Project 18: Analytical Exploration for Duke Development

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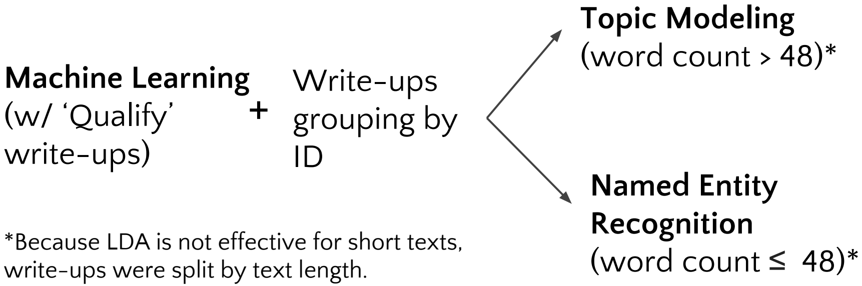
Primary Goal

1. **Triage** prospects to optimize Duke fundraising

2. Based on prospects' interests, categorize them into **12 initiatives**: STEM, Transformative Impact, Bass Connections, Energy, Women's Impact Network, Arts Initiative, Innovation and Entrepreneurship, Sports, Law, Religion, Health, and Philanthropy

Pipeline



Machine Learning (w/ 'Qualify' write-ups) + Write-ups grouping by ID

Topic Modeling (word count > 48)*

Named Entity Recognition (word count ≤ 48)*

*Because LDA is not effective for short texts, write-ups were split by text length.

Data

Notes by gift officers documenting interactions (**contact write-ups**), prospects' lifetime donations to duke, and demographic information for approximately 18,000 prospects (70,000 write-ups total)

Machine Learning

From "Qualify" write-ups, use **Naive Bayes Classifier** to predict if prospect advances to "Cultivate" or "Drop." Labels were created with historical data and features were TF-IDF values.

	Precision	Recall	F1
Cultivate	0.92	0.89	0.91
Drop	0.83	0.88	0.85

Fig. 1a Precision, Recall, F1 metrics

	Predicted Cultivate	Predicted Drop
Actually Cultivate	936	116
Actually Drop	79	558

Fig. 1b Confusion matrix

Topic Modeling

Latent Dirichlet Allocation (LDAMallet implementation) generates topics that occur across all long contact write-ups, and creates a model that predicts **topic occurrence** for each document. This model can be used to predict the topic distribution of new data

- 100 topics (see Fig. 2) were manually labeled and grouped into 12 distinct initiatives (see Fig. 3) .
- Prospects were assigned "compound scores" by averaging the probabilities of each topic under each initiative.

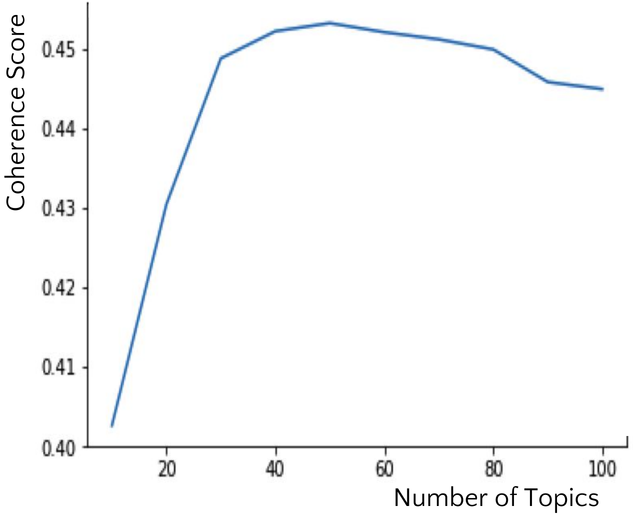


Fig. 2 Coherence is a measure of how closely related words are in a topic. While k=50 had the best coherence score, k=100 had a better balance of specificity and coherence when the topics were manually examined.

Arts Initiative	Bass Connections	Energy Initiative
Topic 25:Media Topic 40:Art Topic 71:Entertainment	Topic 62:Bass Connect Topic 84:Community Topic 88:Health Topic 89:Research	Topic 4:Energy Topic 72:Environment

Fig. 3 Grouping of topics into initiatives (three initiatives shown above). There were 40 unlabeled topics and 22 uncategorized topics.

