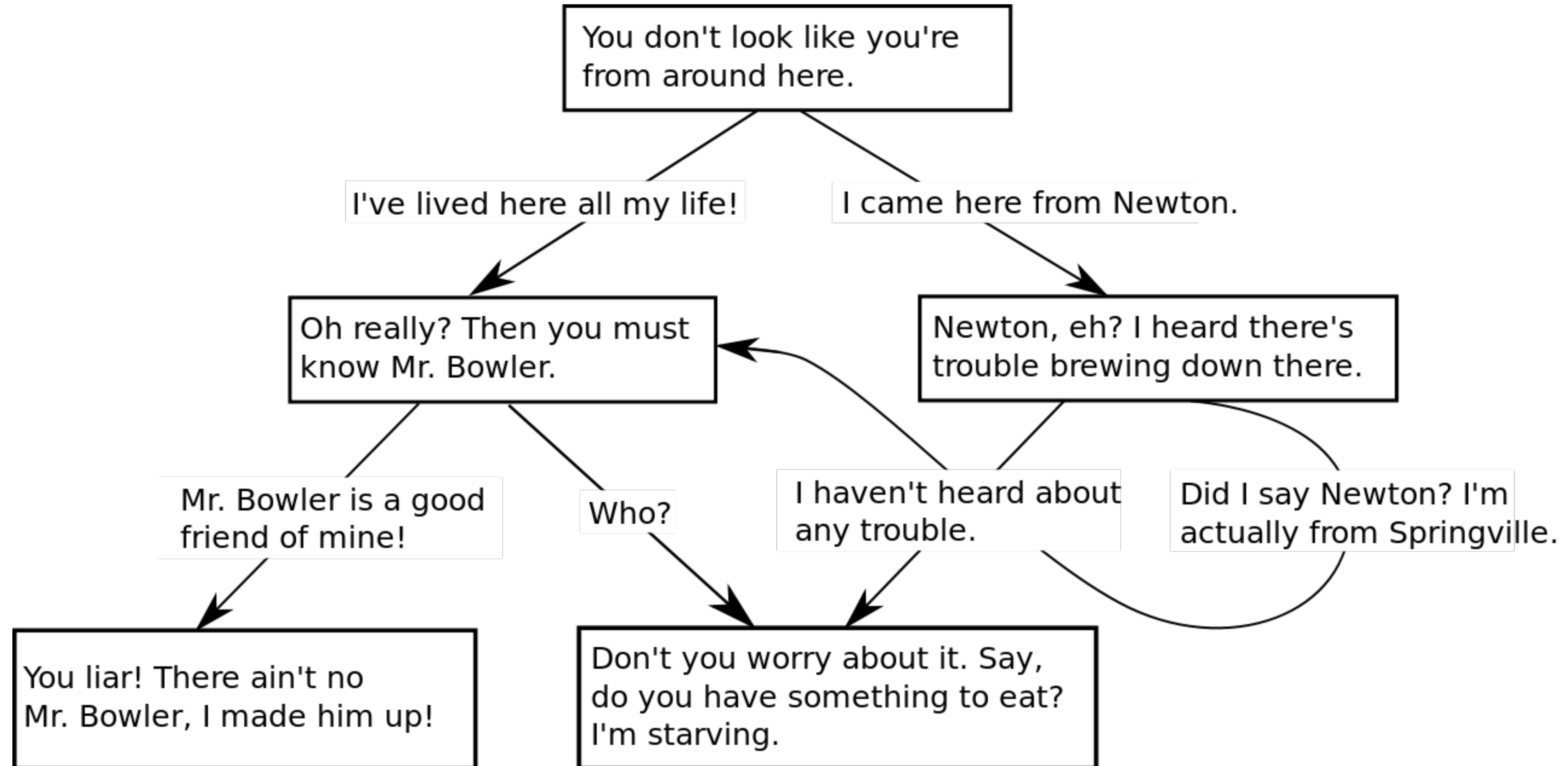


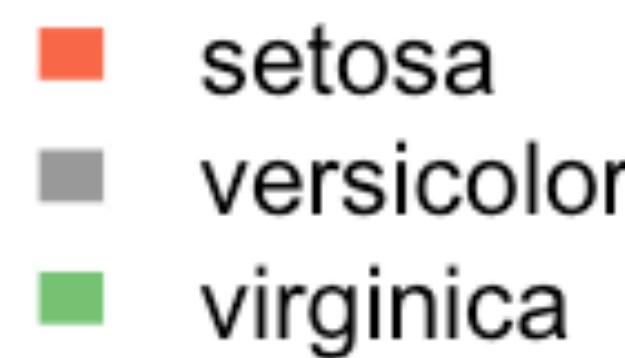
$k=3$



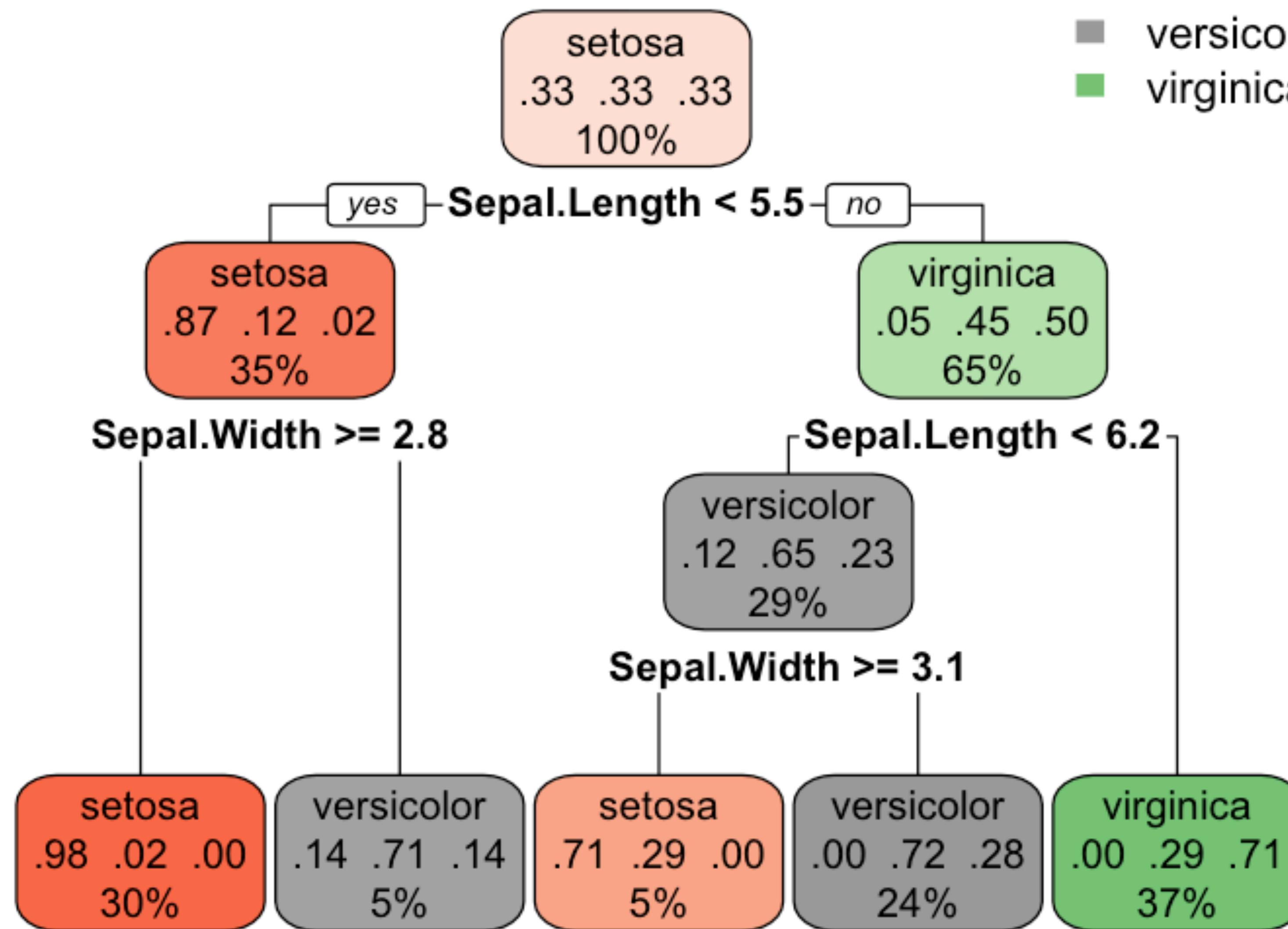
A GUIDE TO
UNDERSTANDING FLOW CHARTS
PRESENTED IN FLOW CHART FORM

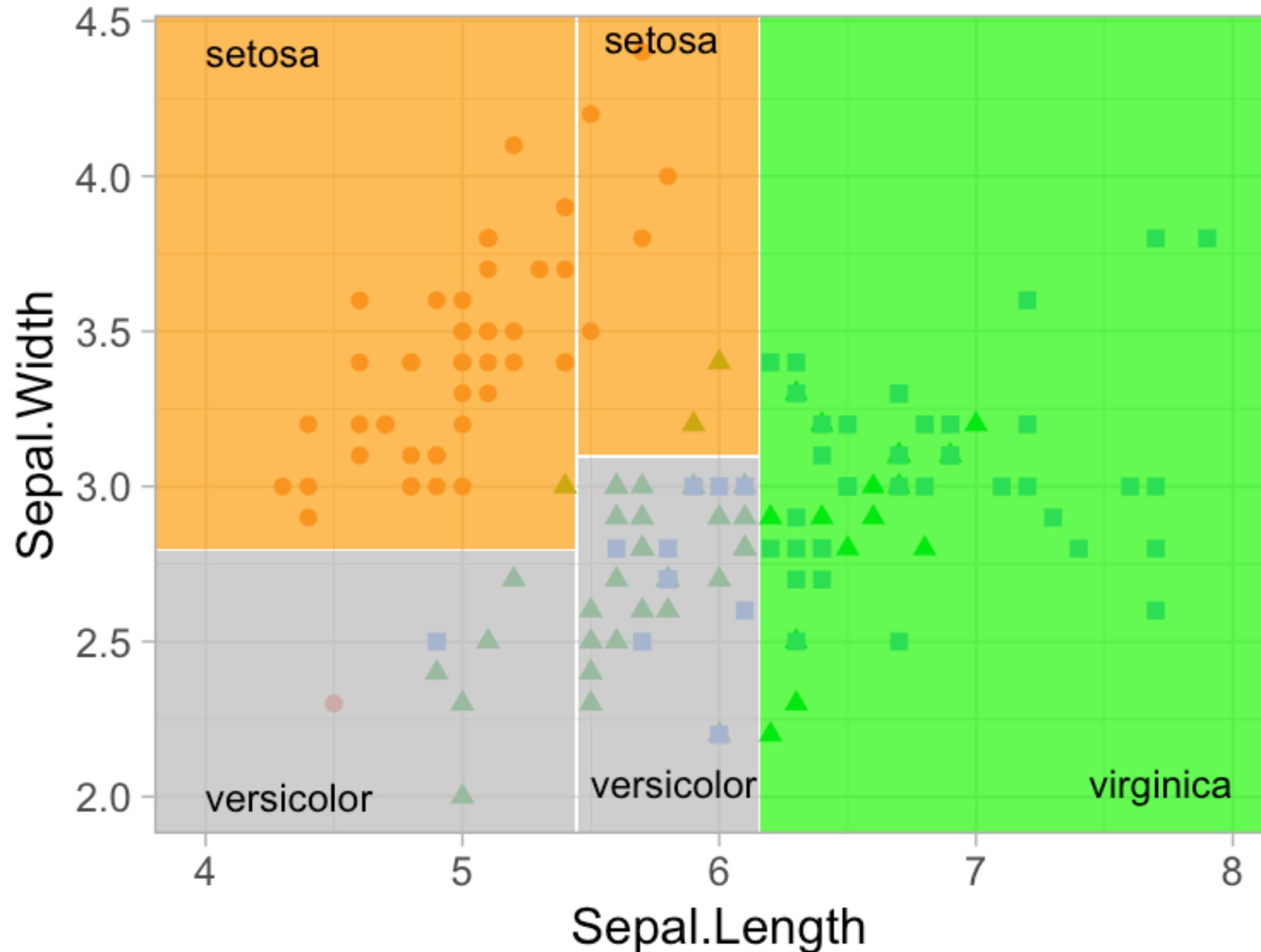






setosa
versicolor
virginica





$$\frac{1}{n_R} \sum_{i \in R} \mathbf{1}(y_i \neq \hat{y}_R)$$

Misclassification Error

$$-\sum_{k \in R} p_k \log p_k$$

(Cross) Entropy

