

Final Project on Kaggle Competition

What's Cooking



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1. Introduction

The main problem

The main issue of this competition is to classify lists of ingredients into correct kinds of cuisines. There are only two given files `train.json` and `test.json`. Each training instance is represented in this format of JSON.

```
{
  "id": 10259,
  "cuisine": "greek",
  "ingredients": [ "romaine lettuce", "black olives", "grape tomatoes", "garlic",
    "pepper", "purple onion", "seasoning", "garbanzo beans", "feta cheese crumbles" ]
}
```

And, each testing instance is represented in the format of JSON.

```
{
  "id": 18009,
  "ingredients": [ "baking powder", "eggs", "all-purpose flour",
    "raisins", "milk", "white sugar" ]
}
```

There are totally 20 kinds of cuisines.

irish	mexican	chinese	filipino	vietnamese
moroccan	brazilian	japanese	british	greek
indian	jamaican	french	spanish	russian
cajun_creole	thai	southern_us	korean	italian

After an initial step of statistics, some basic summaries about data are given below.

Number of training instances	39774
Number of testing instances	9944
Total number of ingredients in training data	6714

The submission needs to be saved as a csv file of this form.

id	cuisine
18009	italian
35203	chinese
...	...

Obviously, this competition is a **supervised problem** of **multi-class classification**. There are several kinds of applicable classifiers.

- Transform to binary - OvR (one-against-all), OvO (one-against-one)
- Extend from binary - Naive Bayes, KNN (IBk), Decision trees (J48), SVM (SMO), Neural networks (Multilayer Perceptron)

The main steps of learning

There are five major steps of machine learning in this project.

- **Data analysis** - We started with **data preprocessing** by these initial process.
 - Delete these special characters: ç, è, é, ®, and ™.
 - Convert all the strings into the type of UTF-8.
- **Visualization** - If we transform the training data into a sparse matrix full of 0 and 1 directly, the matrix will have the size of 39774×6714 . To cope with this matrix more efficiently, we need **dimension reduction** to compress the size of matrix without losing too many varieties of data. **This step is the main difference between related work and our new method** which will be mentioned in the sections 2 & 3.
- **Modeling** - We chose **Weka** environment to create models. The detailed process of converting data matrix to the valid file for Weka environment will be mentioned also in the sections 2 & 3. All the codes used in this project can be found in the GitHub.
 - <https://github.com/alicia6174/Kaggle-Whats-Cooking>

The instructions of how to use Weka will be described in the appendix. We skipped **tuning** in this project because we focused on comparing the results of two methods under different models.

- **Evaluation** - We presented various quantitiest to evaluate different models in the section 4. Finally, we gave the scores of our submissions on Kaggle site.
- **Prediction** - We saved the best model depending on the evaluation and used it to predict the cuisine of each testing data. The process will be mentioned also in the sections 2 & 3.

2. Related work

Descriptions of method

- **Dimension reduction** - The old method collected the **top ingredients** which occur most frequently in the training data as the features. To compare with our method, we chose the number of features to be 1000. In that way, each data could be transformed into a 1000-dimensional vector with the i th component being 1 if its ingredients contain the i th feature and being 0 if otherwise. The training data matrix of size 39774×1000 (without the header and labels) had this form and was saved as a csv file.

1	2	1000	cuisine
0	0	0	greek
1	0	0	southern_us
\vdots	\vdots	\vdots	\vdots
0	1	1	mexican

- **Modeling** - We converted the csv file into an arff file so that the Weka environment would work more smoothly. We tried several multi-class classifiers for comparison. According to the evaluation (see §4), we saved the best model **SMO** to make predictions.
- **Prediction** - We repeated the steps of preprocessing and file conversion to create the arff file of testing data. Then we used Weka again to predict the result. Finally, we saved the result as a needed submission file and uploaded it on the Kaggle site for scoring.
- Matrix???

Detailed steps

Coding files & ML Tools	Created files	Goals
prefixFilter	train.json	delete special characters
create_top_ing.py	ing_top1000.csv	find top 1000 ingredietns
create_weka.py	train_weka_top1000.csv (81M)	create the reduced training data for modeling
weka-csv-arff.pl	train_weka_top1000.arff	convert to arff file
Weka		create models and make evaluations
Weka	train_weka_top1000_SMO.model	create the model of SMO
prefixFilter	test.json	delete special characters
create_weka.py	test_weka_top1000.csv (21.2M)	create the reduced testing data for prediction
weka-csv-arff.pl	test_weka_top1000.arff	convert to arff file
Weka	test_weka_top1000_SMO.txt	make predictions
weka-to-kaggle.pl	test_weka_top1000_SMO.csv	create the submission file for Kaggle

The 1001th attribute in the file test_weka_top1000.arff needs to be modified to the 20 cuisines before testing.

