

# Home Depot Product Search Relevance

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**Abstract**—In this search relevance project, our goal was to build a model to predict the relevance of search items and product on homedepot.com, given the searching items, resulting product titles and product descriptions. Our teams solution relies heavily on feature extraction/selection and model ensembling.

Our solution consists of three parts:

## 1. Text cleaning

Before generating features, we have realized that its reasonable to process the data. So we cleaned the data with spelling correction, synonym replacement, removing dots and stop words. Then we selected the optimal solution of N for each N-grams feature.

## 2. feature extraction

We had tried three types of feature:

a counting features( which is not used in the final result)

b distance features(1-8 grams)

c TF-IDF features (1-8 grams)

## 3. selection and model ensembling.

Model ensembling consisted of two main steps. Firstly, we trained model library using different models, different parameter settings, and different subsets of the features. Secondly, we generated ensemble submission from the possible ensemble selections. Performance was estimated using cross validation within the training set. We tried both classification and regression to compare our results.

a Neural Net

b General Linear Model

c Machine Learning Methods

## I. INTRODUCTION

Shoppers rely on Home Depots product authority to find and buy the latest products and to get timely solutions to their home improvement needs. From installing a new ceiling fan to remodeling an entire kitchen, with the click of a mouse or tap of the screen, customers expect the correct results to their queries quickly. Speed, accuracy and delivering a frictionless customer experience are essential.

In this project, we were asked to help them improve their customers' shopping experience by developing a model that can accurately predict the relevance of search results.

Search relevancy is an implicit measure Home Depot uses to gauge how quickly they can get customers to the right products. Currently, human raters evaluate the impact of potential changes to their search algorithms, which is a slow and subjective process. By removing or minimizing human input in search relevance evaluation, Home Depot hopes to increase the number of iterations their team can perform on the current search algorithms.

The relevance is a number between 1 (not relevant) to 3 (highly relevant). For example, a search for "AA battery" would be considered highly relevant to a pack of size AA batteries (relevance = 3), mildly relevant to a cordless drill battery (relevance = 2), and not relevant to a snow shovel (relevance = 1).

## II. DATA CLEANING

id	product_uid	product_title	search_term	product_description	relevance
2	100001	Simpson Strong-Tie 12-Gauge Angle	angle bracket	Not only do angles make joints stronger, they also pro...	3.00
3	100001	Simpson Strong-Tie 12-Gauge Angle	l bracket	Not only do angles make joints stronger, they also pro...	2.50
9	100002	BEHR Premium Textured DeckOver 1-gal #SC-141 Ta...	deck over	BEHR Premium Textured DECKOVER is an innovative s...	3.00
16	100005	Delta Vero 1-Handle Shower Only Faucet Trim Kit in C...	rain shower head	Update your bathroom with the Delta Vero Single-Han...	2.33
17	100005	Delta Vero 1-Handle Shower Only Faucet Trim Kit in C...	shower only faucet	Update your bathroom with the Delta Vero Single-Han...	2.67
18	100006	Whirlpool 1.9 cu. ft. Over the Range Convection Micro...	convection otr	Achieving delicious results is almost effortless with thi...	3.00
20	100006	Whirlpool 1.9 cu. ft. Over the Range Convection Micro...	microwave over stove	Achieving delicious results is almost effortless with thi...	2.67
21	100006	Whirlpool 1.9 cu. ft. Over the Range Convection Micro...	microwaves	Achieving delicious results is almost effortless with thi...	3.00
23	100007	Lithonia Lighting Quantum 2-Light Black LED Emergen...	emergency light	The Quantum Adjustable 2-Light LED Black Emergen...	2.67
27	100009	House of Fara 3/4 in. x 3 in. x 8 ft. MDF Fluted Casing	mdf 3/4	Get the House of Fara 3/4 in. x 3 in. x 8 ft. MDF Flute...	3.00
34	100010	Valley View Industries Metal Stakes (4-Pack)	steel stake	Valley View Industries Metal Stakes (4-Pack) are 9 in. g...	2.67
35	100011	Toro Personal Pace Recycler 22 in. Variable Speed Self...	briggs and stratton lawn mower	Recycler 22 in. Personal Pace Variable Speed Self-Prop...	3.00
37	100011	Toro Personal Pace Recycler 22 in. Variable Speed Self...	gas mower	Recycler 22 in. Personal Pace Variable Speed Self-Prop...	3.00
38	100011	Toro Personal Pace Recycler 22 in. Variable Speed Self...	honda mower	Recycler 22 in. Personal Pace Variable Speed Self-Prop...	2.00
48	100012	Hampton Bay Caramel Simple Weave Bamboo Rollup S...	hampton bay chestnut pull up shade	The 96 in. wide Caramel Simple Weave Rollup Bamboo...	2.67
51	100013	InSinkErator SinkTop Switch Single Outlet for InSinkE...	disposer	The InSinkErator SinkTop Switch Single Outlet for Indin...	2.67
65	100016	Sunjoy Cates 8 ft. x 5 ft. x 8 ft. Steel Tile Fabric Grill G...	grill gazebo	Make grilling great with this handsome and functional...	3.00
69	100017	MD Building Products 36 in. x 36 in. Coverleaf Alumin...	door guards	The MD Building Products 36 in. x 36 in. x 1/50 in. Al...	1.00