$$\sum_{k \in R} p_k(1 - p_k)$$

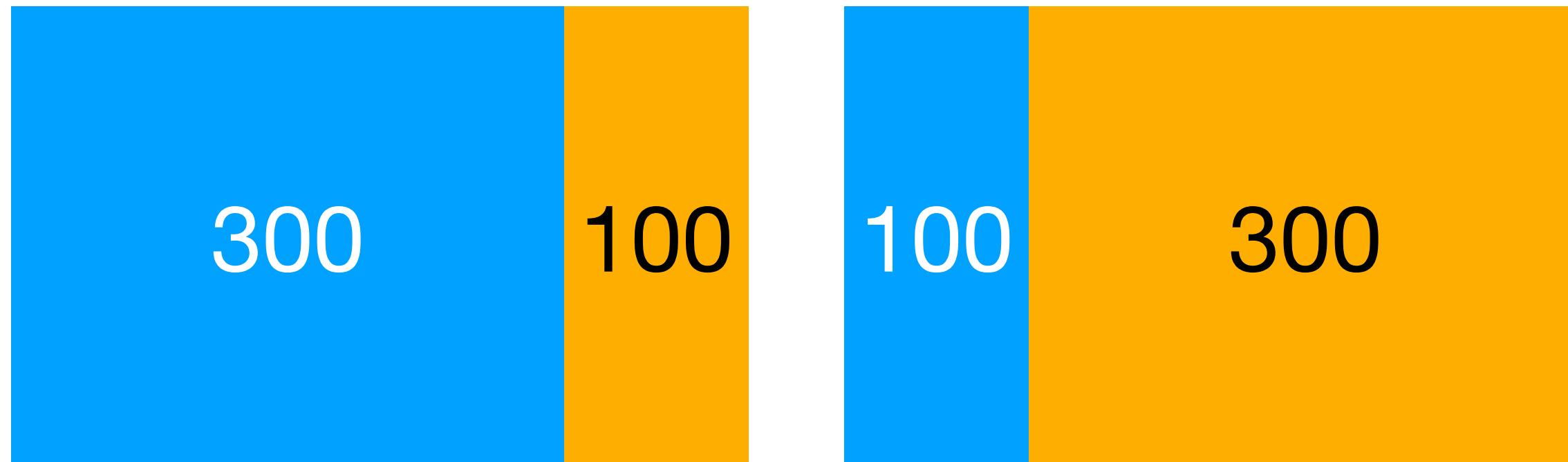
Gini Impurity

Parent



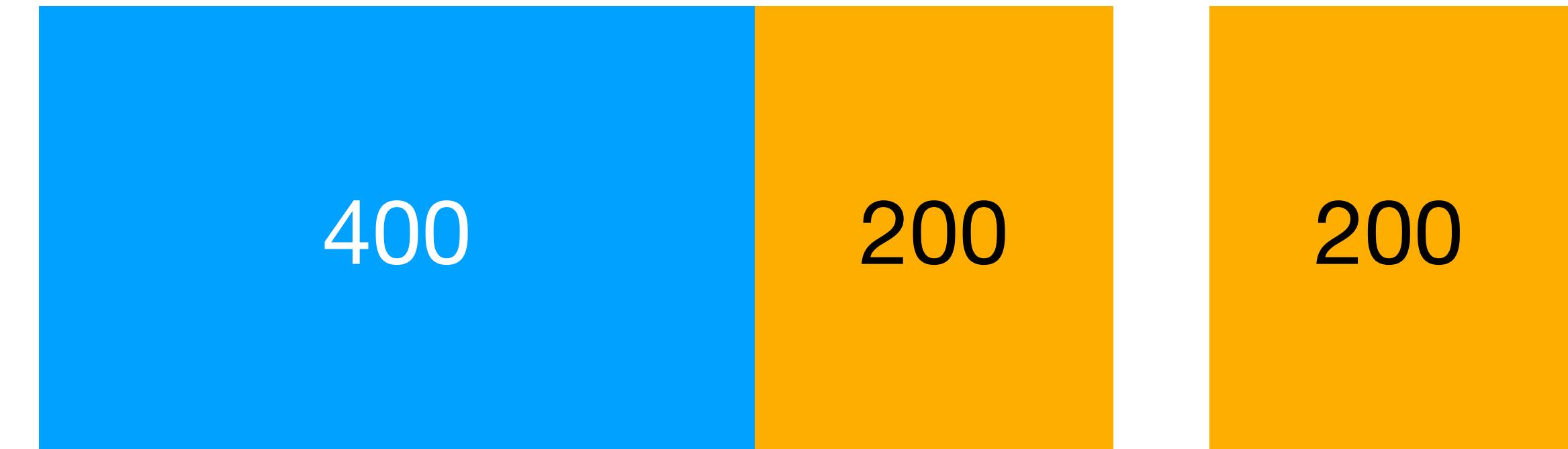
Misclassification: 0.5
Gini: 0.5
Entropy: 0.693

Split Option 1



Misclassification: 0.25
Gini: 0.375
Entropy: 0.56

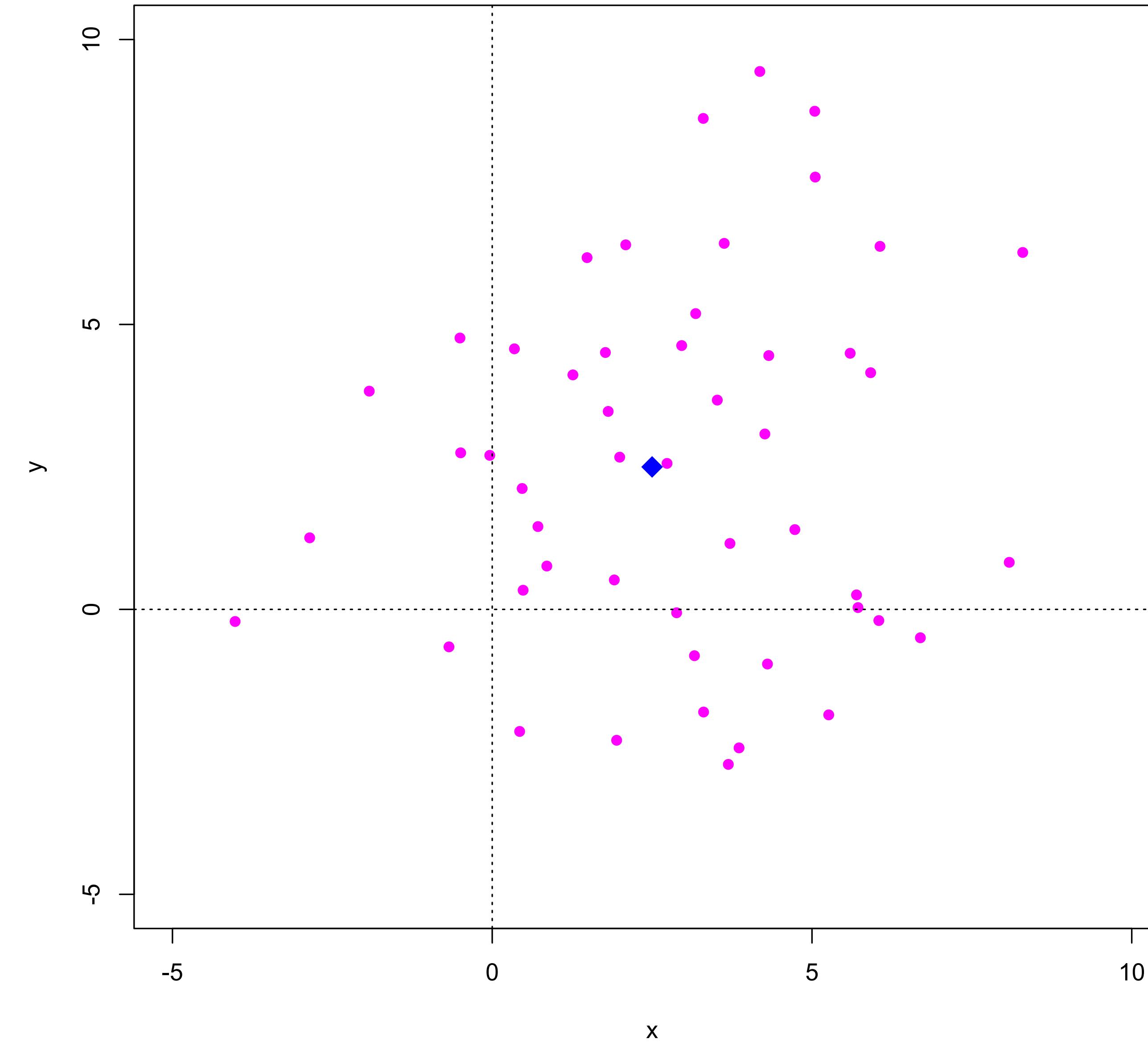
Split Option 2



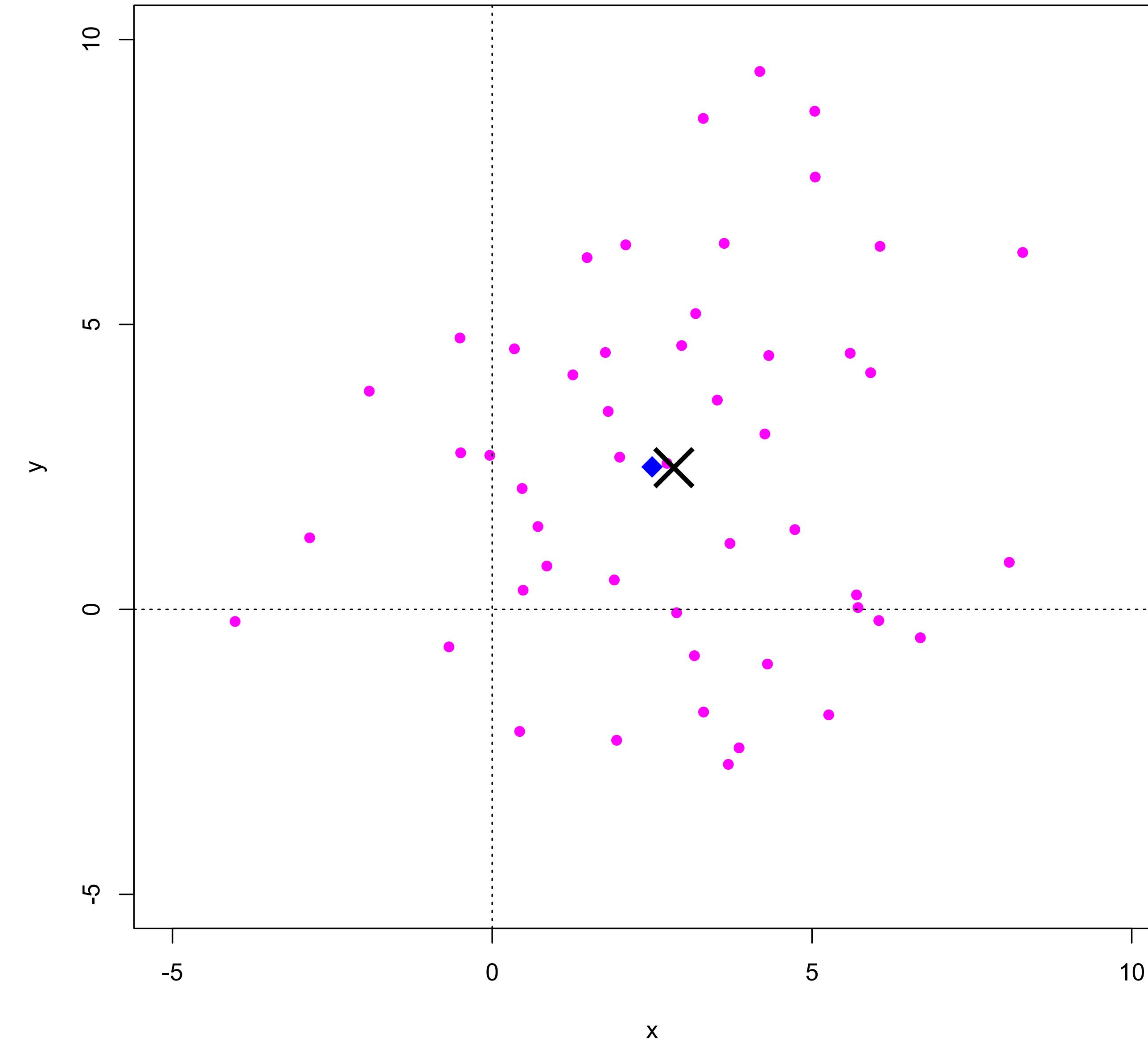
Misclassification: 0.25
Gini: 0.333
Entropy: 0.477