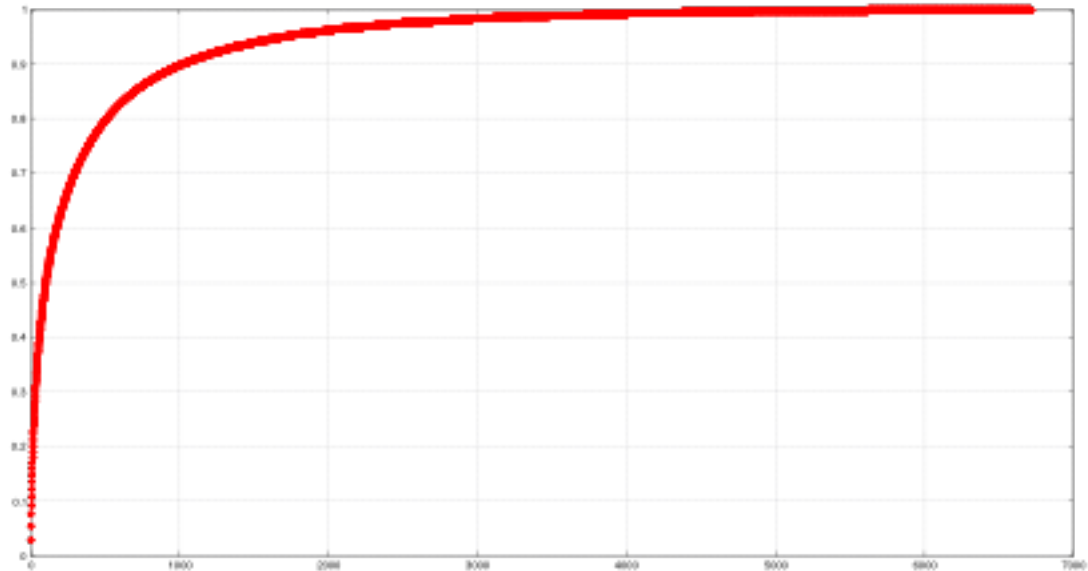
3. New methods

Descriptions of method

- **Dimension reduction** - Our method adopted **PCA** which is a linear unsupervised reduction. First we collected the totally 6714 ingredients as features and each data could be transformed into a 6714-dimensional vector with the i th component being 1 if its ingredients contain the i th feature and being 0 if otherwise. In that way, we could create the training data matrix of size 39774×6714 . Second we computed the eigenvalues and eigenvectors of the corresponding covariance matrix. Third we chose the number of reduced dimension to be 1000 according to the score defined by

$$\text{Score}(k) = \frac{\sum_{i=1}^k \lambda_i}{\sum_{i=1}^{6714} \lambda_i}$$

where λ_i s are the eigenvalues which satisfy $\lambda_1 \geq \lambda_2 \geq \dots \geq \lambda_{6714}$. This grapf of score versus number of eigenvalues shows that 1000 corresponds to the score of 90.



Finally we multiplied the training data matrix by this matrix composed of the top 1000 eigenvectors to obtain the reduced training data matrix. Each feature had been normalized and rounded to the second decimal.

$$\begin{bmatrix} v_1 & v_2 & \dots & v_{1000} \end{bmatrix}_{6714 \times 1000}$$

The reduced training data matrix of size 39774×1000 (without the header and labels) had this form and was saved as a csv file.

1	2	1000	cuisine
0.71	0.34	0.45	greek
0.49	0.57	0.47	southern_us
⋮	⋮	⋮	⋮
0.30	0.30	0.47	mexican

- **Modeling** - This step was conducted almost in the same way as in the section 2. The main difference was that **SMO** still served as the best model after evaluation (see §4).
- **Prediction** - We conducted the same step of dimension reduction to obtain the reduced testing data matrix. The reduced testing data matrix of size 9944×1000 (without the header and labels) had this form and was saved as a csv file. The following steps was conducted in the same way as in the section 2.

1	2	1000	cuisine
0.83	0.67	0.52	?
0.93	0.63	0.53	?
⋮	⋮	⋮	⋮
0.70	0.20	0.47	?

