DUNNHUMBY SHOPPERS' MISSIONS

STAT 645: Mini-Project 2

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OUTLINE

Introduction

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INTRODUCTION

PROBLEM DESCRIPTION

1. Dunnhumby Dataset.
2. Identify latent missions for shoppers.
3. Link missions to demographics and/or product categories.

QUESTIONS

1. Can we group products into distinguishable categories?
2. Can we identify demographic attributes that distinguish specific shoppers from the rest of the population?
3. Can we identify a temporal pattern in shoppers' topics?
4. Can we show how the distinguishing attributes can be leveraged for more effective marketing campaigns?

DATA REVIEW

DATA REVIEW

High Level Numbers

- 2,595,732 unique transactions
- 276,484 unique shopping baskets
- 92,339 unique products
- 2,500 unique households

Mapping to Topic Model

- Corpus is all baskets across all transactions.
- Documents are baskets.
- Words are products in each basket.
- (Products can be identified in various ways.)
- (Authors can be identified based on household key or demographic classifications.)

IDENTIFYING UNIQUE PRODUCTS

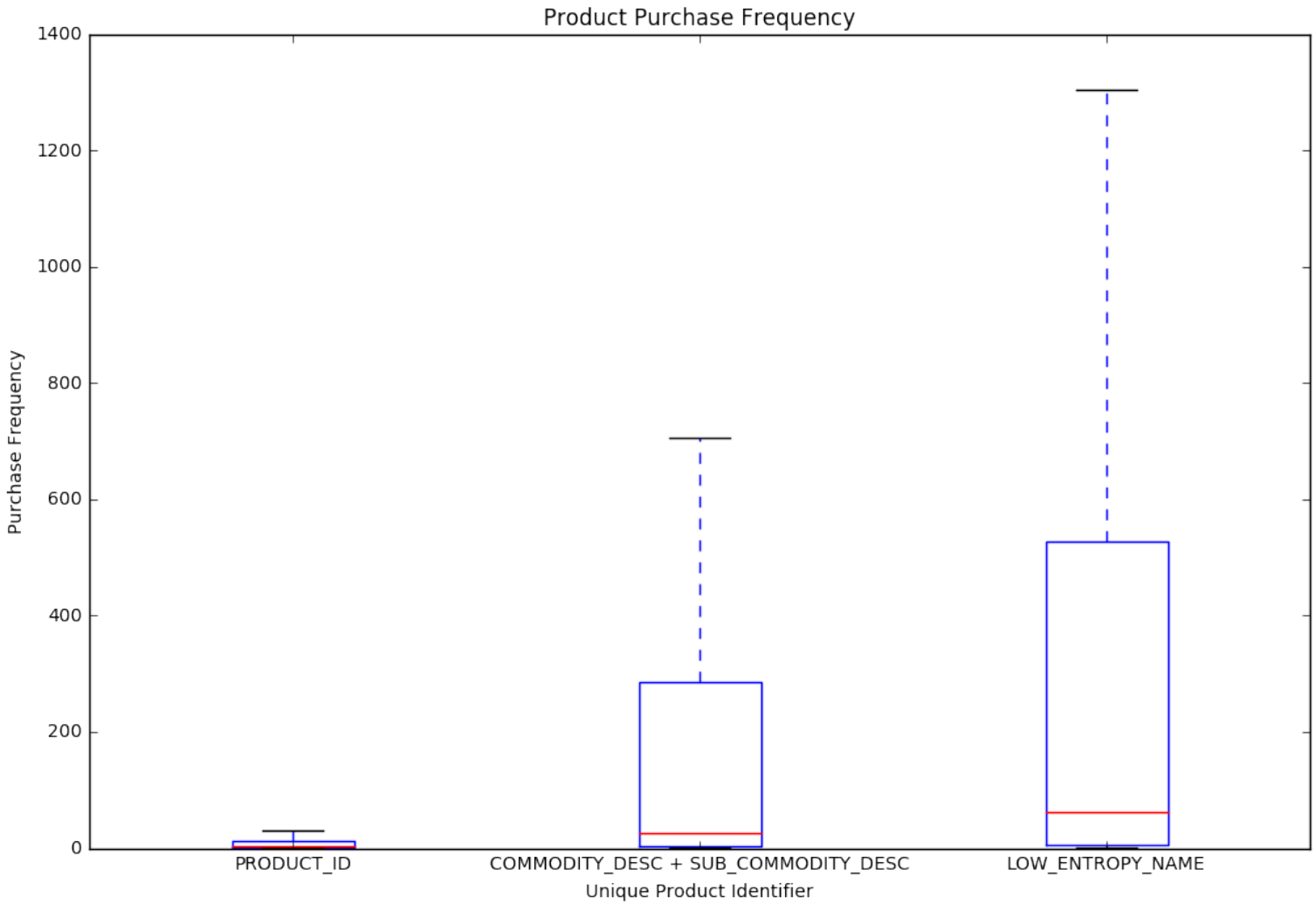


Figure: If you use PRODUCT_ID as an identifier, the same product gets purchased relatively few times

