ECE571: Final Project — Digit Recognizer

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Outline

MNIST Database

MNIST

The MNIST database (Mixed National Institute of Standards and Technology database) is a large database of handwritten digits. Totally, there are **60,000** training samples and **10,000** testing samples.

Figure: Samples from NMIST

Previous work

Table: Previous results on MNIST database

Classifier	Preprocessing	Error rate (%)
Pairwise linear classifier	Deskewing	7.6
Boosted Stumps	Haar features	0.87
SVM	Deskewing	0.56
kNN	Shiftable edges	0.52
Neural Network	None	0.35
CNN	Width normalizations	0.23

Subset of MNIST

We use a subset of MNIST, roughly **5,000** samples.

Challenge

Achieve a good result on the subset.

Data Preprocessing

Vectorization

Figure: Vectorization of a image

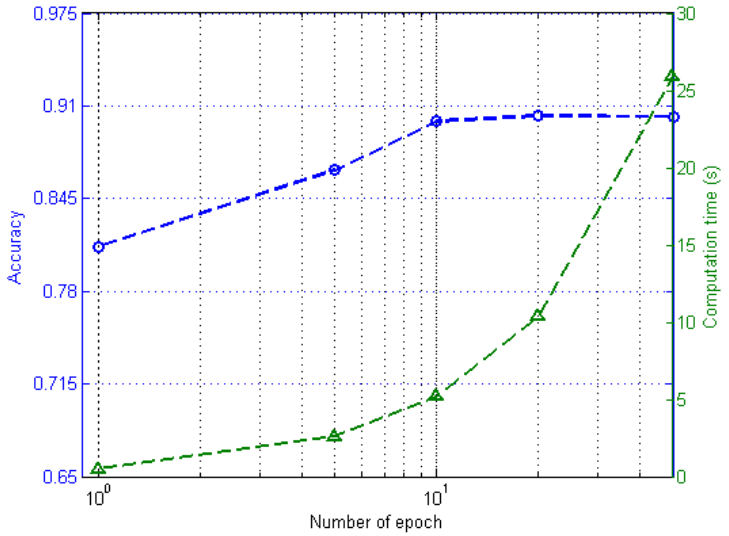
Correlation detection

Delete features that are not strong correlated to the groundtruth.

$$\text{Dimension reduction: } 28 \times 28 = \mathbf{784} \rightarrow \mathbf{440}$$

Leave-20%-out Cross Validation

- Randomly select 20% samples as testing data
- The remain is training data
- Apply classifier and record accuracy



Number of epoch	Accuracy	Standard error	Computation time (s)
1	0.8114	0.0311	0.52
5	0.8650	0.0130	2.59
10	0.8993	0.0055	5.18
20	0.9029	0.0053	10.36
50	0.9026	0.0033	25.90

Classifier Implemented in the Project

- Maximum Posterior Probability (MPP)
- K Nearest Neighbors (kNN)
- Back-Propagation Neural Network (BPNN)
- K-means and Winner-take-all (WTA)
- Self-Organizing Map (SOM)
- Decision Tree (DT)
- Support Vector Machine (SVM)
- Random Forest (RF)
- Convolutional Neural Network (CNN)

Random Forest (RF)

Advantage over decision tree

Avoid over fitting and improve performance.

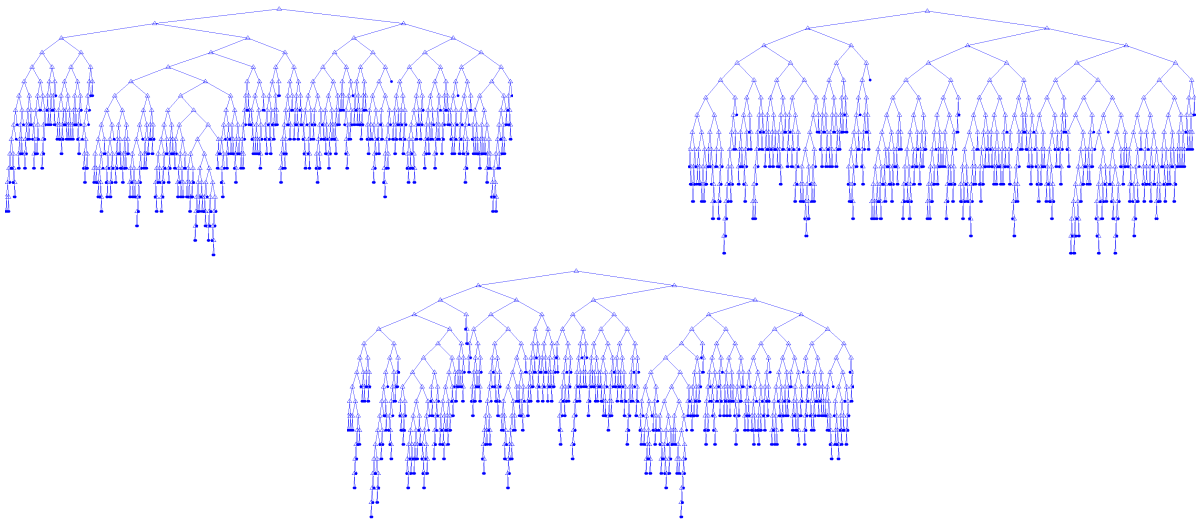


Figure: Individual trees from random forest

Converlutionsal Neural Network (CNN)

Difference from BPNN

Each node is a map (image), rather than a number in BPNN.