Detailed steps

Coding files & ML Tools	Created files	Goals
prefixFilter	train.json	delete special characters
create ^{toping} .py	ing.csv	find all the 6714 ingredients
create_mtx.py	train_mtx.csv	create the training data matrix of size 39774 x 6714
do_pca.cpp	eigVal_eigVec	find the PCs and eigenvalues of the above matrix
create_eigVec.pl	eigVec	divide the file eigVal_eigVec into eigVec and eigVal
create_eigVal.pl	eigVal	divide the file eigVal_eigVec into eigVec and eigVal
create_pca_mtx.m	train_pca_mtx_1000.csv	create the reduced training data matrix of size 39774 x 1000 by matrix mutiplication
create_weka.py	train_weka_pca1000.csv (187M)	create the reduced training data for modeling
weka-csv-arff.pl	train_weka_pca1000.arff	convert to arff file
Weka		create models and make evaluations
Weka	train_weka_pca1000_SMO.model	create the model of SMO
prefixFilter	test.json	delete special characters
create_mtx.py	test_mtx.csv	create the testing data matrix of size 9944 x 6714
create_pca_mtx.m	test_pca_mtx_1000.csv	create the reduced testing data matrix of size 9944 x 1000 by matrix mutiplication
create_weka.py	test_weka_pca1000.csv (48.7M)	create the reduced testing data for prediction
weka-csv-arff.pl	test_weka_pca1000.arff	convert to arff file
Weka	test_weka_pca1000_SMO.txt	make predictions
weka-to-kaggle.pl	test_weka_pca1000_SMO.csv	create the submission file for Kaggle

The 1001th attribute in the file test_weka_pca1000.arff needed to be modified to the 20 cuisines before

testing.

4. Comparison results

Evaluation

- Put some of these results in the appendix since the matrix of results are too large!
- The device we used is Google * 4. We run four PC simultaneously for convenience.
- Correctness / Accuracy / Error rate. We computed Percent 66% instead of K-fold cross-validation since the data is too large!

Old method:

- Naïve Bayes 63.3365 %
- IBk, k=1501 31.7533 % Take k=1501 for some reason
- SMO xxx %
- MultilayerPerceptron ??? %
- J48 64.2387 %
- MultiClassClassifier(OvR)??? %
- MultiClassClassifier(OvO)??? % (pink)

New method:

- Naïve Bayes 3x.xxx %
 - IBk, k=1501 30.8364 % Take k=1501 for some reason
 - SMO 73.2382 %
 - MultilayerPerceptron ??? %
 - J48 40.0281 %
 - MultiClassClassifier(OvR)xxx %
 - MultiClassClassifier(OvO)Out of memory!
- Training time
 - Confusion matrix
 - ROC, AUC ...

Kaggle score

- Old: Top 1000, S=???
- New: PCs 1000, S=0.66020
- Screen Shot of Kaggle score

5. Discussion and conclusion

- The file size 81M vs. 187M due to the float type of PCA data.
- Why did we choose the number of features to be 1000? Score.pdf
 - Old method: We've tried Top 200 ing. + ing_len (normalized) -> Not good enough.
 - New method: We've tried PCA 2000 (normalized) -> Out of memory.
- Why did we choose 66 % instead of k-fold validation? The data is too large.
- Why did we choose those models?
- The parameter K of KNN was taken as K=1501 due to the reference. Actually, we made a KNN algorithm ourselves with some specific distance and K=21 created a better result! (Screen Shot of Kaggle score) You can find the code also in our GitHub site.
 - <https://github.com/alicia6174/Kaggle-Whats-Cooking>
- The result of the new method seemed the same as the old one. We don't know why..
- Future work - Text mining, Compressed sensing, Factorization Machines (2010), Latent Dirichlet Allocation.

Appendix

How to use Weka

Version of Weka.

- 3.8.0
- Need to install Java

Sketch the steps.

- Transform training data to a csv file.
- Try several multi-class classifications and choose features (ex. #(ing.) for each cuisine).
- Compute the accuracy and cross validation.
- Choose a model to test. ex. J48, KNN, PLA, Bayes...

Formal steps.

- Create a new csv data file (in a needed form).
- Convert it to UTF8 encoding. (use instruction in vim [A]).
- Convert it into train and test arff files (Hsin's shell-script [A]).
- Train train.arff by xxx on Weka, analyze the data (MAE, ROC...), and save xxx.model.
- Test test.arff by the model, and save result_xxx.txt.
- Convert resultxxx.txt to resultxxx.csv.

How to use Automatic Weka & Version of AutoWeka

Version of Weka.

- For the newest Weka 3.8.0 and Auto-Weka 2.5, it needs to install Java and JDK and type the specific instruction to avoid java executable issue.

Sketch the steps.

- ...

References

1. Y.-J. Lee, Y.-R. Yeh, and H.-K. Pao. Introduction to Support Vector Machines and Their Applications in Bankruptcy Prognosis. *Handbook of Computational Finance*, 731-761, 2012.
2. 袁梅宇. 王者歸來：WEKA機器學習與大數據聖經 3/e. 佳魁資訊, 2016.