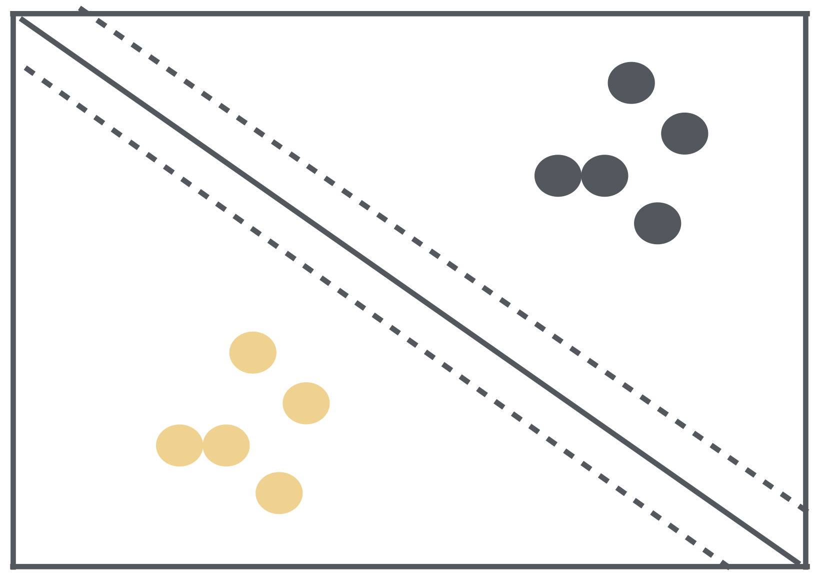
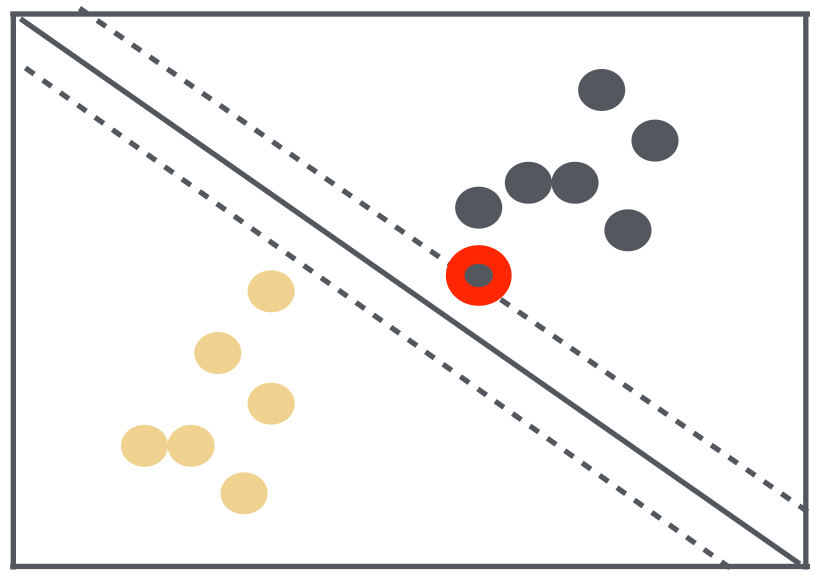
Support Vector Machine

