Predicting Airbnb User Booking Destinations

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About the Competition

- Recruiting competition hosted on Kaggle from November 2015 to February 2016
- **Task:** build a model to predict where new Airbnb users will book their first destinations
- **12 possible destinations to predict:** Australia, Canada, France, Germany, Italy, Netherlands, Portugal, Spain, United Kingdom, US, other and no destination found (NDF)

About the Data

- **train_users**
  - 213,415 observations and 16 variables
  - Contains information about users from 2010 to 2014
- **sessions**
  - 1,048,575 rows and 12,994 unique users
  - contains information about web session activity for each user
  - 10% of rows from each unique user were randomly sampled
  - New sampled data contained 104,424 rows

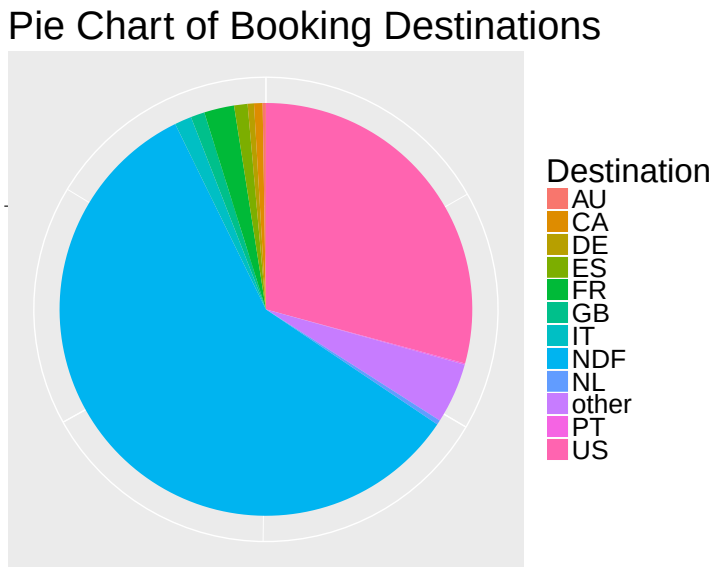
Models

- Extreme Gradient Boosting (XGBoost)
- Random forest
- Stacked model

Feature Engineering

- Date features
- Age and gender
- Count features created from the sessions data (e.g. number of times a user viewed recent reservations, number of times a user viewed similar listings...)
- Summary statistics of seconds elapsed for each user's web session

Booking Destinations: Extremely Imbalanced Classes



Destination	Percentage of the data (%)
NDF	58.35
US	29.22
other	4.73
FR	2.35
IT	1.33
GB	1.09
ES	1.05
CA	0.67
DE	0.50
NL	0.36
AU	0.25
PT	0.10

Figure: Percentage of bookings made to each destination

Model Building: Feature Importance

- Full data was split into training (70% of the data) and test sets
- 5-fold cross-validation was performed with XGBoost and random forest models, with just the top 200 most important features
- **Accuracy:** 87%
- Both models only made predictions for US and NDF

Model Building: Feature Importance

XGBoost	**Random Forest**
firstbook_y.1	firstbook_sn.1
age_clean	firstbook_wkd.1
signup_flow	firstbook_y.1
firstbook_snspring	lag_acb_binNA
affiliate_channelother	lag_acb_bin.1..365.
gender_cleanFEMALE	firstbook m.1
gender_cleanMALE	lag_bts_bin.1..1369.
age_bucket.1	lag_bts_binNA
lag_acb_bin.1..365.	firstbook_snspring
firstbook_y2014	firstbook y2013

Table: Top 10 most important features for each model

Model Building: Accounting for Imbalanced Classes

- Two techniques:
  - Oversampling with replacement from under-represented destinations, under-sampling from over-represented destinations
  - Synthetic Minority Oversampling Techniques (SMOTE) combined with under-sampling from over-represented destinations
- Under-represented destinations made up at least 4% of the training data after oversampling

Model Building: Results of Oversampling Techniques

- **Accuracy:** 87%

	AU	CA	DE	ES	FR	GB	IT	NDF	NL	other	PT	US
AU	0	0	0	0	1	0	0	0	1	5	0	22
CA	1	2	0	0	3	0	1	0	1	2	0	14
DE	0	0	0	0	1	1	1	0	0	4	0	14
ES	0	0	1	0	1	1	1	0	1	3	0	17
FR	0	0	2	1	2	0	0	0	0	1	0	9
GB	0	0	0	0	1	2	0	0	0	1	0	8
IT	0	0	1	0	0	0	0	0	1	3	0	7
NDF	0	0	0	0	0	0	0	26154	0	0	0	0
NL	0	0	1	0	5	0	2	0	0	5	0	10
other	1	0	3	1	5	1	1	0	0	6	1	25
PT	0	4	1	0	4	0	3	0	1	7	1	43
US	111	294	213	470	1032	483	586	0	155	2082	43	12930

Figure: Confusion matrix of predictions made with XGBoost on the regular over-sampled training set

Model Building: Stacked Modeling

- Training data was partitioned into five folds, each containing 20% of the data
- Build each model on four of the training folds, test on the held-out fold
- Repeated the process until each fold was used as a test fold
- Stored those predictions in two columns in the training set
- Fit each model to the full training set, predict on the test data, store predictions in the test set
- Final XGBoost fit to the predictions stored in the training set and tested on predictions stored in the test set

Model Building: Results of Stacking

- **Accuracy:** 87%

	AU	CA	DE	ES	FR	GB	IT	NDF	NL	other	PT	US
AU	0	0	0	3	0	2	2	0	0	11	0	42
CA	0	2	0	2	3	1	2	0	0	7	0	47
DE	0	3	2	2	2	2	2	0	1	6	0	52
ES	0	2	1	4	2	3	1	0	1	7	0	30
FR	0	0	0	0	1	0	0	0	0	0	0	2
GB	0	1	4	1	2	3	0	0	0	5	0	26
IT	0	1	0	3	3	1	4	0	1	1	0	20
NDF	0	0	0	0	0	0	0	37362	0	0	0	0
NL	1	2	1	3	5	0	6	0	0	5	1	35
other	1	2	3	1	8	2	6	0	0	26	0	95
PT	1	2	3	4	7	2	3	0	1	13	0	73
US	158	413	304	651	1473	681	824	0	224	2947	64	18290

Figure: Confusion matrix of stacked model predictions, trained on the regular over-sampled training set

Model Building: Last Steps

- Perform five-fold cross-validation with XGBoost, random forest, and stacked model on the full data
- **Accuracy:** 87%
- Run times:
  - Random forest: 27.5 min
  - XGBoost: 28.7 min
  - Stacked model: 3.24 hr

Discussion: Model Performance

- Extremely imbalanced classes
- Base classifiers of the stacked model performed poorly in similar ways

Discussion: Next Steps

- Stack more than two models
- Build additional models to predict missing values for certain variables
- Incorporate the other available data sets
- Parameter tuning

Thank you!