Ex1 MC:

1. What is the difference between boosting and Random Forests?
    1. Random forests never train on bootstrapped data
    2. Boosting uses weighted averaging of predictions
    3. ?
    4. ?
2. What is the VC dimension
    1. Minimum dimension to shatter a number of points
3. What is true for backpropagation?
    1. Computes each weight independently
    2. Backpropagates the error from the output to the input
    3. A Neural net can be trained without parameters
    4. Can only be used for fully connected Neural Nets
4. ?

Ex2

a.) Given the Dataset $D = \{1, 2, 4\}$ produced by the Density function $\theta(1-\theta)^{x_i - 1}$ with $x_i - 1 \geq 0$
derive a closed form solution for the Data Likelihood
b.) Compute Maximum likelihood solution $\hat{\theta}$
c.) Compute $P(x_4 = 1|\hat{\theta})$
d.) Bayesian View: Assuming a prior of $P(\theta) = 2(1-\theta)$ show that can be written as

$$P(\theta|D) = \frac{\theta^a(1-\theta)^b}{\int_0^1 \theta^a(1-\theta)^b d\theta}$$

state the values of a and b
e.) Using your Bayesian Classifier: compute $P(x_4 = 1|\theta)$

Ex3

PCA
a.) Derive the necessary condition for the optimization problem using the Lagrangian:

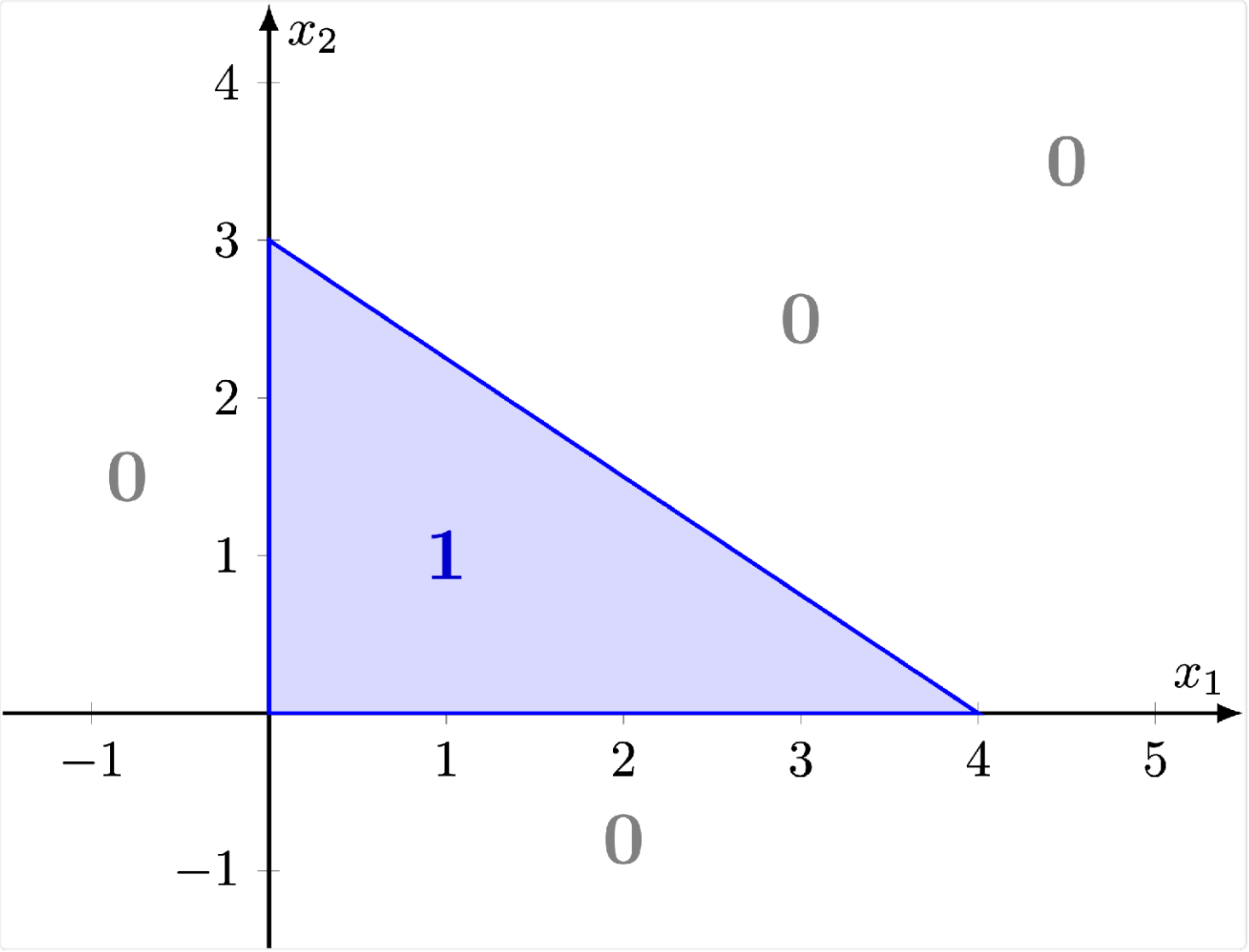
$$\max_u u^T C u$$

$$\text{s.t.} \quad \|u\|_2 = 1$$

b.) show that the solution is obtained by the Eigenvector corresponding to the largest Eigenvalue of C.
c.) Let $\{\boldsymbol{u_1}, \ldots, \boldsymbol{u_d}|\}$ be an Eigenbasis of C. Assuming C is centered i.e. $\mathbb{E}[\boldsymbol{x}\boldsymbol{x}^T] = 0$
Show that $\mathbb{E}[||\mathbf{x} - (\hat{\mathbf{x}})||^2] = \sum_{i=2}^{d} \lambda_i$ with $\hat{\mathbf{x}} = \boldsymbol{u}_i^T \boldsymbol{x} \boldsymbol{u}_i^T$
$(hint)$ Write x in the Eigenbasis.

Ex 4.

a)Given the Neural network activation function:
$a_j = \mathbf{1}_{\sum_i \boldsymbol{w}_{ij}^T \boldsymbol{x}_i + b_j}$
Construct a Neural network which performs the following classification. Draw it. Annotate your drawings with the weights, biases etc.



b.) State all activations for the point $x_i = (3, 1)$ and provide the final classification

EX5

a.)
a few numpy functions given (only their names, not the actual docstring or similar)
Compute the Kernel function:

$k(x, z) = (\boldsymbol{x}^T z + c)^p$

```
def kernel(X,Z=None,p):
    # X nxd
    # Z nxd
```

```
    return K
```

If Z is None the Kernel Matrix $k(x_i, x_j)$ should be returned

b.)
Compute the alpha for KRR. Your function should be efficient (no for loops) and numerically stable

```
def compute_alpha(X, y, c):
    # X nxd
    # y n,
    # c = small value larger than zero



    return alpha
```