

MACHINE LEARNING

PART 29

L1 and L2 regularization Explained

L1 Regularization and L2 Regularization are techniques used to prevent overfitting in machine learning models, including neural networks.

They involve adding a regularization term to the loss function during training to penalize large weights.

L1 Regularization

Penalty Term:

- Adds the sum of absolute values of weights to the loss function.

Effect:

- Encourages sparsity in the weight matrix. It tends to drive some weights to exactly zero, effectively performing feature selection.

Loss Function with L1 Regularization:

$$\text{Loss}_{L1} = \text{Loss}_{\text{original}} + \lambda \sum_{i=1}^n |w_i|$$

Hyperparameter λ

Regularization Strength:

- λ is a hyperparameter that controls the strength of the regularization. Higher values lead to stronger regularization.

Grid Search:

- The choice of λ often involves experimentation and is often determined through techniques like grid search.

Elastic Net

Elastic Net:

- Combines both L1 and L2 regularization. It includes both the absolute values of weights and squared values in the penalty term.

Loss Function with Elastic Net:

$$\text{Loss}_{\text{Elastic Net}} = \text{Loss}_{\text{original}} + \lambda_1 \sum_{i=1}^n |w_i| + \lambda_2 \sum_{i=1}^n w_i^2$$

Keras Implementation



```
from tensorflow.keras import regularizers

model.add(Dense(64, input_dim=10, activation='relu',
kernel_regularizer=regularizers.l1_l2(l1=0.01, l2=0.01)))
```

Use Cases

- **Preventing Overfitting:**
 - Regularization helps prevent overfitting by discouraging overly complex models.
- **Feature Selection:**
 - L1 regularization can lead to sparse weight matrices, effectively performing feature selection.
- **Improving Generalization:**
 - L2 regularization encourages models to generalize well to unseen data.
- **Stability:**
 - Regularization improves the stability of training by avoiding extreme weight values.

Considerations

Choosing the Regularization Term:

- *The choice of λ depends on the specific task and may require experimentation.*

Impact on Model Complexity:

- *Regularization impacts the complexity of the model. It helps balance the trade-off between fitting the training data well and avoiding overfitting.*

Both L1 and L2 regularization techniques are valuable tools in the machine learning toolbox and can be applied based on the specific characteristics of the data and the task at hand.