Support Vector Machines

$$y = t(w^T x + b)$$



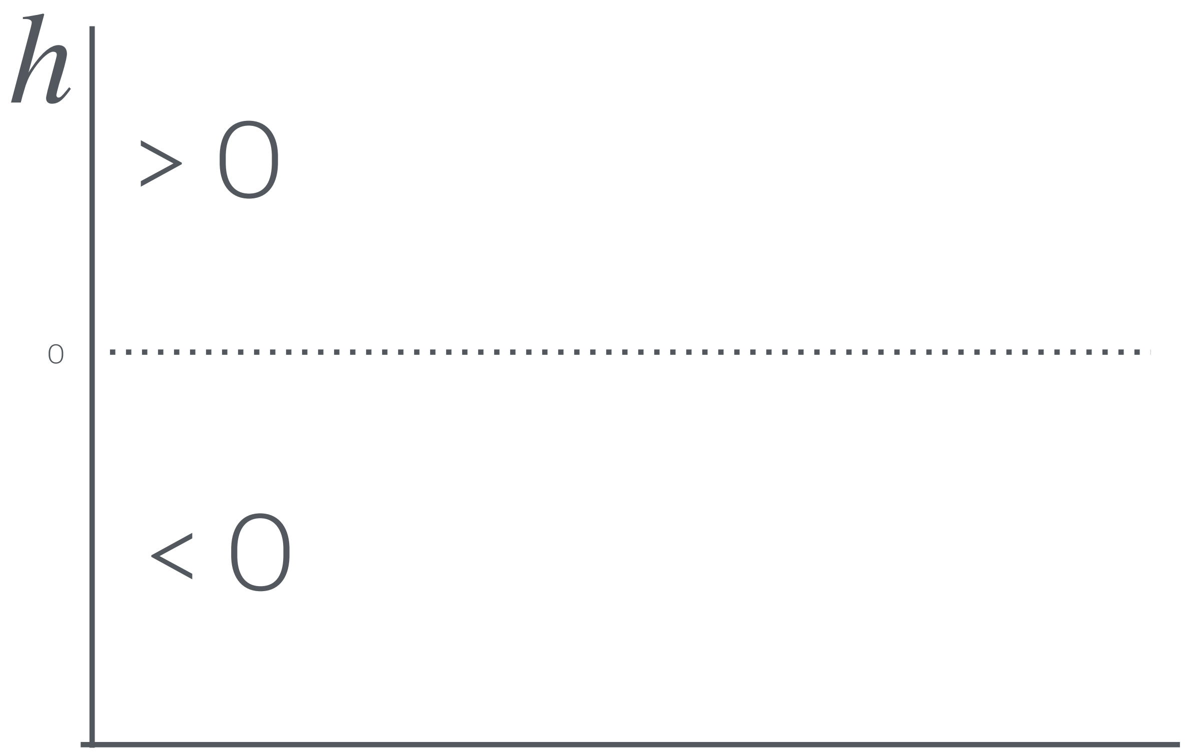
Hard Margin-
No instances can live inside the margin



Soft Margin-
Limit violations

Prediction

$$h \begin{cases} 0 \ if \ w^T x + b < 0 \\ 1 \ if \ w^T x + b \geq 0 \end{cases}$$



Label = Cancer = 1

Label = Not Cancer = -1

Goal is to create a model which wides the margin (by minimizing weight vector)

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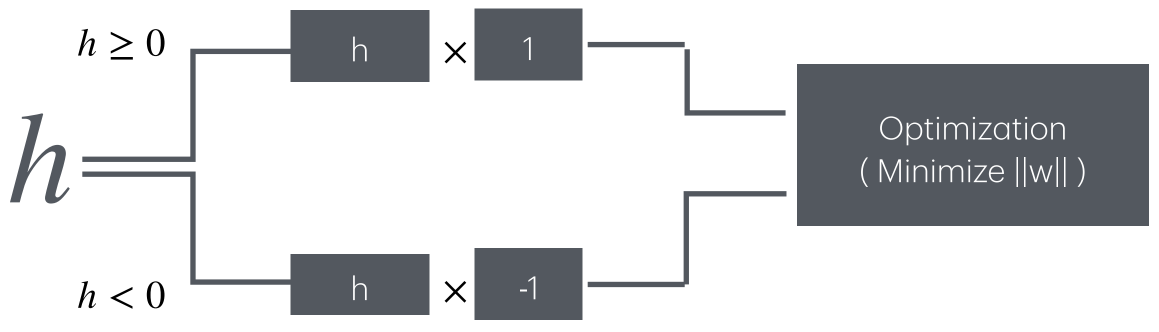
X1	x2	Label (t)
...	...	1
...	...	-1
...	...	1
...	...	-1