INFLATED GASOLINE QUANTITIES

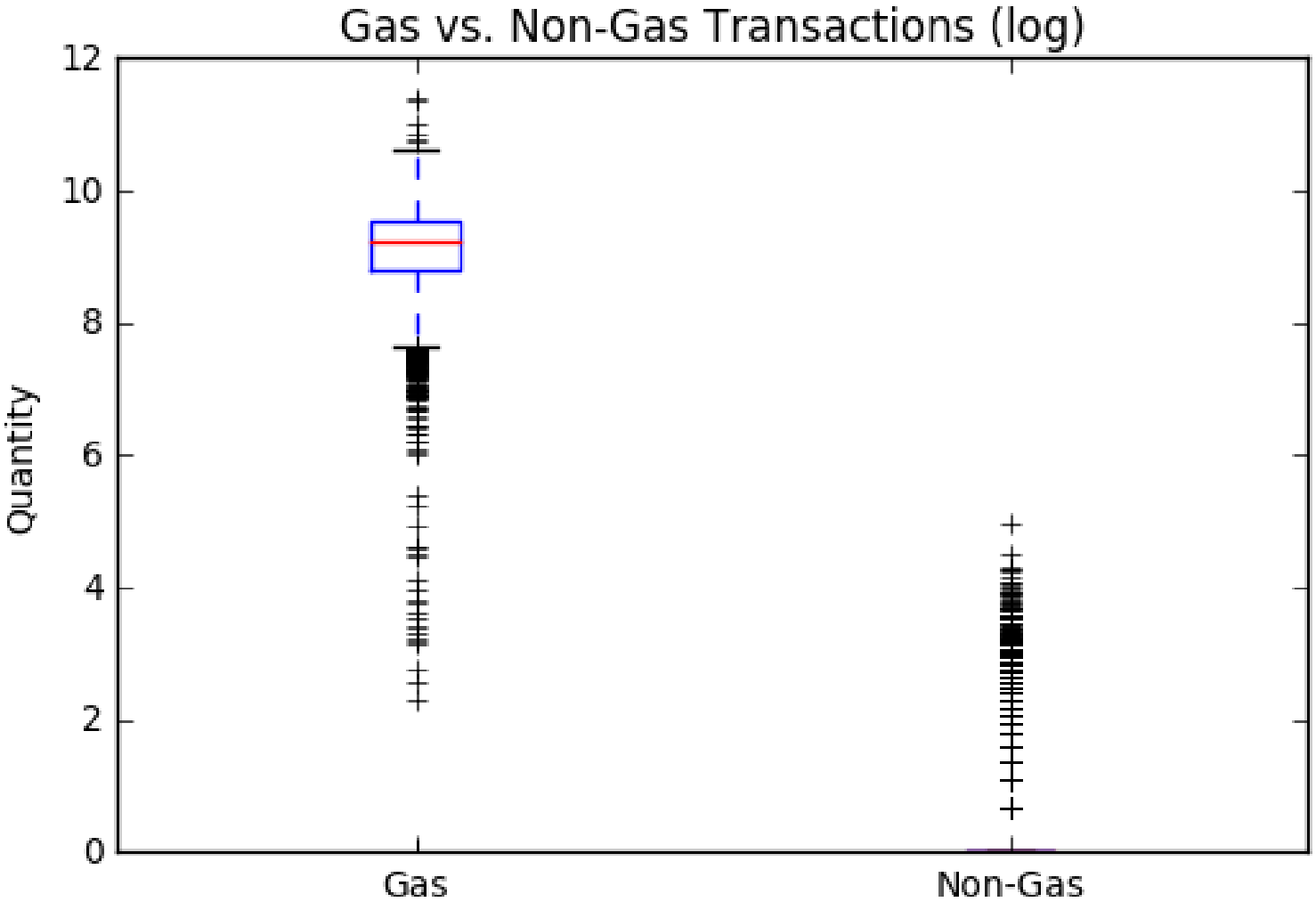


Figure: Mean quantity for GASOLINE-REG UNLEADED was 10,308!