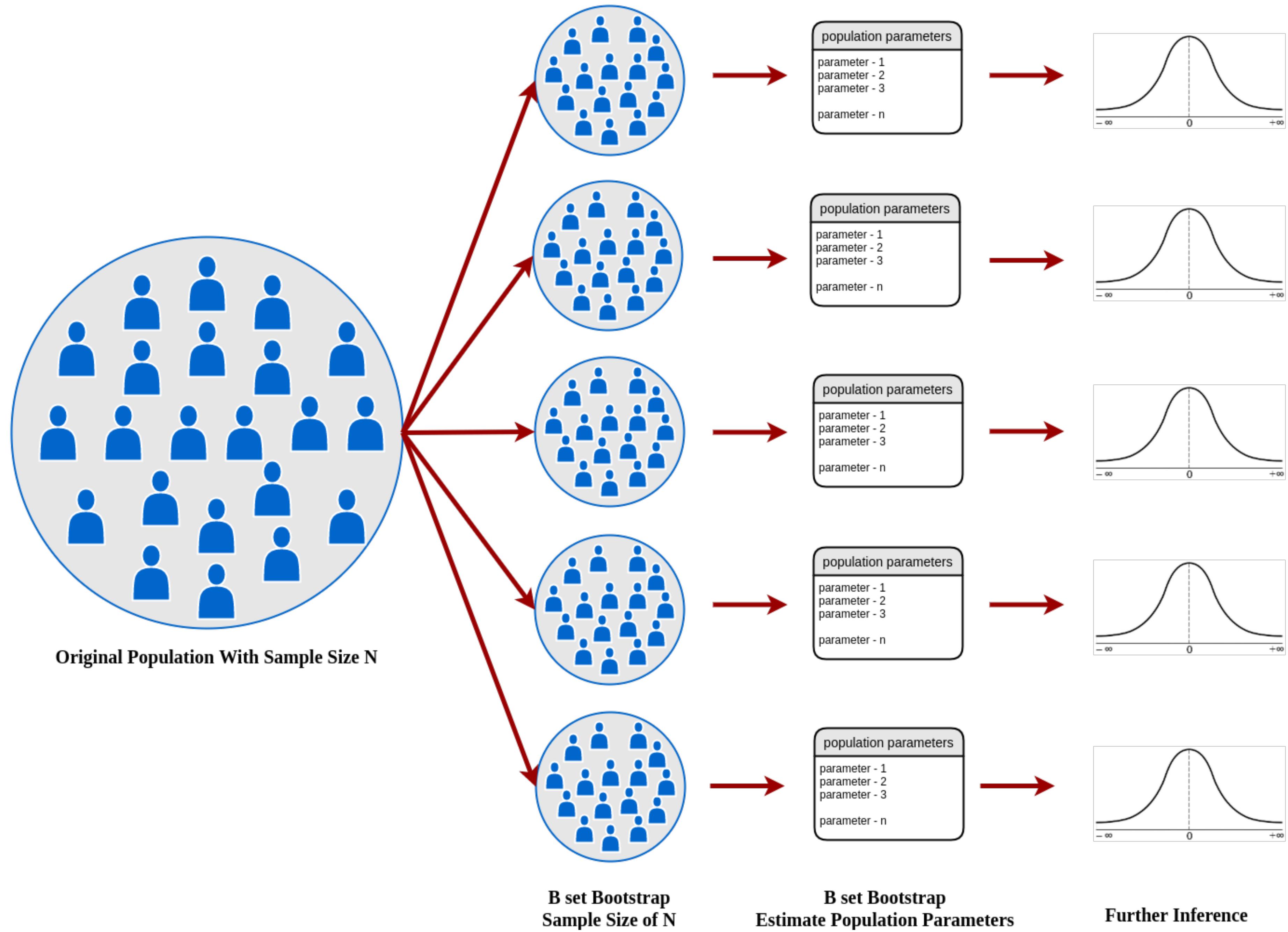
High Variance, Low Bias



High Variance, Low Bias

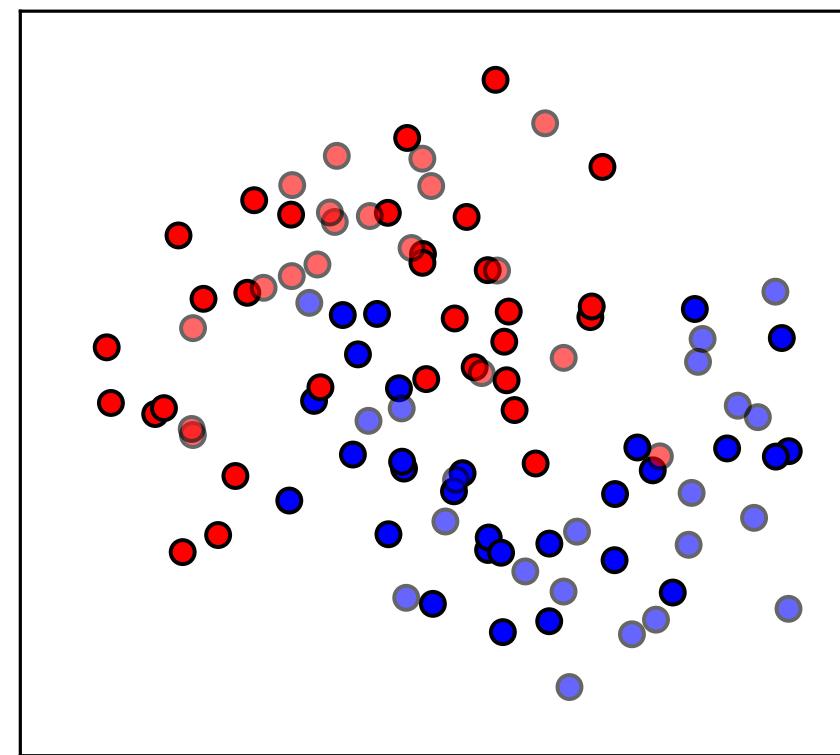




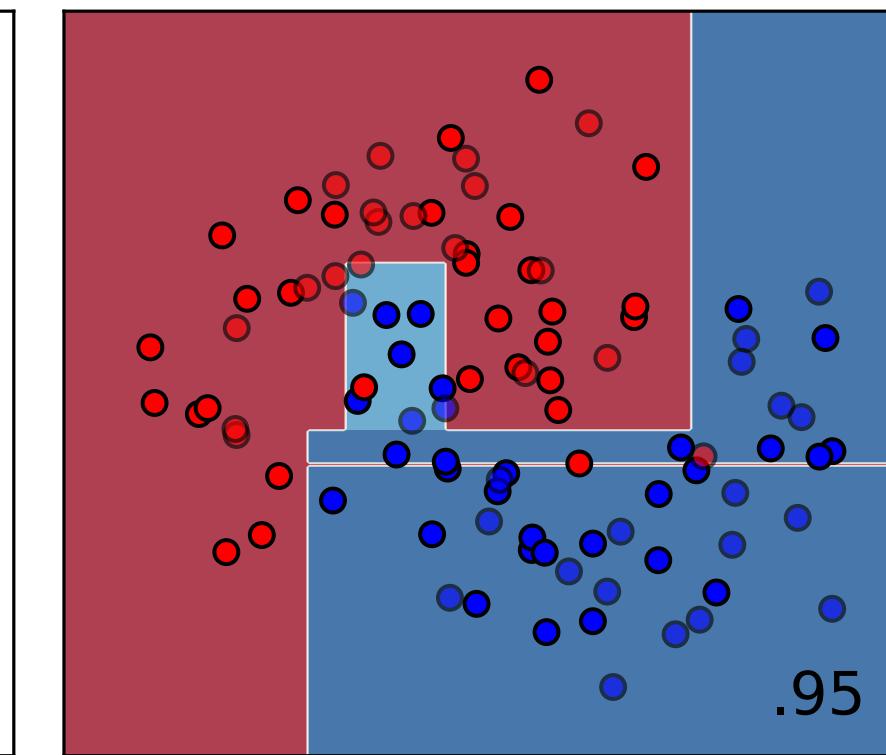




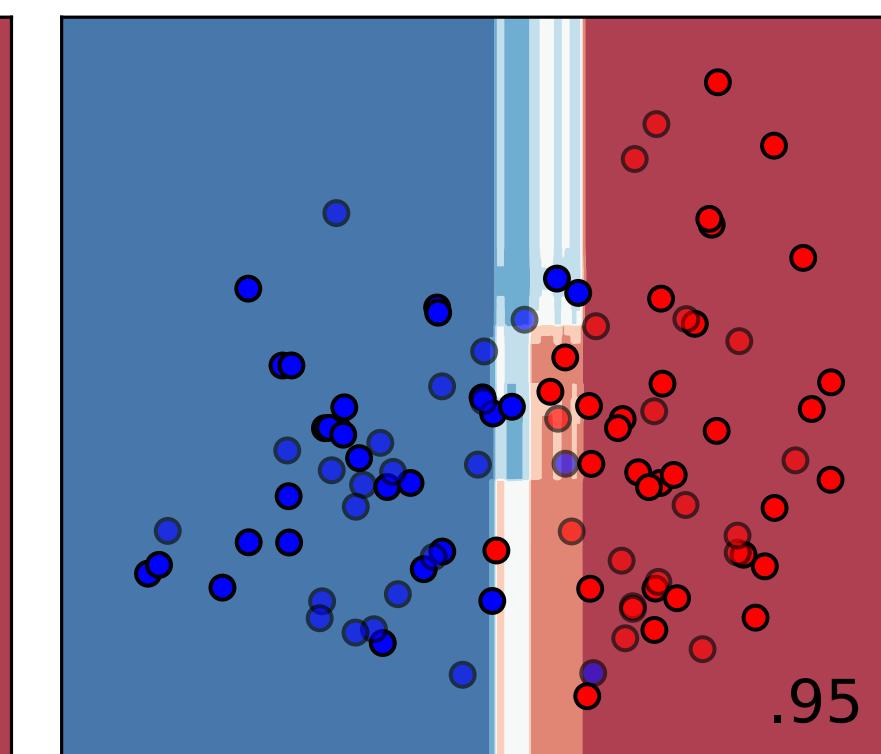