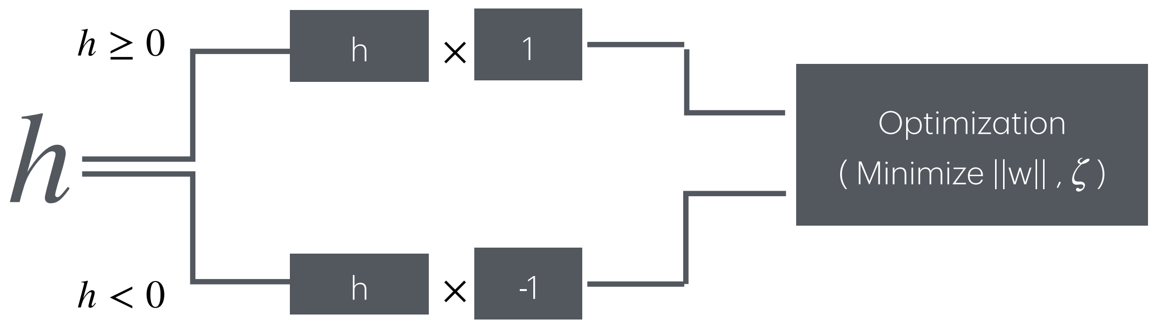


Trainable elements:

weights and bias
- train to make the model as large as possible without producing violations

$$\underset{w,b,c}{\text{minimize}} \ \frac{1}{2} w^T w$$

X1	x2	Label (t)	Slack
...	...	1	
...	...	-1	
...	...	1	
...	...	-1	



Trainable elements:

weights and bias
- train to make the margin as large as possible without producing violations
- Minimize weights widens margin

slack variable ζ, how much an instance is allowed to violate margin
- train to make this small
- Minimize slack variable

$$\underset{w,b,c}{\text{minimize}} \ \frac{1}{2} w^T w + C \Sigma_{i=1}^{m} \zeta$$