DATA PREPARATION

LOW-ENTROPY NAMES

Goals

1. Avoid similarly named products in different categories.
2. Similarly-named products should be identified as the same product.

Method

1. Tokenize every product: Combine COMMODITY_DESC + SUB_COMMODITY_DESC, split into words, remove punctuation, stem, remove stop-words, replace synonyms.
2. Count frequency of tokens across corpus.
3. Each product's LOW_FREQUENCY_NAME is the product's two most frequent tokens.

LOW-ENTROPY NAMES

Low Entropy Name	Matching	Original Names
everyday spli	1323	GREETING CARDS/WRAP/PARTY SPLY PARTY EVERYDAY, GREETING CARDS/WRAP/PARTY SPLY CARDS EVERY-DAY
chocol candi	1016	CANDY - PACKAGED CANDY BAGS-CHOCOCLATE, CANDY - PACKAGED CANDY BOXED CHOCOLATES, NO COMMODITY DESCRIPTION CANDY BAGS-CHOCOCLATE, CANDY - PACKAGED SEASONAL CANDY BAGS-CHOCOLATE, CANDY - PACKAGED SEASONAL CANDY BOX-CHOCOLATE W, CANDY - PACKAGED SEASONAL CANDY BOX-CHOCOLATE
beer ale	772	BEERS/ALES BEERALEMALT LIQUORS
entre premium	665	FRZN MEAT/MEAT DINNERS FRZN SS PREMIUM ENTREES/DNRS/T, FRZN MEAT/MEAT DINNERS FRZN SS PREMIUM