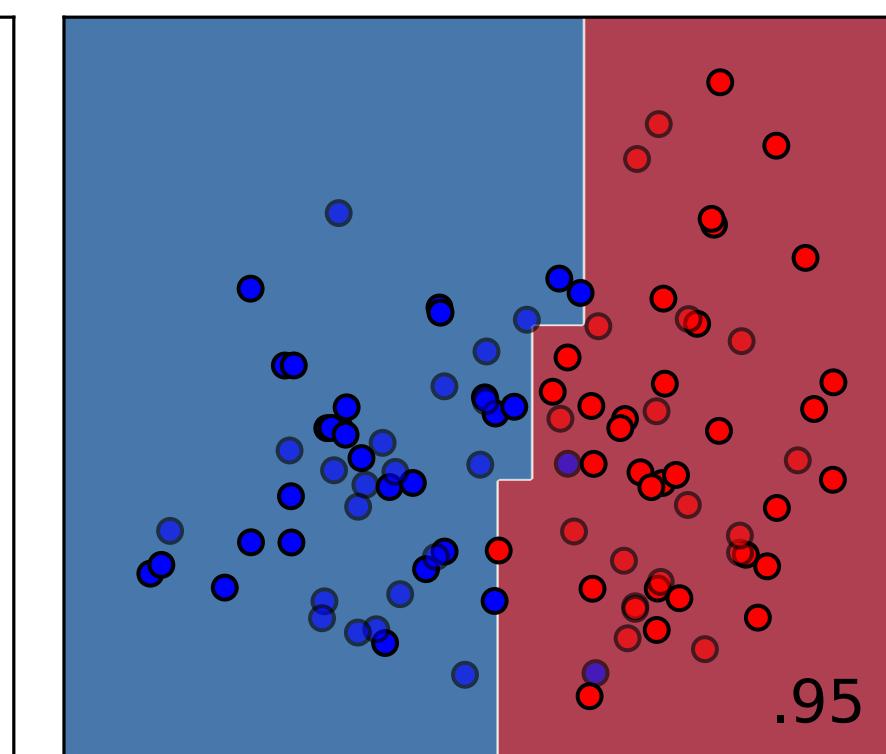
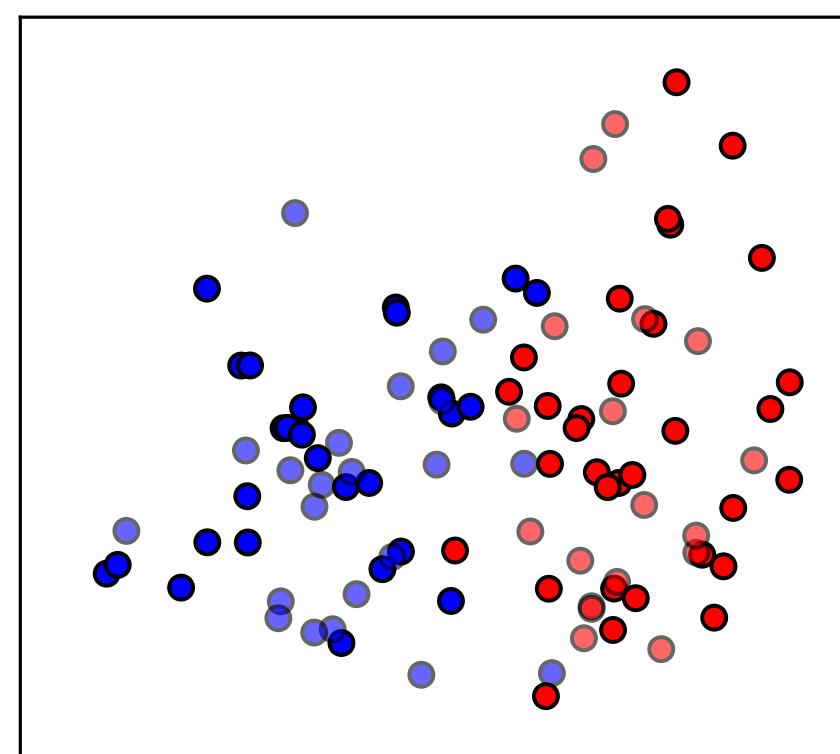
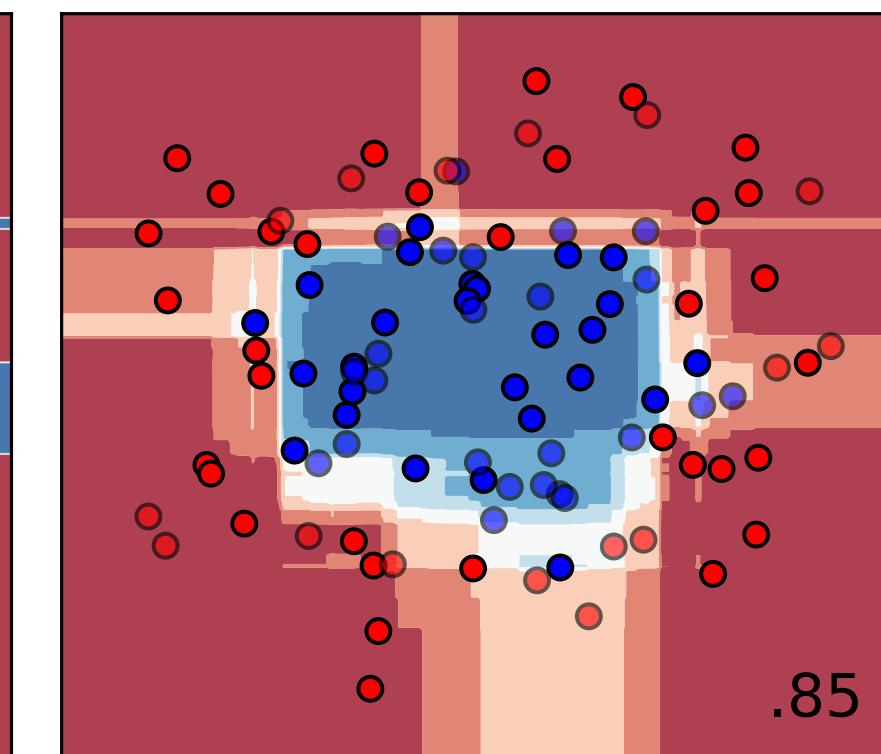
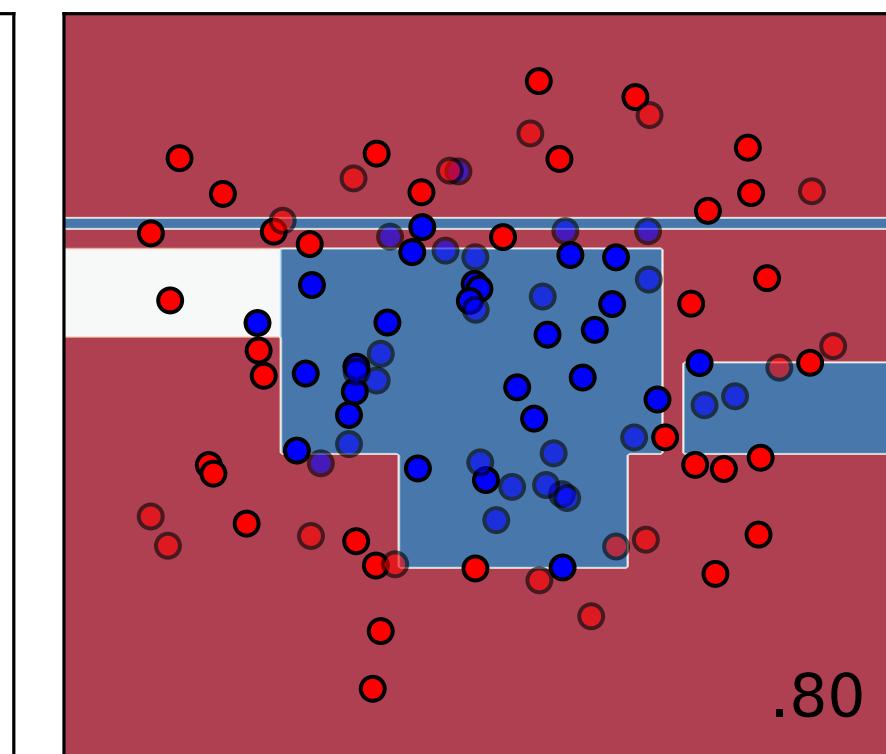
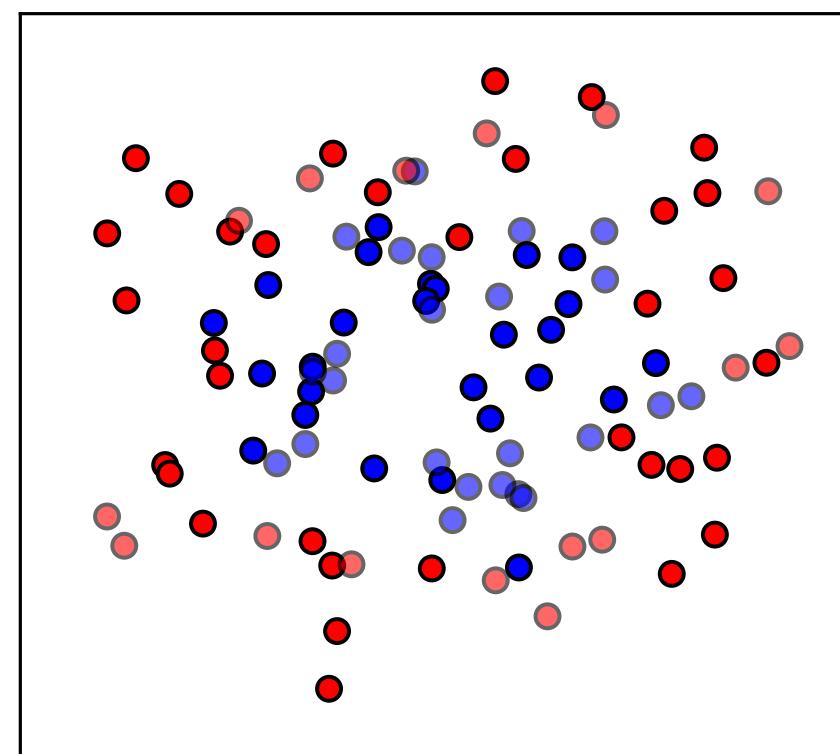
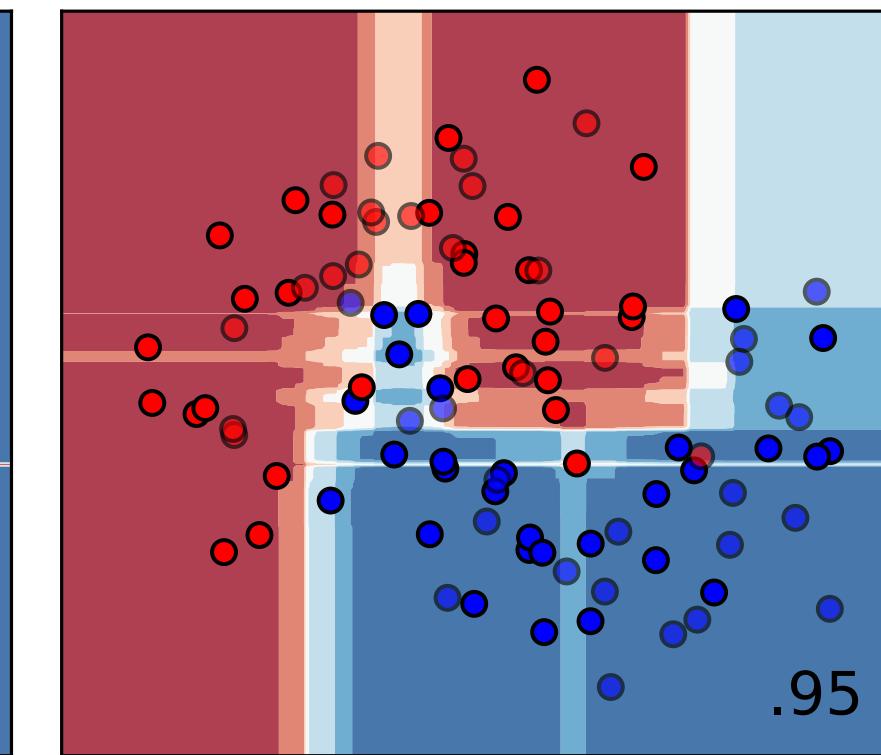
Input data