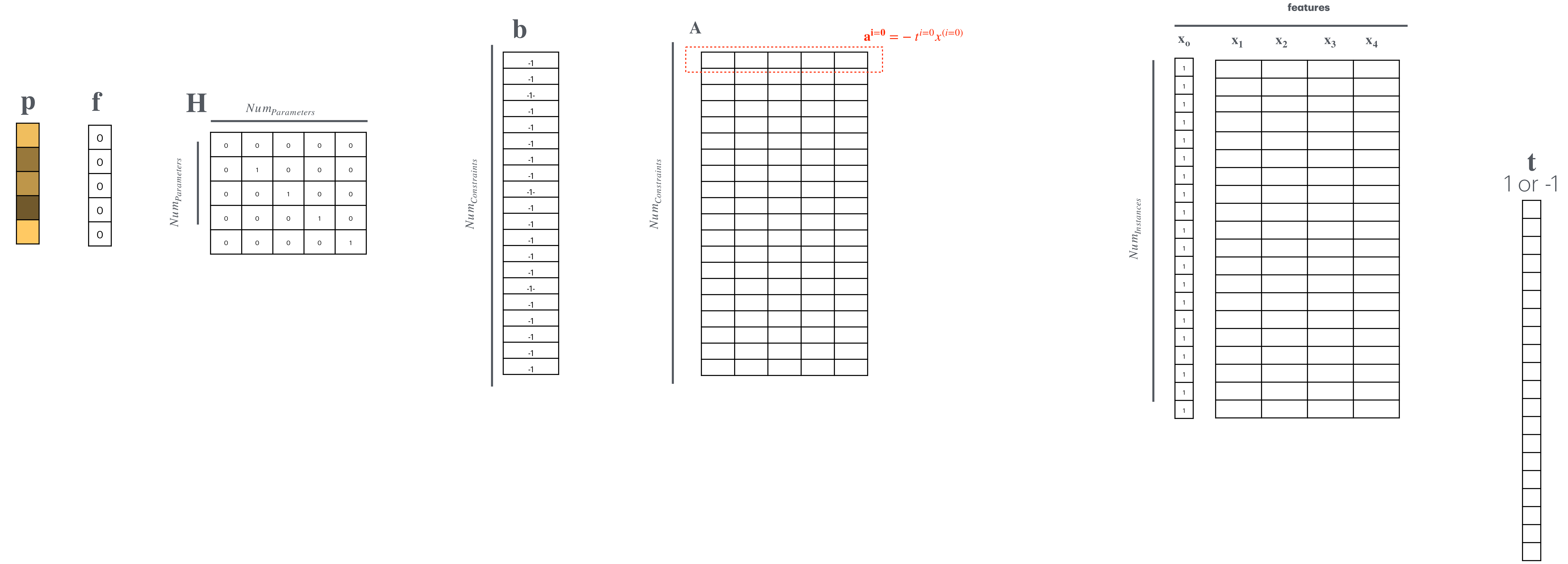
Quadratic Problem: Hard

Features

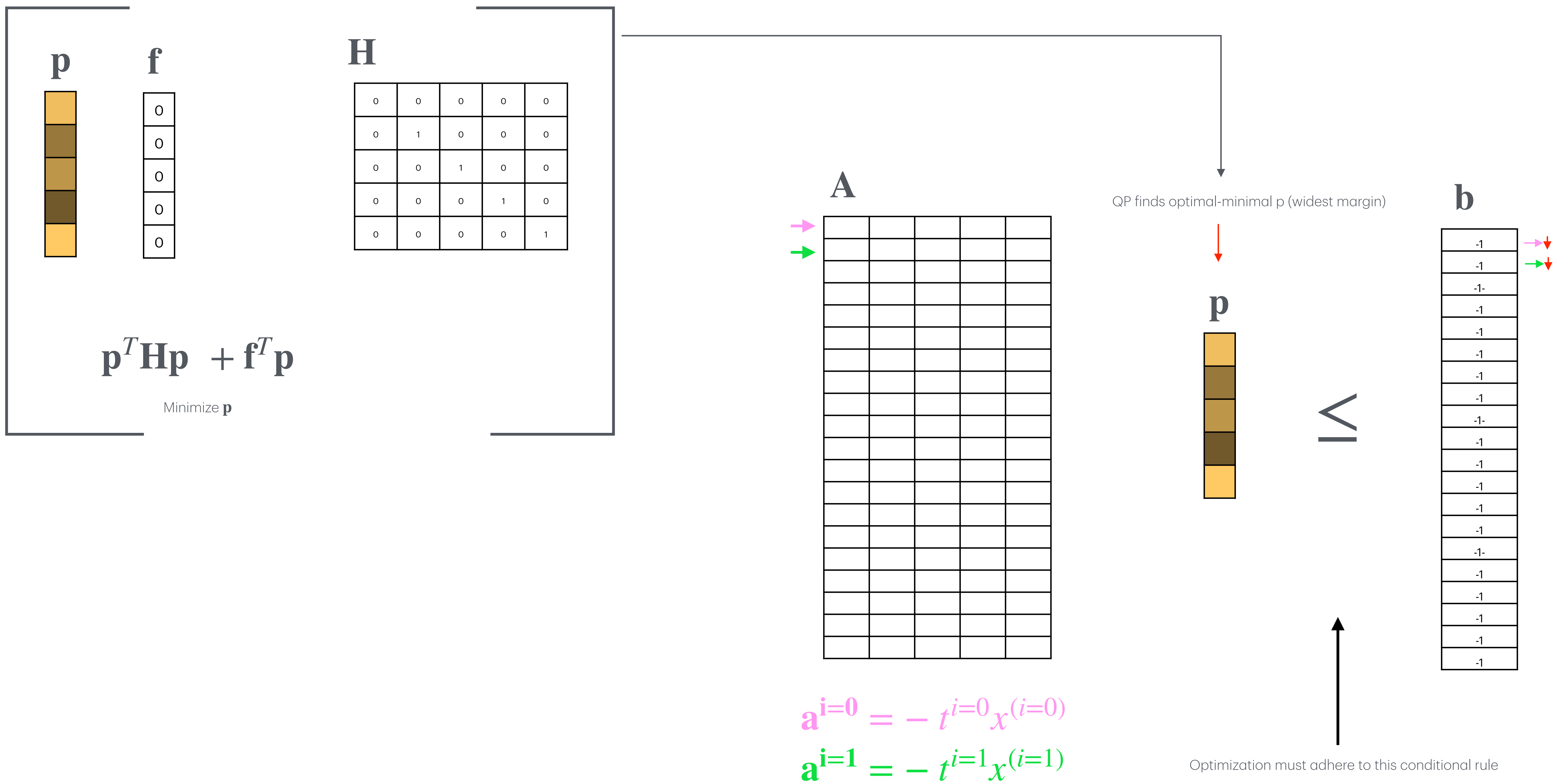
Bias	Petal Length	Petal Width	Septal Length	Sepal Width