LDA WITH LOW-ENTROPY NAMING

LDA PIPELINE

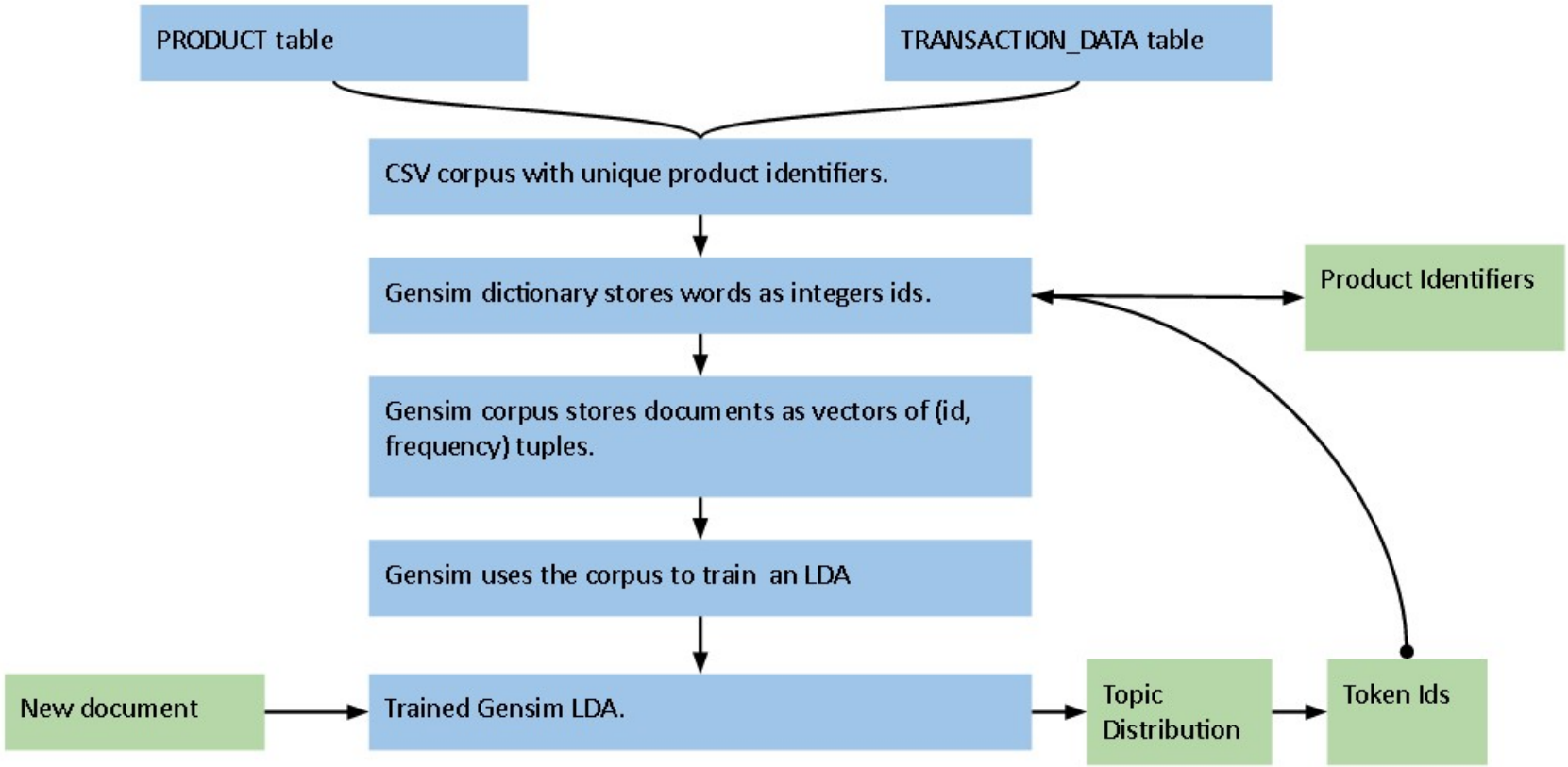


Figure: Pipeline for preparing documents, fitting the LDA, and evaluating new documents.