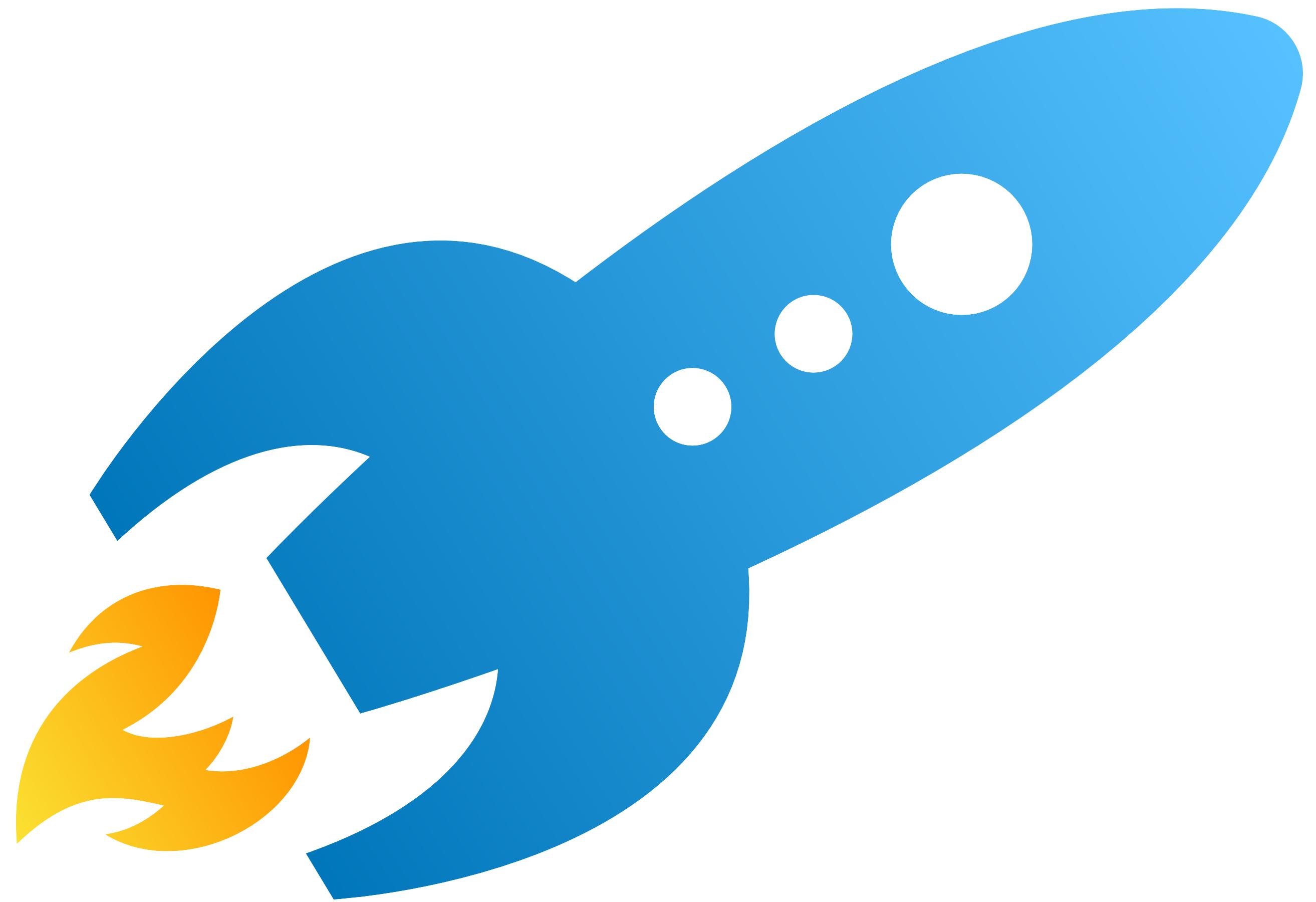


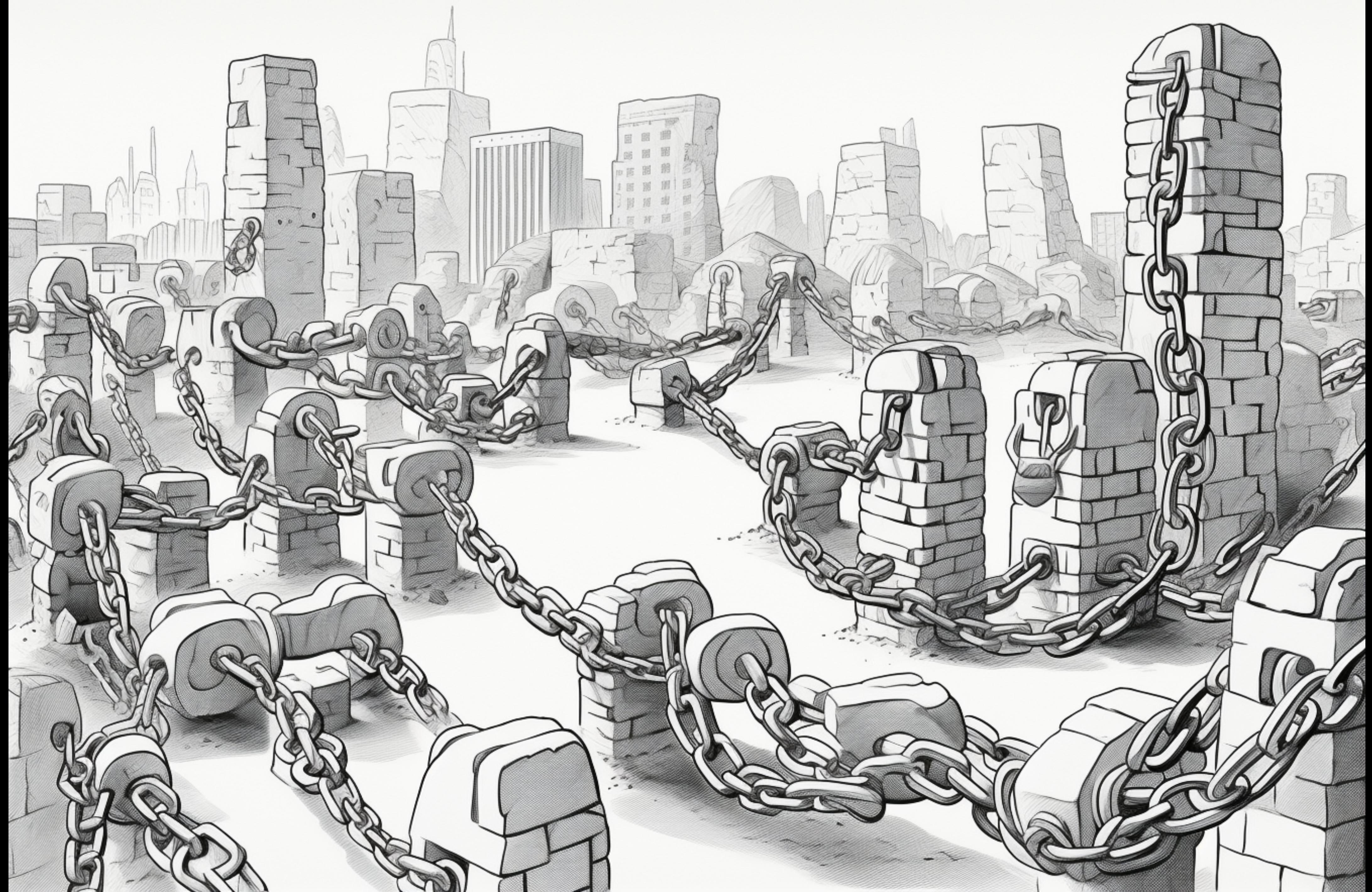
Decision Tree



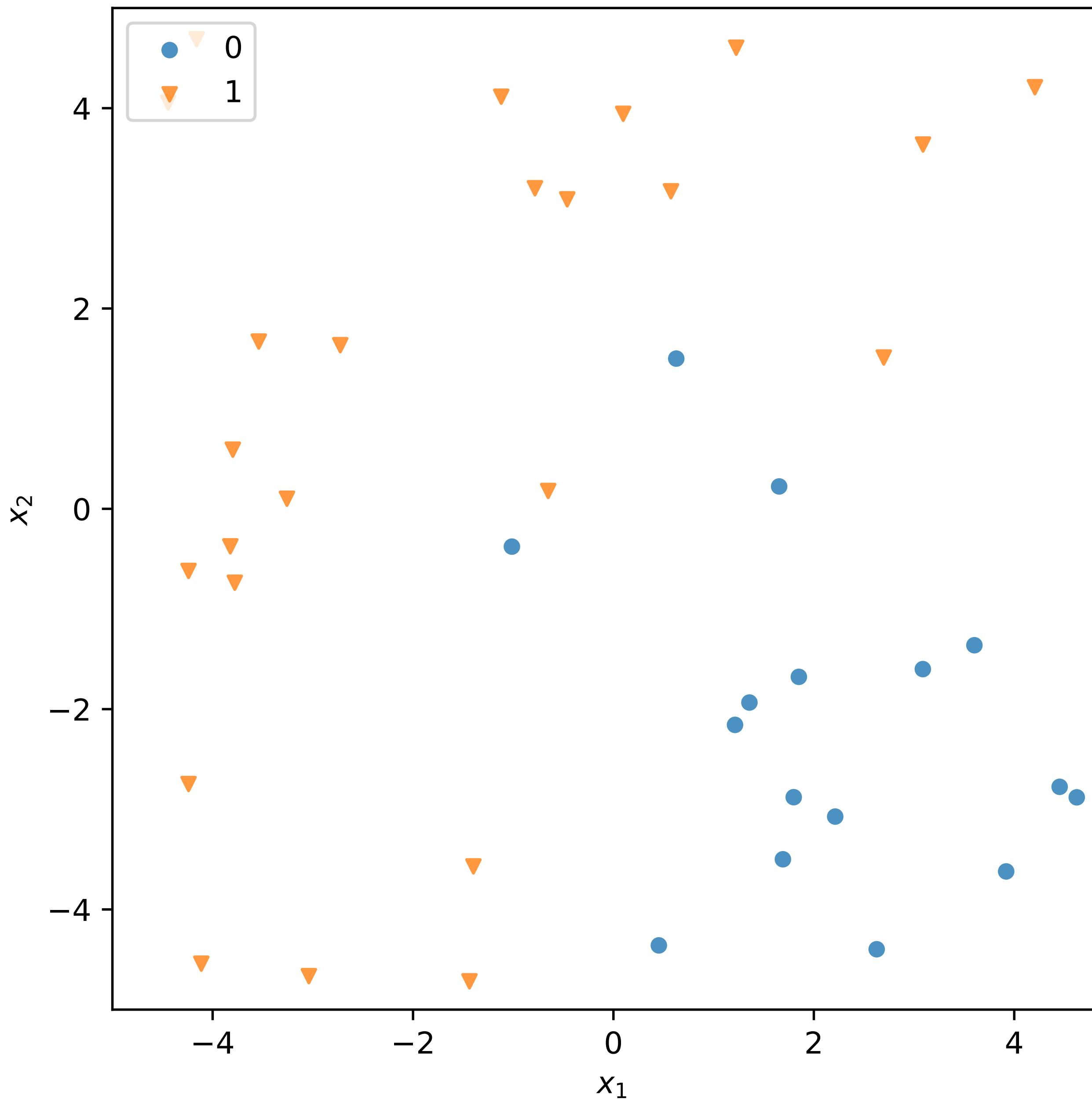
Random Forest



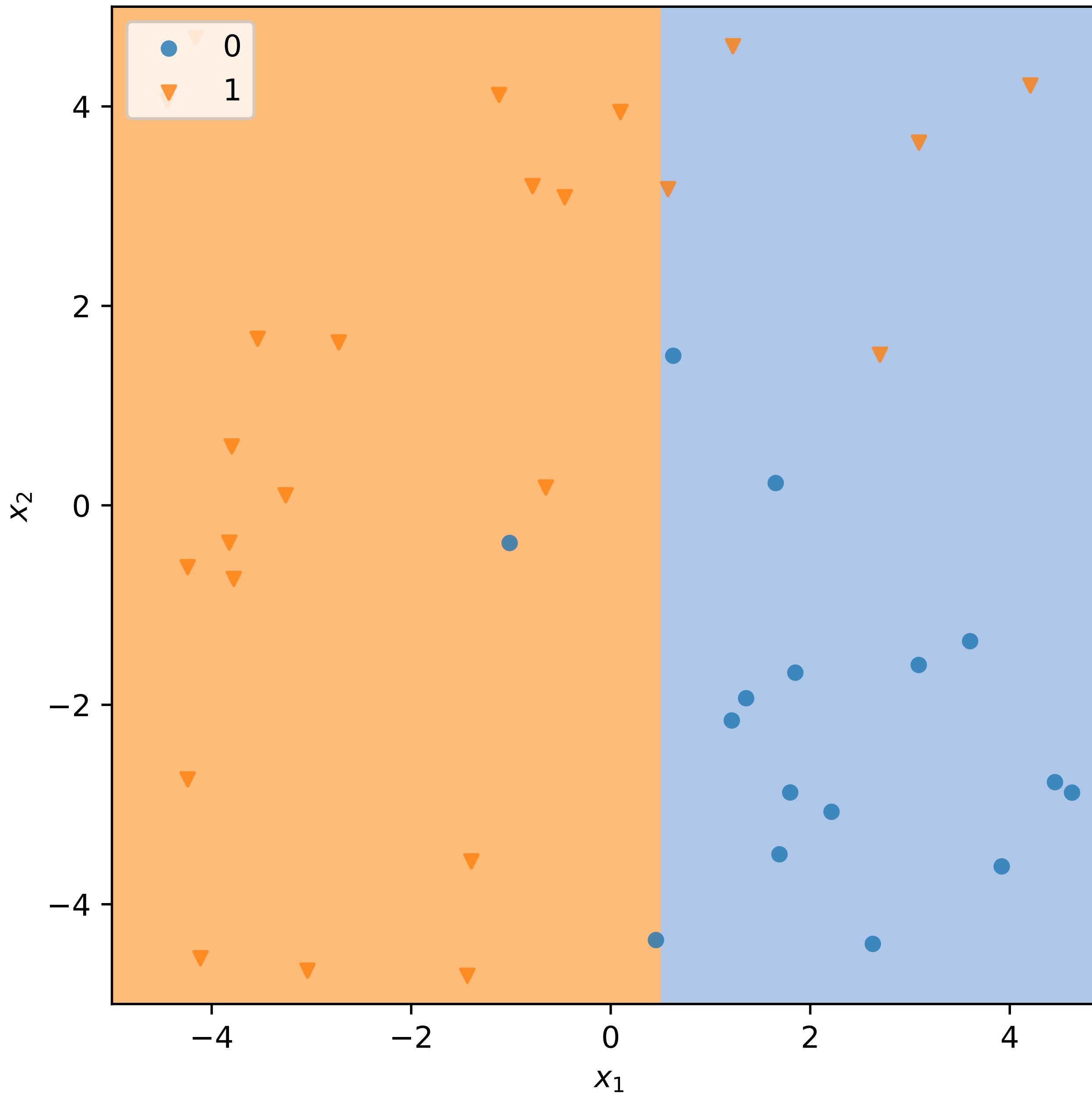




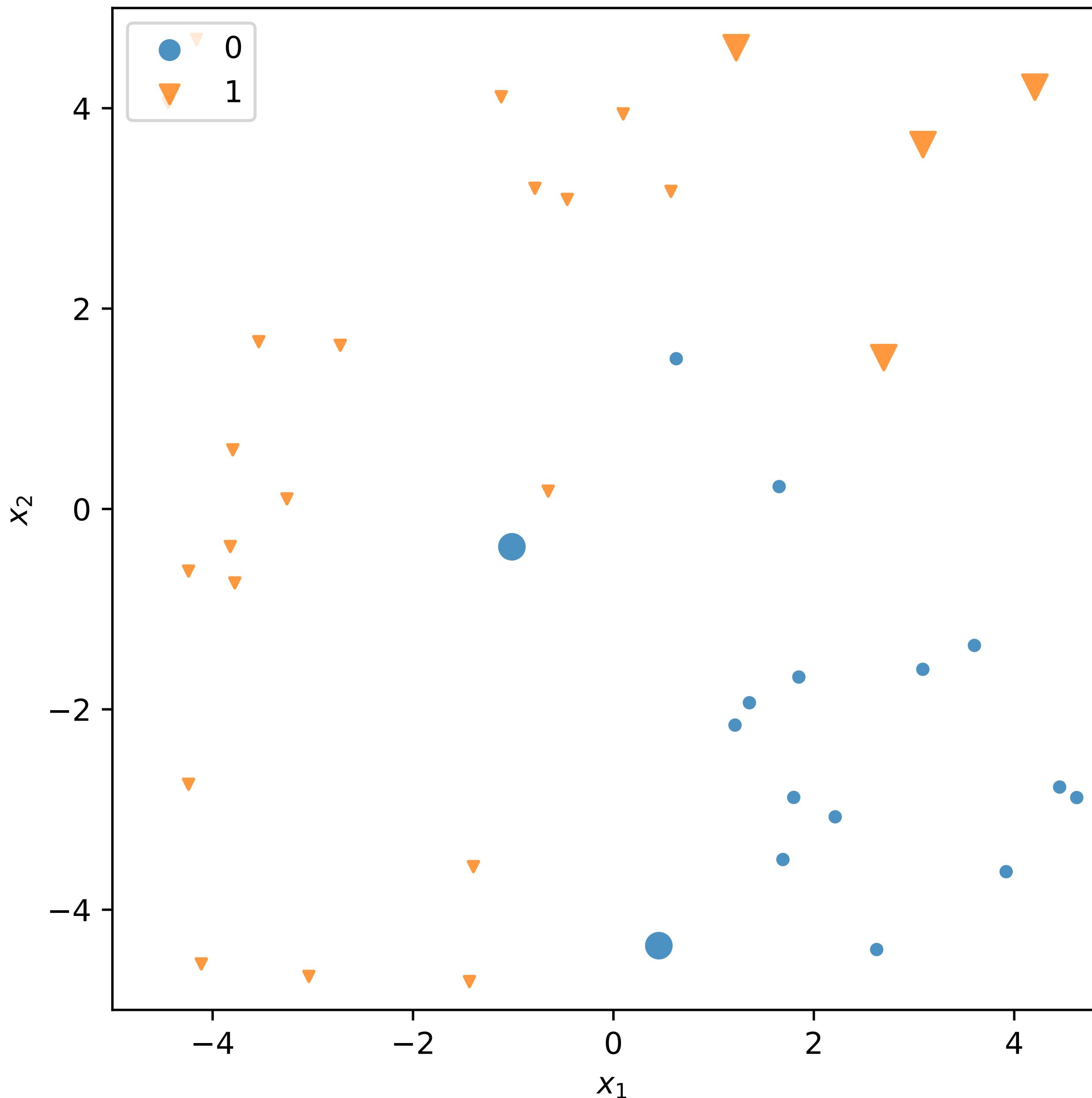