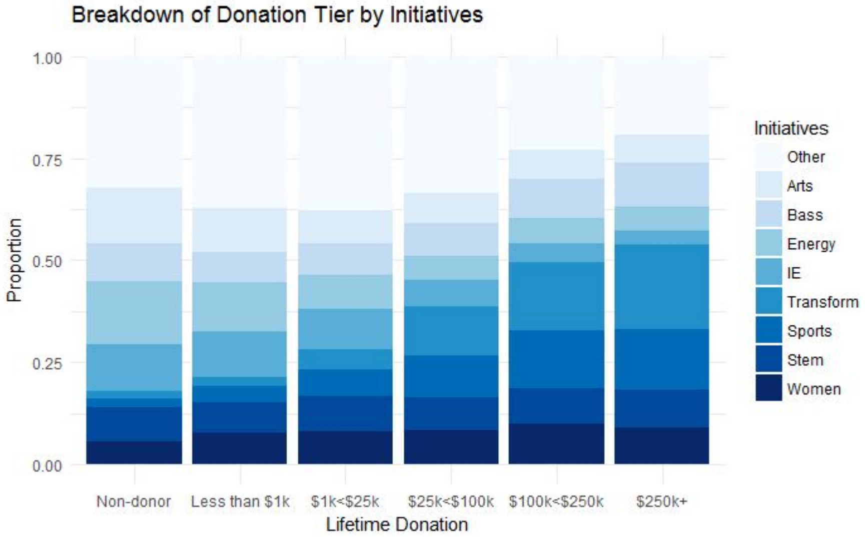
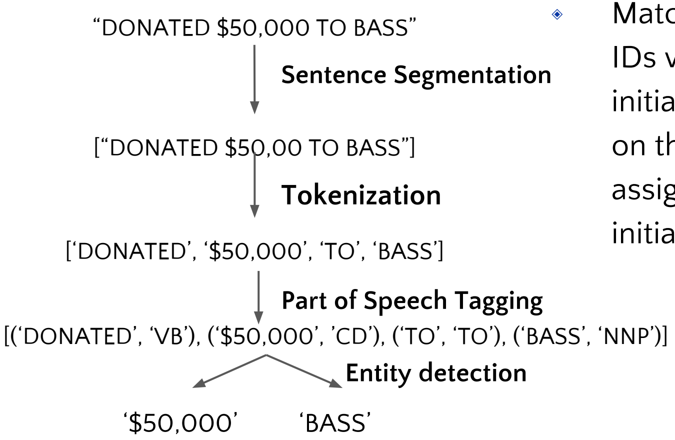


Fig. 4 Proportion of potential transformative impact and sports prospects increases as donation tier increases. Proportion of potential arts, energy, and I&E prospects decreases, most likely because these initiatives are newer and attract younger prospects who tend to have less capacity.

Named Entity Recognition

Identifies names of organizations, events and/or amount of money mentioned in each of the 2,856 short contact write-ups (SpaCy implementation)

Write-up: **ID 12345 "Donated $50,000 to Bass."**



"DONATED $50,000 TO BASS"
Sentence Segmentation
["DONATED $50,00 TO BASS"]
Tokenization
['DONATED', '$50,000', 'TO', 'BASS']
Part of Speech Tagging
[('DONATED', 'VB'), ('$50,000', 'CD'), ('TO', 'TO'), ('BASS', 'NNP')]
Entity detection
'$50,000'
'BASS'

- Matches prospect IDs with relevant initiative(s) based on the keywords assigned to each initiative

Categorization: ID 12345: **[Transformative Impact, Bass Connections]**

Results

1. A prospect's "Qualify" write-up is a strong predictor of whether or not the prospect is dropped (Fig. 1).
    - Prospects classified as "Cultivate" donate significantly more and have more subsequent contacts than those classified as "Drop," which reflects the data accurately.

2. Topic modeling and named entity recognition grouped more than two-thirds of prospects based on interests.
    - Approximately 12,000 unique prospects categorized by topic modeling
    - Approximately 600 unique prospects categorized by named entity recognition

3. Pipeline was incorporated into a python script that can be applied to new data in the future.

Future Research

The following analytical tools and their visualizations can be used to further understand giving trajectories:

- Sentiment analysis
- Network analysis
- Time series analysis

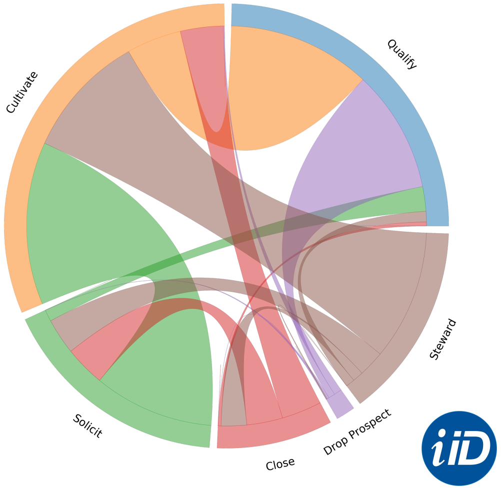


Fig. 5 This chord graph visualizes the relationships between the different moves that occur in the donation process. Notably, a similar proportion of prospects move to "Cultivate" and "Drop" from "Qualify."