Fig. 1. 74067 observations

## A. Word Replacement

By exploring the provided data, it seems important to perform some word replacements/alignments, e.g., spelling correction and synonym replacement, to align those words with the same or similar meaning.

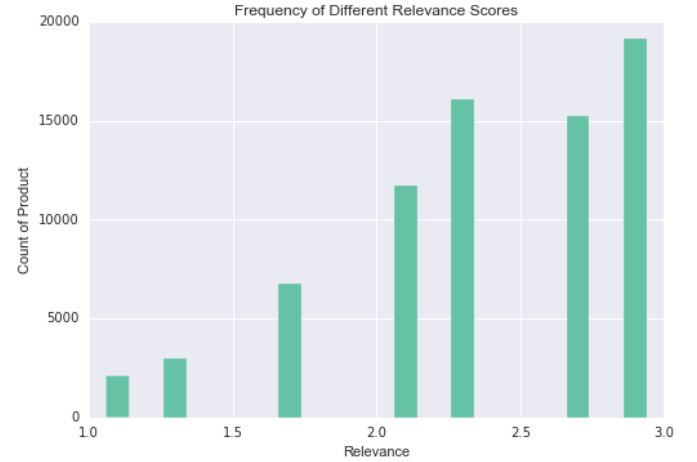


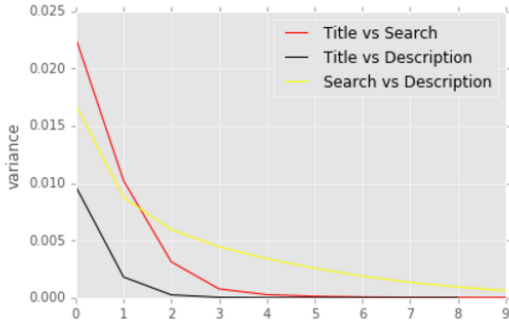
Fig. 2. Relevance

1) *Spelling Correction*: We just fixed the typo like "hel-loWorld" to "hello World", which seperated two individual word. What is more, we delete the stop words like "the", "and", for these words don't lend any support to our training.

2) *Synonym Replacement*: We replaced the synonym to reduce and simplify our data size.

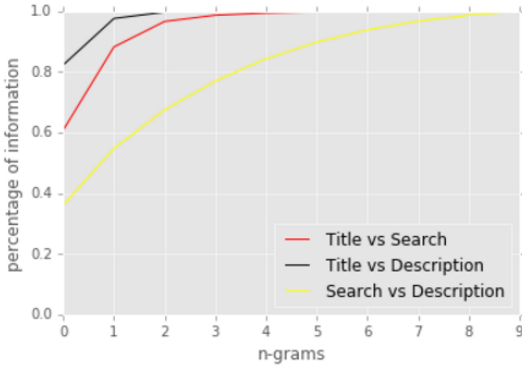
3) *Other Replacements*: Including but not limited to removing insignificant punctuation like "# , .", translating plurality like "feet" to "foot".