Target

Iris Virsonica	Not Iris Virsonica



Quadratic Problem: Hard



$$\mathbf{Ap} \leq \mathbf{b}$$

Quadratic Programming Constraints

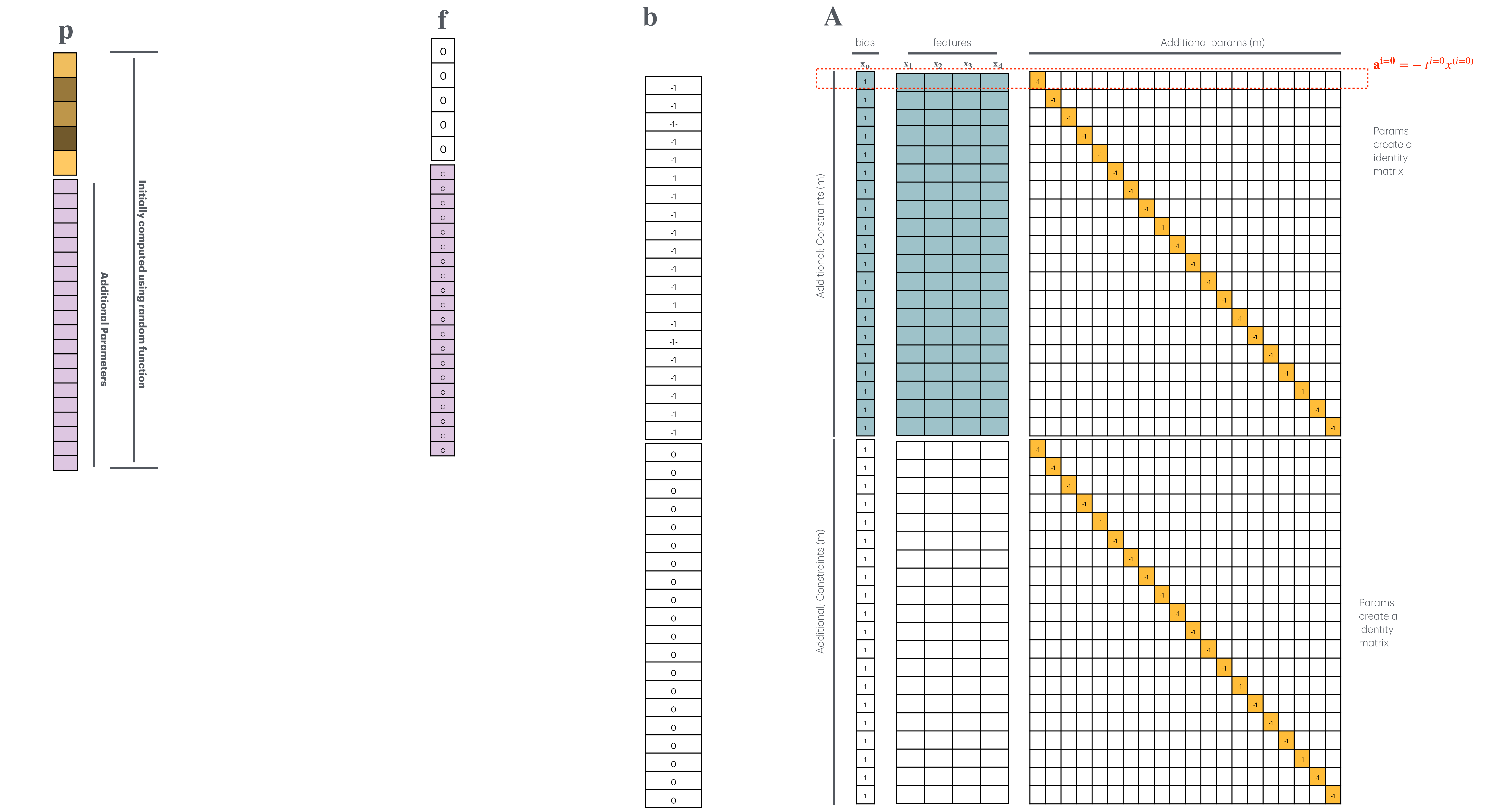
Quadratic Problem: Soft

Features

Bias	Petal Length	Petal Width	Septal Length	Sepal Width

Target

Iris Virsonica	Not Iris Virsonica