Weighted Samples 1



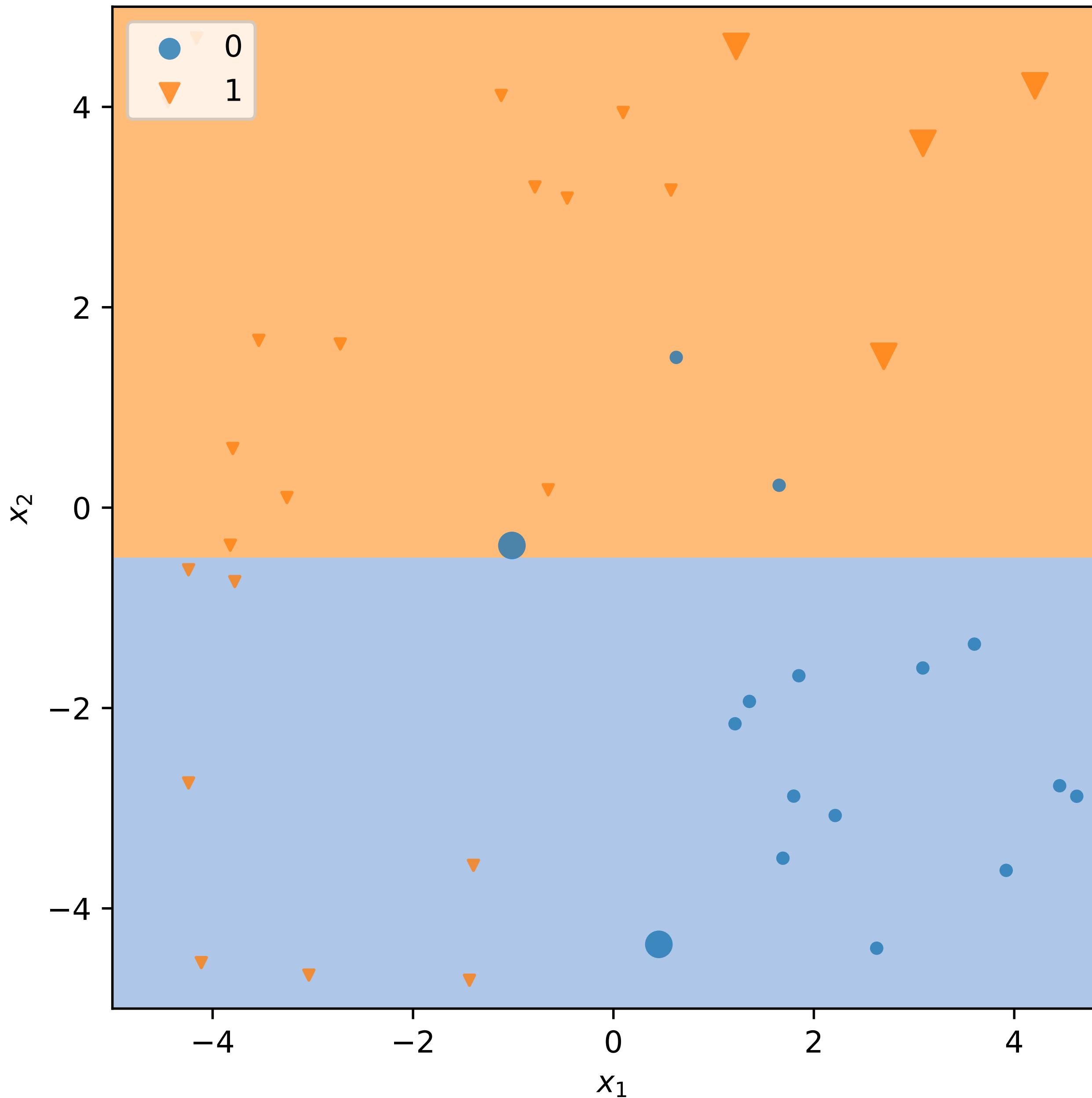
Decision Stump 1



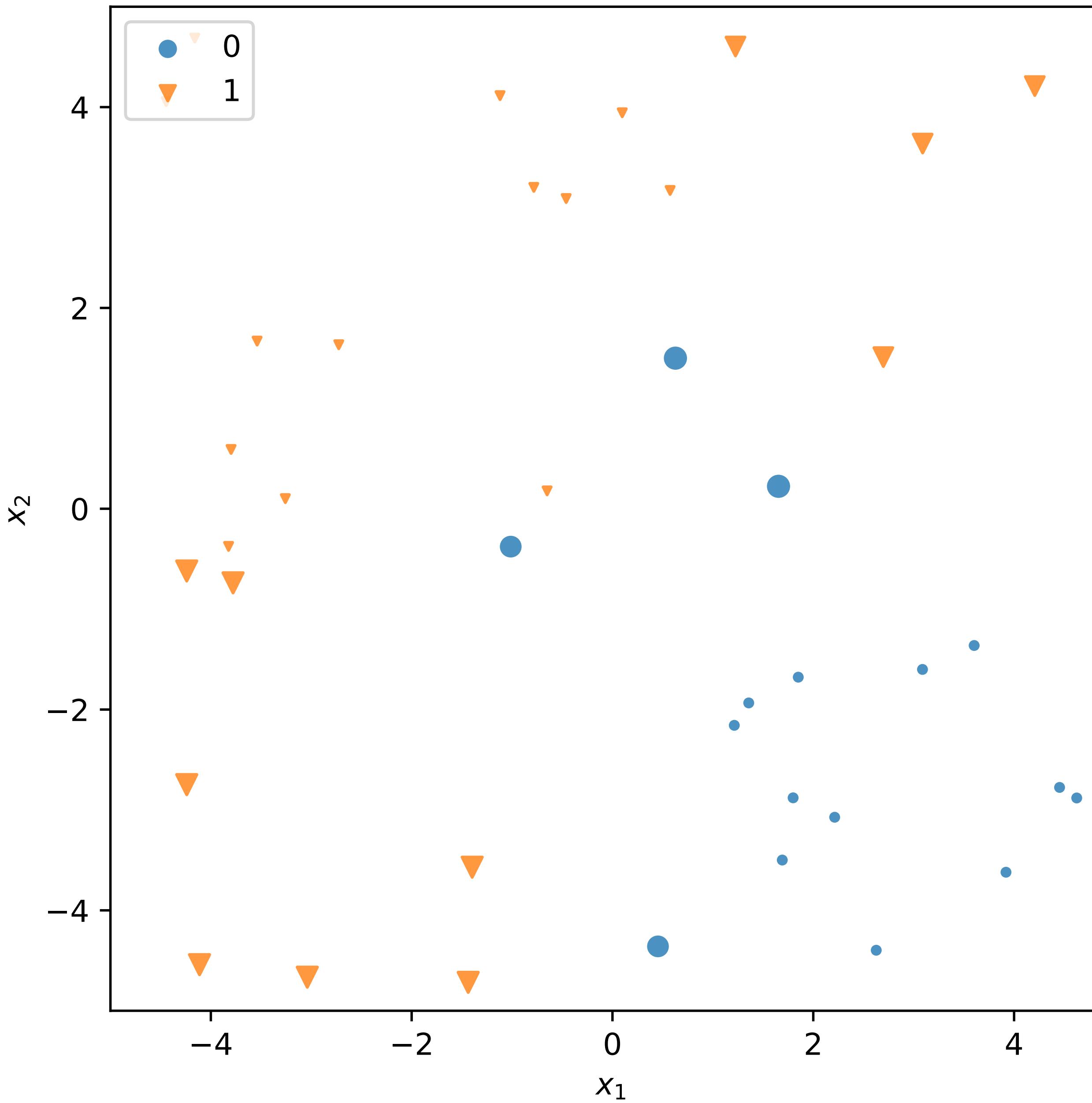
Weighted Samples 2



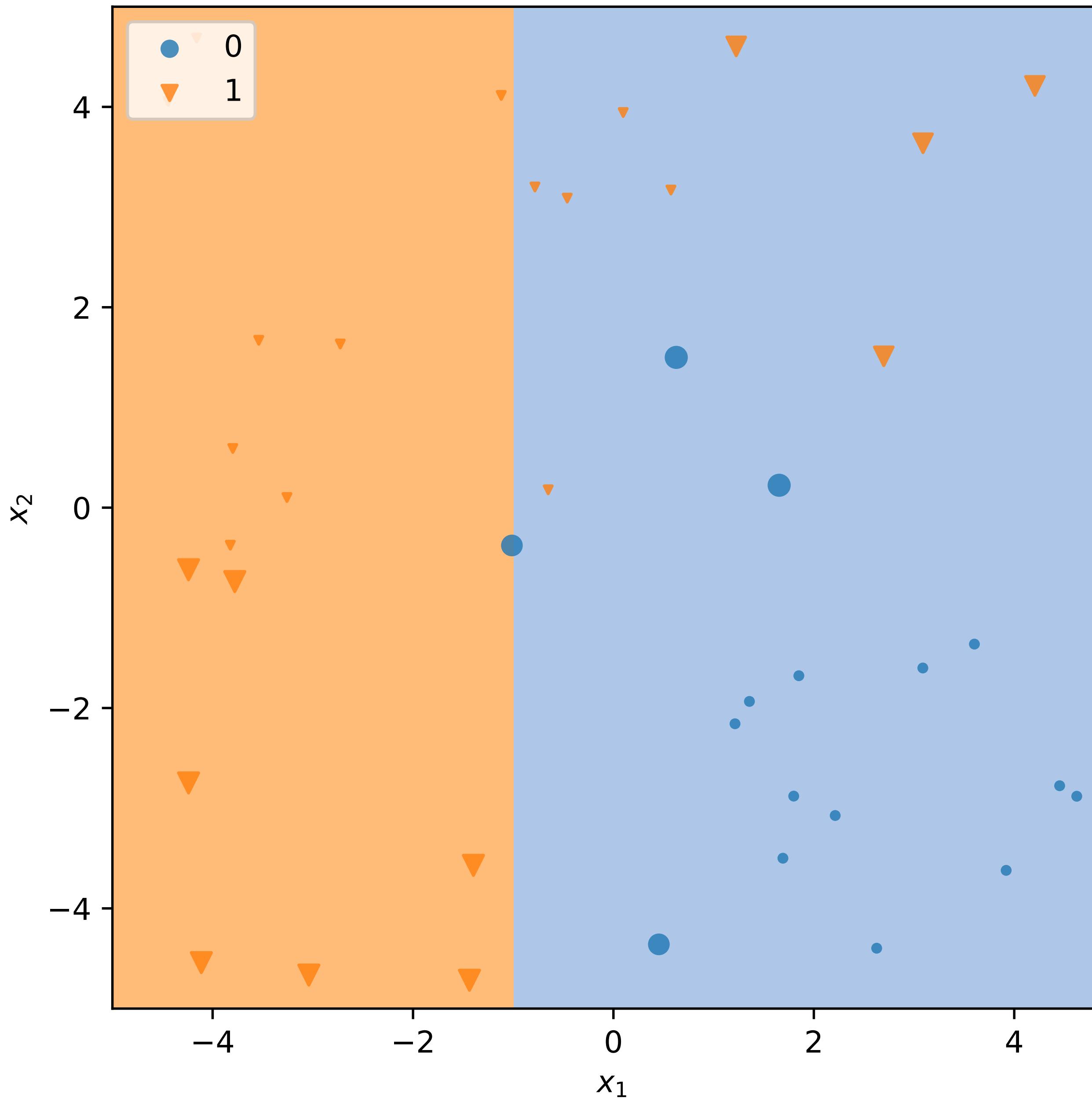
Decision Stump 2



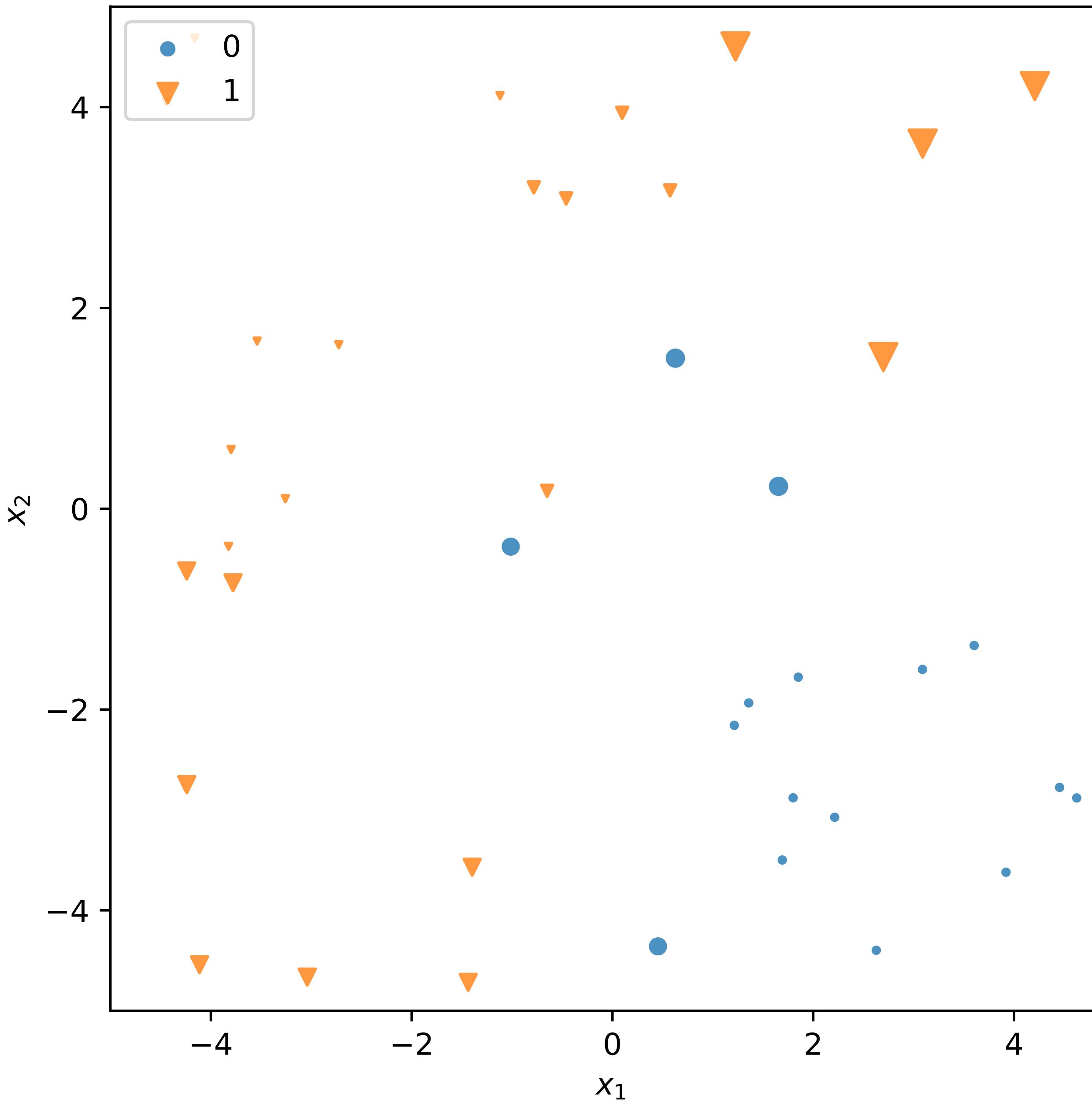