Therefore, we will choose  $n = 4$  for our training model

Fig. 7. TF-IDF Feature



Percentage of information: cumulative variance / sum of variance

Thus, we choose  $n$  as follow:

- Title vs Search:  $n = 3$ ,
- Title vs Description:  $n = 2$
- Search vs Description:  $n = 8$

Fig. 8. n-gram for TF-IDF Feature

and material. In these features, we used the method the same as Jaccard coefficient. Obviously, as many items only have one word in their color and material description, we would prefer 1-gram here.

#### E. Combined Features

Combined all the features above as our predictors.

### IV. REGRESSION ANALYSIS

Because we found the relevance scores in training set are 1, 1.33, 1.5, 1.67, 2, 2.33, 2.5, 2.67, 3, we think regression should be better than classification.

For each model selection method, we use 5-fold cross-validation to avoid overfitting problem. The training data is broken up into 5 sections called folds. At each iteration, we

	product_uid	name	value
279	100010	Color/Finish	Silver/Gray
282	100010	Material	Steel
283	100010	MFG Brand Name	Valley View Industries

Fig. 9. Combined Features

hide one fold and train the selected model on the remaining 4 folds. Grid search is applied to find several possible costs for most models. For each cost we quantify the models performance by taking the average test error over all folds, then pick the cost parameters with the lowest overall test error.

#### A. Simple Linear Regression

- The basic understanding of relationship
- Try as a starting point

#### B. Ridge Regression

- Alleviate multicollinearity among predictor variables
- Grid-search to find optimal penalty
- Search Range:  
Alpha:  $10e^{-6}$  to  $10e^{-2}$

#### C. Random Forest

Random forest is a substantial modification that builds a large collection of de-correlated trees and then averages them. It is a popular ensemble selection method as the performance of random forest is very similar to boosting and corresponding parameters are simpler to train and tune.

- Parameters range for grid-search:  
Number of trees in forest: 10-35  
Maximum depth of tree: 2-20

The final output shows that the optimal number of trees in forest is 33 and the maximum depth of tree is 10.

#### D. Extreme Gradient Boosting

XGBoost, short for Extreme Gradient Boosting, is also a ensemble model for supervised learning problem. It applies a more regularized model formalization to control over-fitting, which often gives a better performance.

- Search Range:  
Number of tree depth for base learners: 2-20  
Number 10-35

The final output shows that the optimal number of tree depth is 9 and number of boosted trees to fit is 31.

#### E. Neural Network Regressor

- Layers: 4
- Nodes: 50/layers
- Steps: 5000

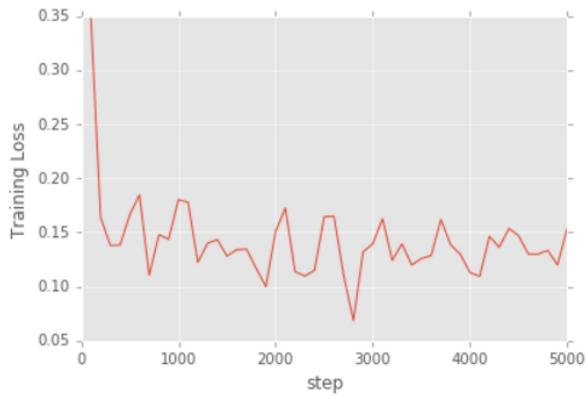


Fig. 10. Neural Network Loss

## V. CONCLUSION

We applied 5-folds cross validation for each regressors to generated the following table:

## REFERENCES

- [1] <https://github.com/tensorflow/skflow>
- [2] [https://github.com/ChenglongChen/Kaggle\\_CrowdFlower](https://github.com/ChenglongChen/Kaggle_CrowdFlower)
- [3] <https://github.com/dmlc/xgboost>