Pattern Recognition, Homework 4

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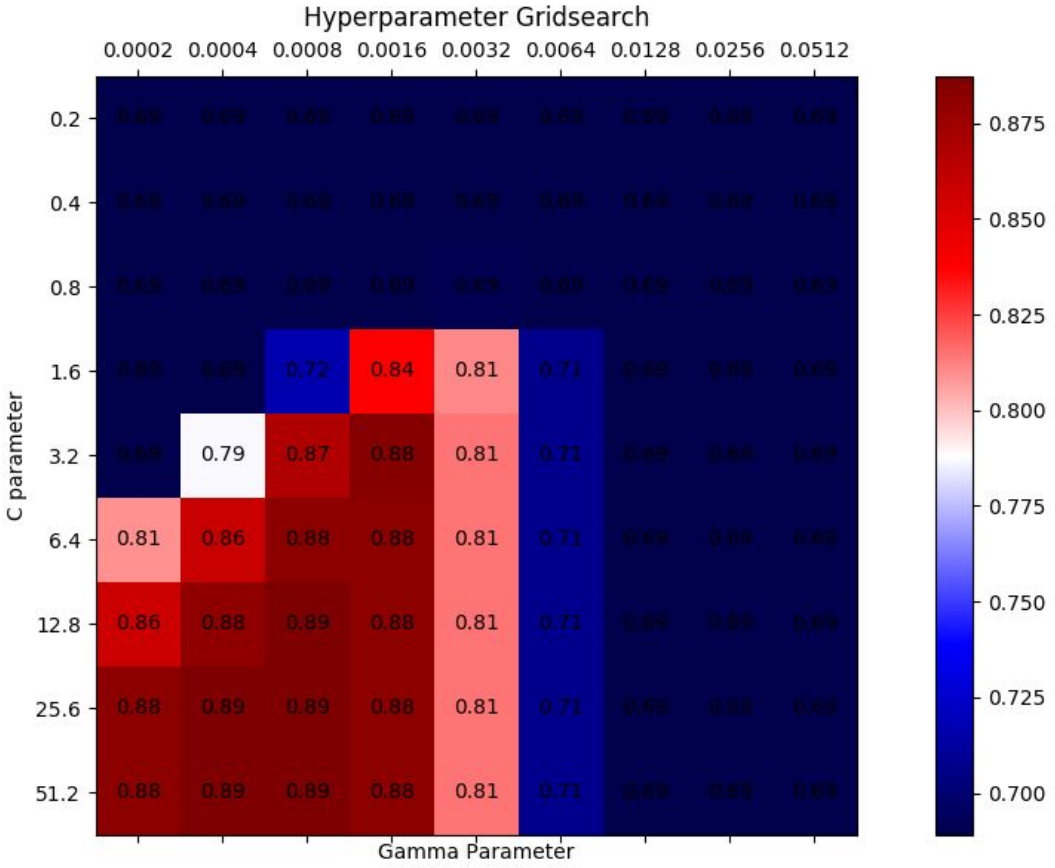
Part. 1, Coding

1. K-fold data partition
2. Grid Search & Cross-validation

```
C: 25.6, Gamma: 0.0004, Val acc: 0.8872727272727273
```

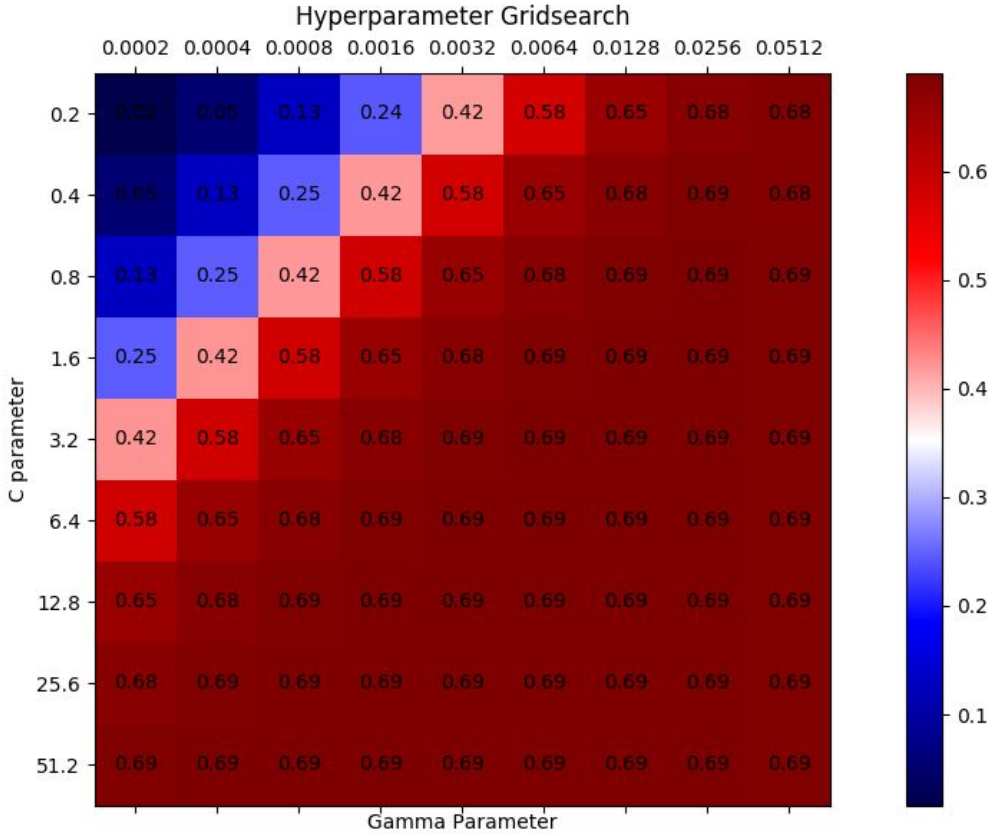
3. Plot the grid search results of your SVM



4. Train SVM model by the best hyperparameters

```
Accuracy score:  0.90625
```

5. Comparing with HW1 dataset and methodSVR




```
C: 51.2, Gamma: 0.0016, Val score: 0.6903255070751074
Square error of SVM regresssion model:  0.0736177622596237
```

- Linear Regression

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Square error of Linear regression:  0.068708202594858 91
```

Part. 2, Questions

1. Given a valid kernel $k_1(x, x')$, prove that 1) $k(x, x') = ck_1(x, x')$ and 2) $k(x, x') = f(x)\, k_1(x, x')\, f(x')$ are valid kernels, where $c > 0$ is a positive constant and $f(\cdot)$ is any real-valued function.

$$k(x, x') = c\, k_1(x, x')$$
$$= c\, \phi_1^T(x)\, \phi_1(x')$$
$$= \left(\sqrt{c}\, \phi_1^T(x)\right)\left(\sqrt{c}\, \phi_1(x')\right)$$
$$= \phi^T(x)\, \phi(x') \quad \#$$
where $\phi(x) = \sqrt{c}\, \phi_1(x)$

$$k(x, x') = f(x)\, k_1(x, x')\, f(x')$$
$$= f(x)\, \phi_1^T(x)\, \phi_1(x')\, f(x')$$
$$= \left(f(x)\, \phi_1^T(x)\right)\left(f(x')\, \phi_1(x')\right)$$
$$= \phi^T(x)\, \phi(x') \quad \#$$
where $\phi(x) = f(x)\, \phi_1(x)$