Weighted Samples 3



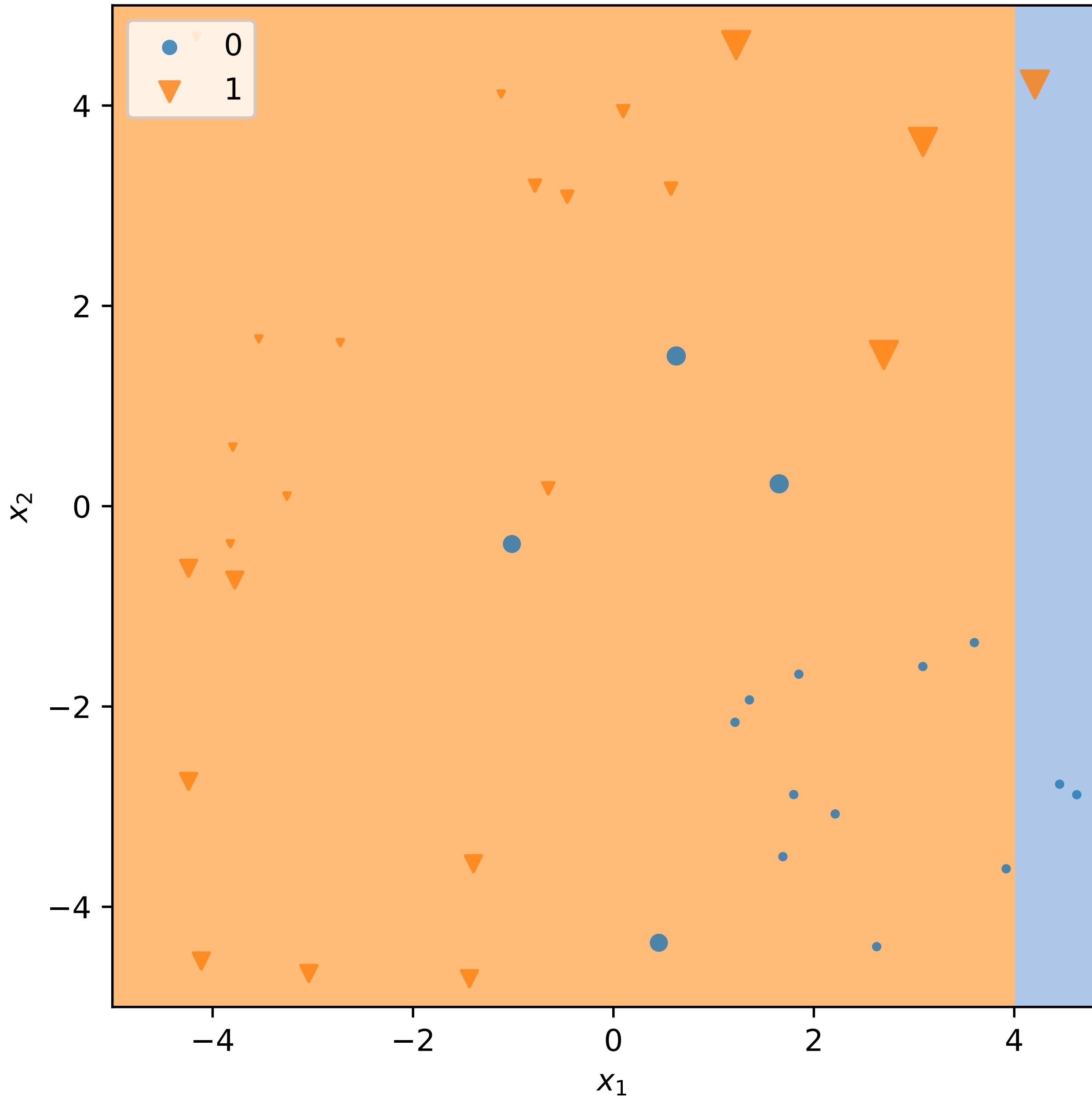
Decision Stump 3



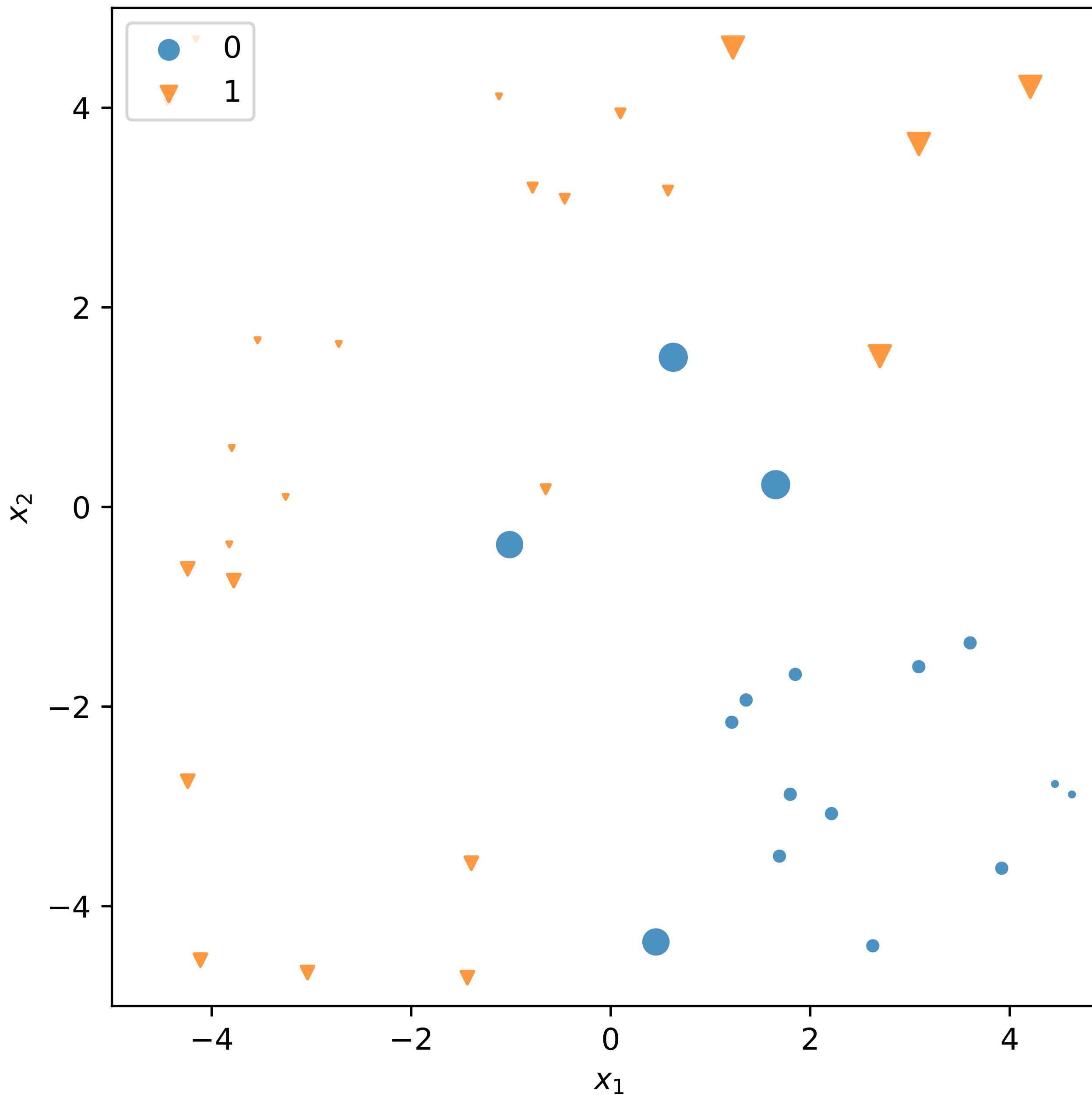
Weighted Samples 4



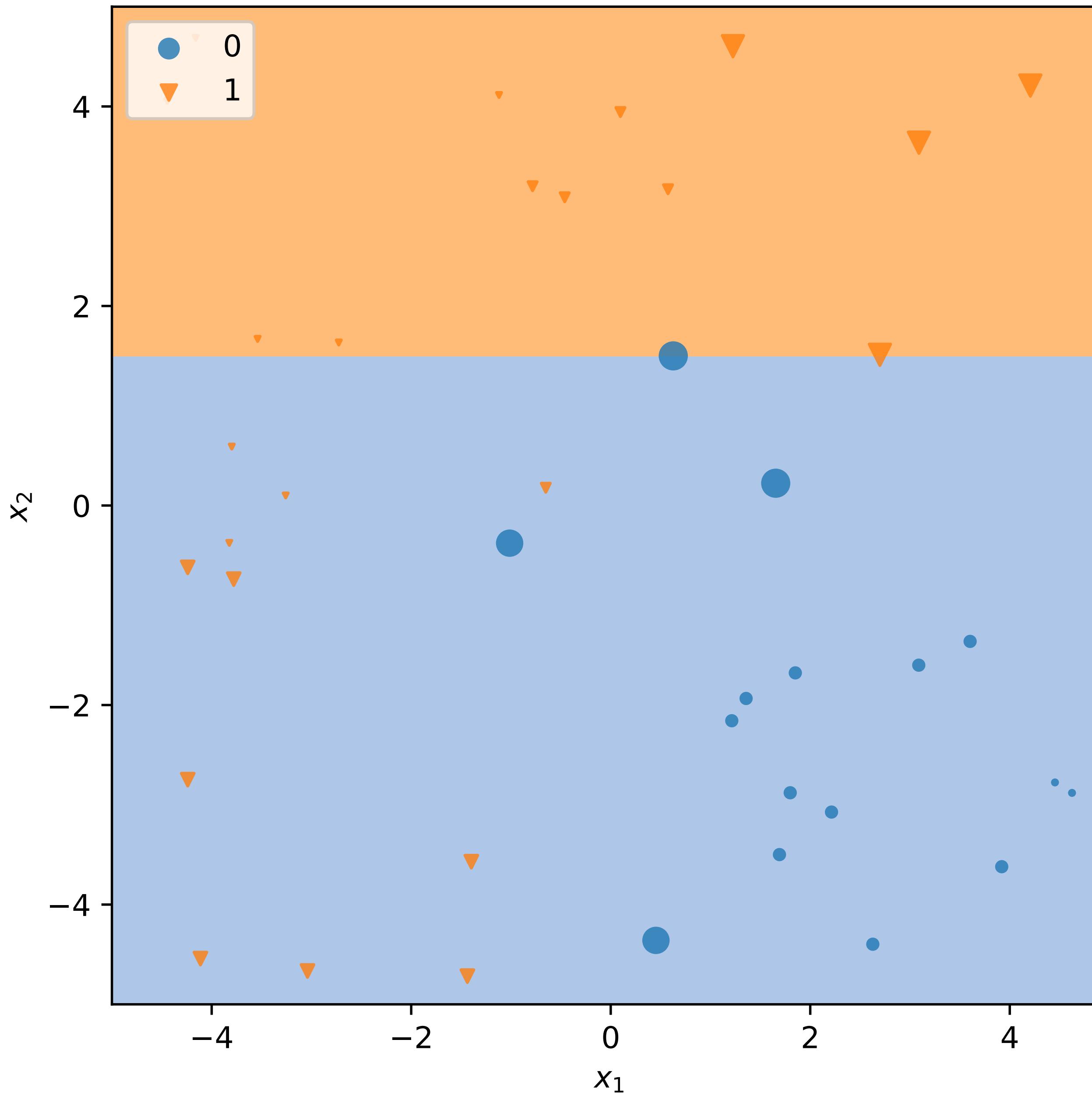
Decision Stump 4



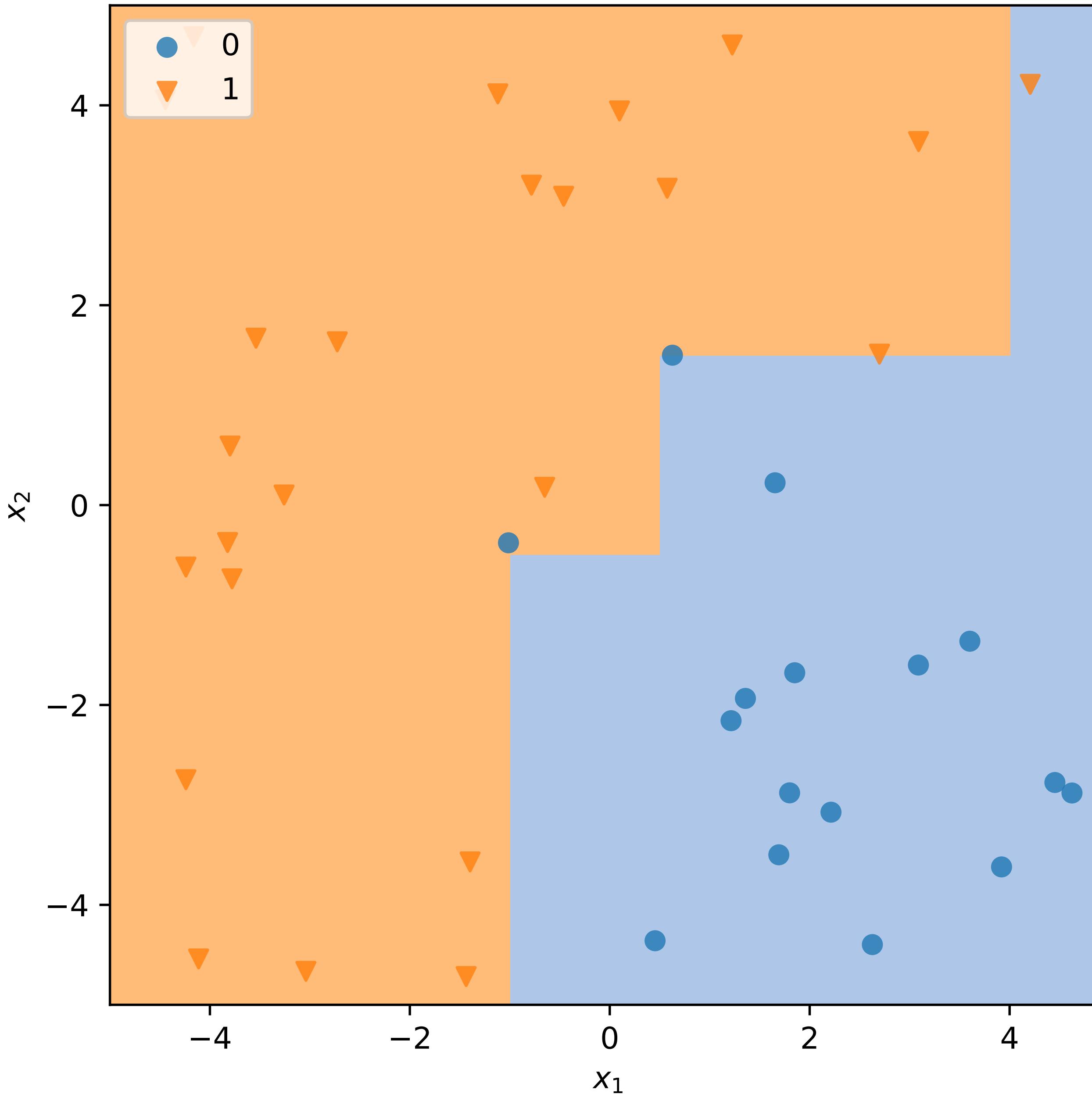