Quadratic Problem: Soft

H

bias | features | Additional params (m)

Additional params (m)

x_0	x_1	x_2	x_3	x_4																				
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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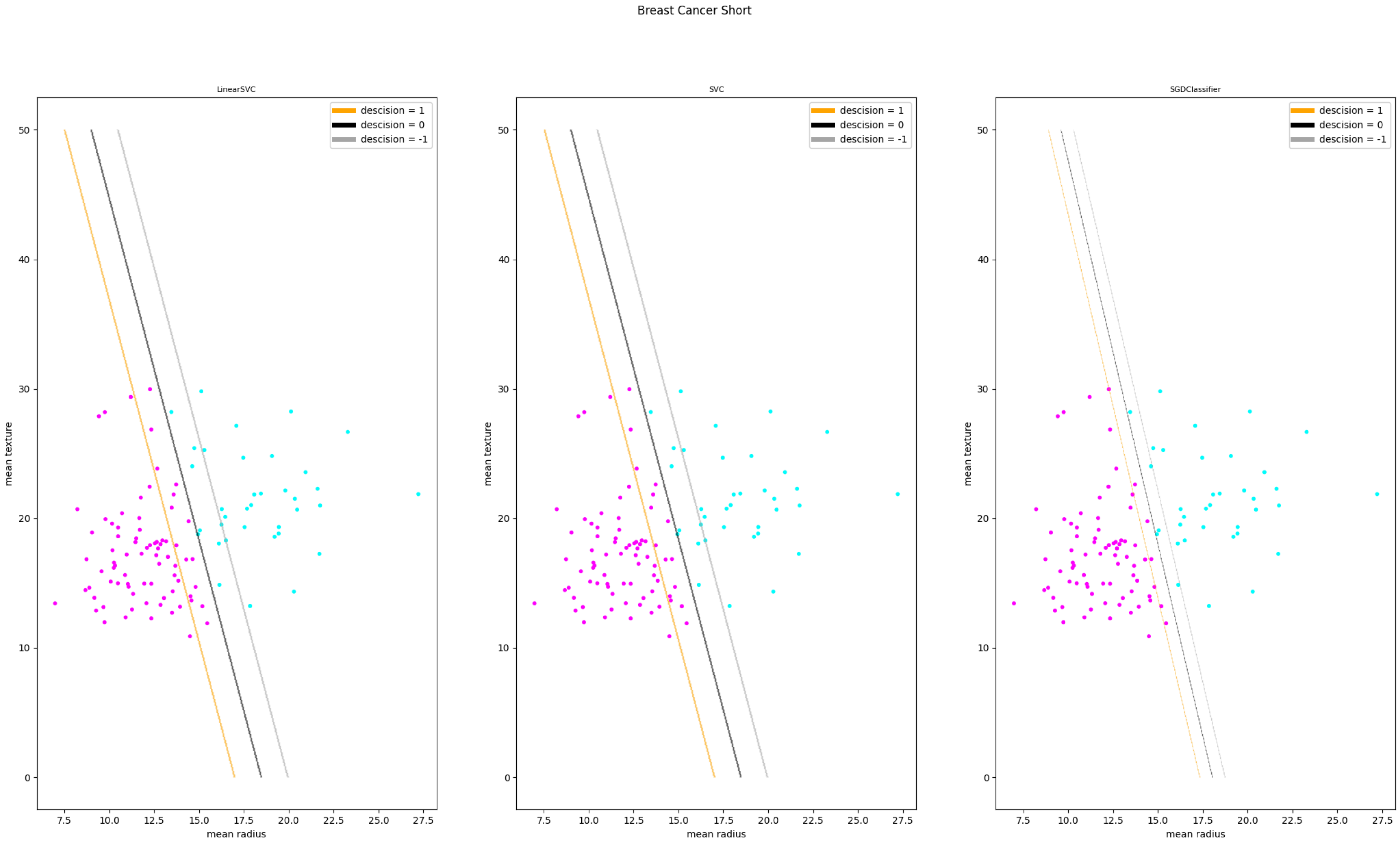
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