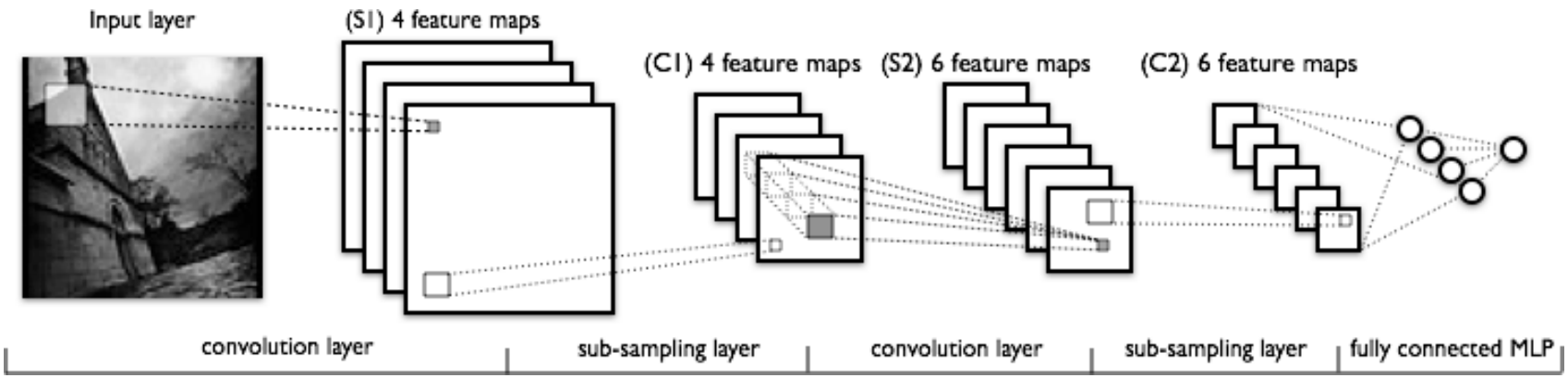
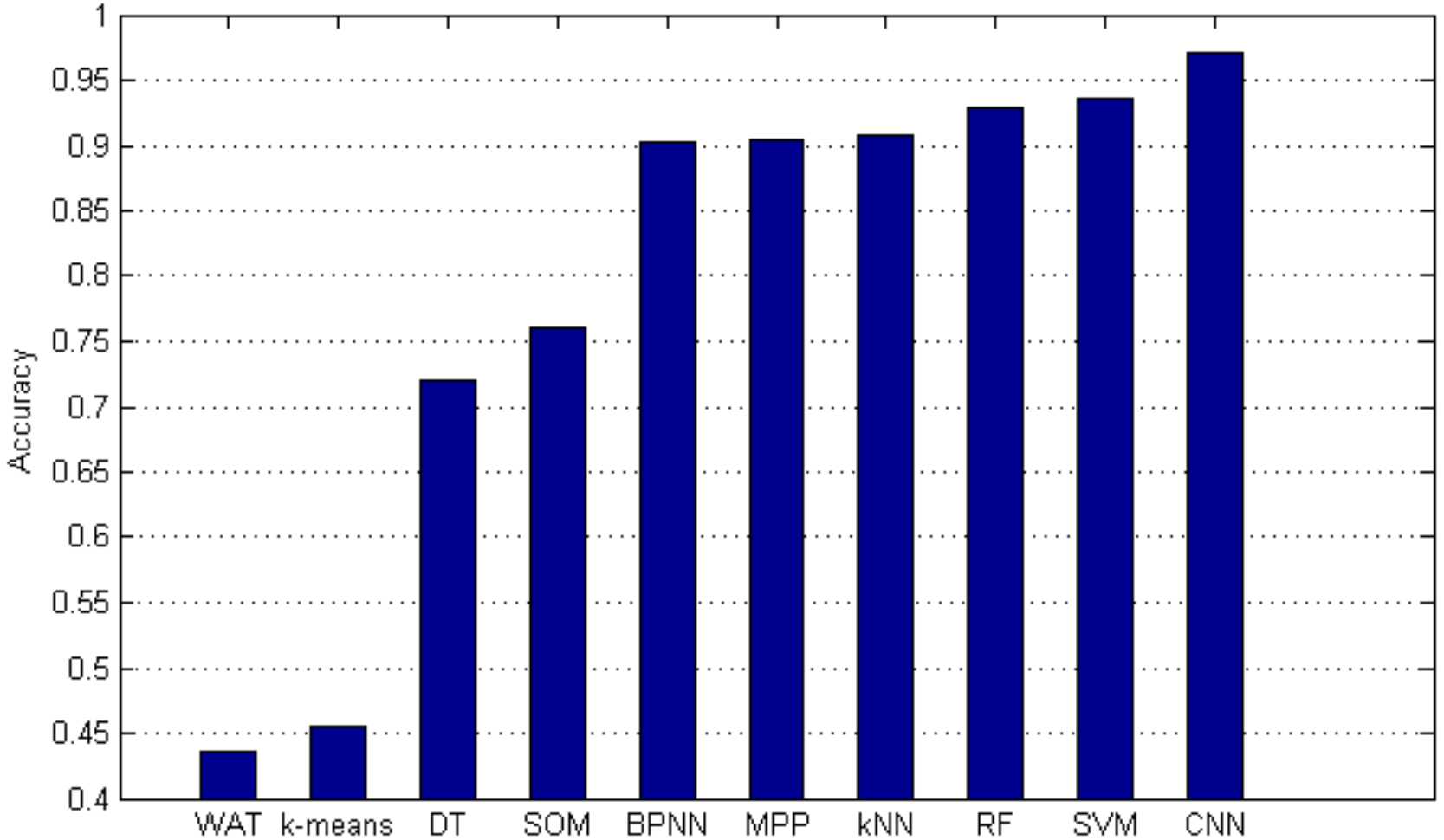