Weighted Samples 5



Decision Stump 5

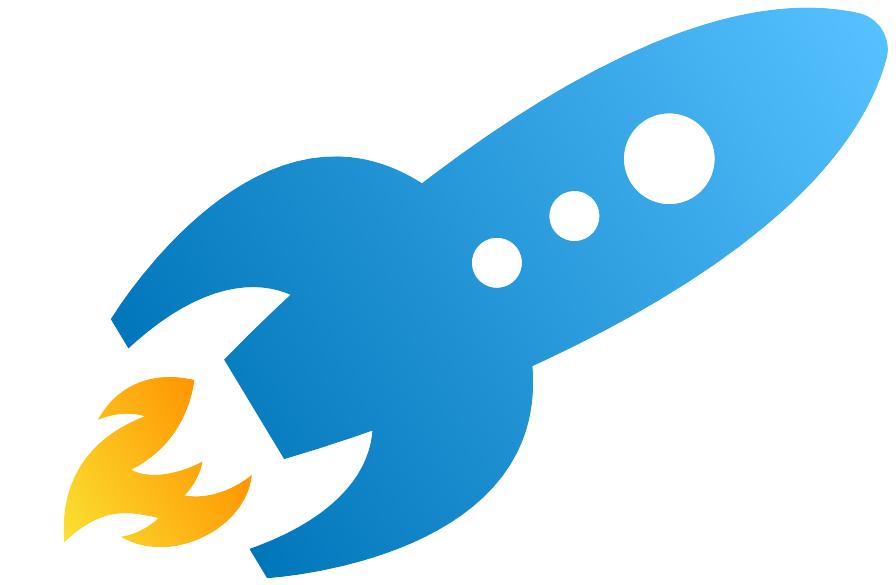


AdaBoost Combined





strong learners
parallel
reduce variance



weak learners
sequential
increase accuracy

Questions?

Next week: Linear Models Revisited