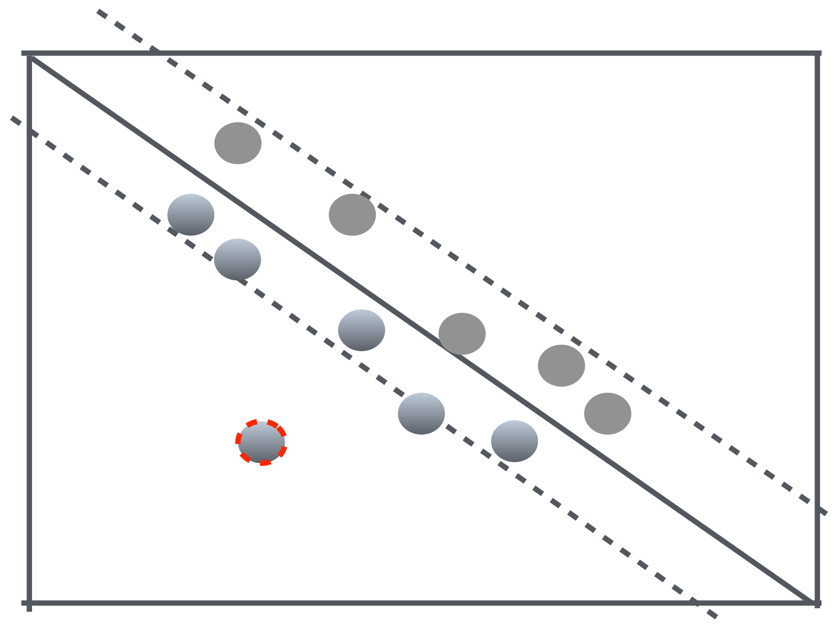
Breast Cancer:

Malignant	Benign

['
mean radius'
'**mean texture**'
'mean perimeter'
'mean area'
'mean smoothness'
'mean compactness'
'mean concavity'
'mean concave points'
'mean symmetry'
'mean fractal dimension'
'radius error'
'texture error'
'perimeter error'
'area error'
'smoothness error'
'compactness error'
'concavity error'
'concave points error'
'symmetry error'
'fractal dimension error'
'worst radius'
'worst texture'
'worst perimeter'
'worst area'
'worst smoothness'
'worst compactness'
'worst concavity'
'worst concave points'
'worst symmetry'
'worst fractal dimension'
]



Support Vector Regression



Fit dataset instances 'inside the street'

Can be used to find non-conforming outliers within a dataset