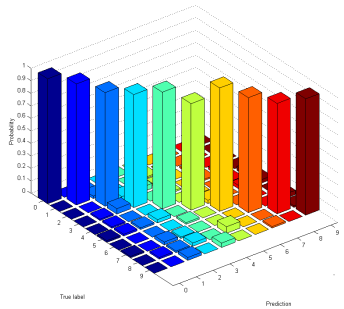
Figure: CNN model

Comparisoin of Accuracy

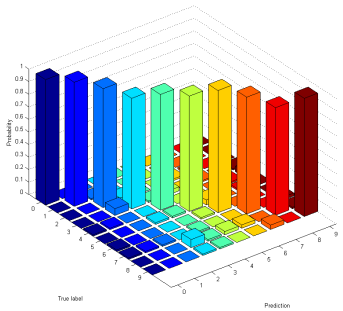


Fusion Methods

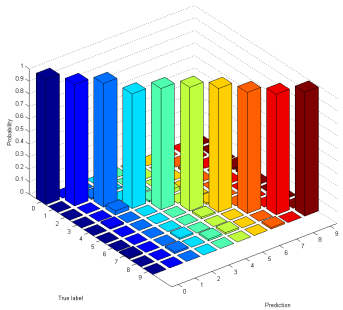
- Majority voting (RF, SVM and CNN)
- Confusion matrix



(a) RF

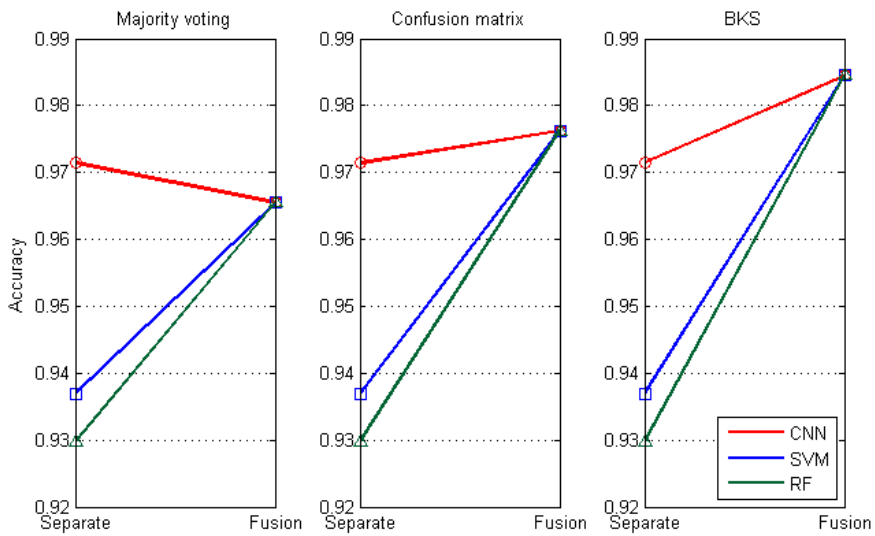


(b) SVM



(c) CNN

- Behavior-knowledge space (BKS) **Accuracy = 98.5%**



Work Distribution

Z. Zhang	S. Zhong	L. Tong
SVM	MPP	kNN
RF	BPNN	SOM
CNN	k-means	DT
Fusion	WTA	PCA

Thank you!