PERPLEXITY

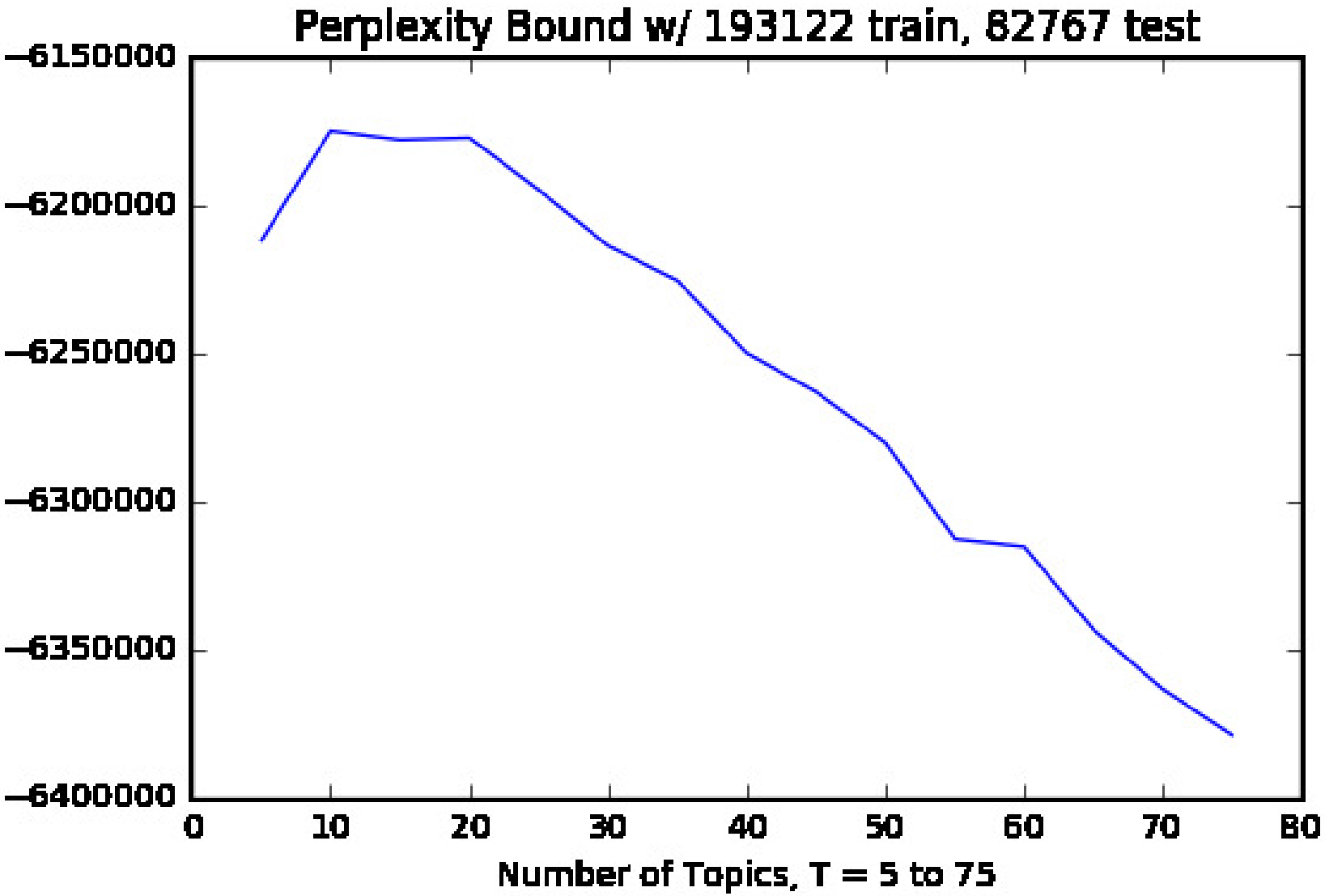


Figure: LDA perplexity lower bound; note that higher is better.

MANUAL TOPIC EVALUATION

Topic 0 Word	Low-Entropy Word	p(w|z)
SOFT DRINKS 12/18&15PK CAN CAR	15pk car	0.29
GASOLINE-REG UNLEADED	unlead fuel	0.14
BEERALEMALT LIQUORS	beer ale	0.09
SW GDS:DONUTS	donut breakfast	0.06
CARDS SEASONAL	spli greet	0.02
PREP FD: SIDE DISHES (HOT)	prep side	0.02
COLD AND FLU - DXM	dxm flu	0.02
TORTILLA/NACHO CHIPS	nacho tortilla	0.01
ROLLS: DINNER	roll dinner	0.01
BREAD:ITALIAN/FRENCH	italian french	0.01

Table: LDA top ten words in topic 0 (T = 10), ”convenience store topic”

MANUAL TOPIC EVALUATION

Topic 5 Word	Low-Entropy Word	p(w|z)
FLUID MILK WHITE ONLY	white fluid	0.09
BANANAS	banana tropic	0.03
ORANGES NAVELS ALL	navel orang	0.02
CIGARETTES	cigarett	0.02
DAIRY CASE 100% PURE JUICE - O	pure 100	0.02
EGGS - X-LARGE	egg	0.01
ALL FAMILY CEREAL	famili cereal	0.01
MAINSTREAM WHEAT/MULTIGRAIN BR	wheat multigrain	0.01
CREAM CHEESE	cream chees	0.01
MAINSTREAM WHITE BREAD	white bun	0.01

Table: LDA top ten words in topic 5 (T = 10)

MANUAL TOPIC EVALUATION

Topic 9 Word	Low-Entropy Word	p(w|z)
BABY FOOD - BEGINNER	beginn babi	0.06
PAPER TOWELS & HOLDERS	holder towel	0.04
BABY FOOD JUNIOR ALL BRANDS	junior babi	0.03
CANDY BARS (MULTI PACK)	multi pack	0.03
TOILET TISSUE	toilet tissu	0.03
FACIAL TISSUE & PAPER HANDKE	handk tiss	0.03
CHEWING GUM	gum chew	0.03
LIQUID LAUNDRY DETERGENTS	deterg laundri	0.02
BABY DIAPERS	diaper dispos	0.02
BAR SOAP	soap liquid	0.02

Table: LDA top ten words in topic 9 (T = 10), ”parent topic”

DEMOGRAPHIC DISTRIBUTION COMPARISON

Intuition

- Given a household falls into INCOME_DESC = X, what is the probability of purchasing a product from each of the topics?
- How **different** is that demographic distribution relative the population?

Method

- Concatenate entire corpus to compute population distribution.
- Narrow down specific demographics, concatenate their documents to compute demographic distributions.
- Use KL-divergence to quantify difference.

DEMOGRAPHIC DISTRIBUTIONS

	Demographic	Category	Entropy	Top Topic
0	INCOME_DESC	175-199K	0.102886	5
1	INCOME_DESC	200-249K	0.093301	5
2	INCOME_DESC	250K+	0.060177	5
3	INCOME_DESC	150-174K	0.052650	5
4	INCOME_DESC	100-124K	0.046601	5
5	HOMEOWNER_DESC	Probable Owner	0.040425	8
6	INCOME_DESC	125-149K	0.033437	5
7	AGE_DESC	19-24	0.027506	1
8	AGE_DESC	65+	0.024285	5
9	HH_COMP_DESC	1 Adult Kids	0.020416	8
10	INCOME_DESC	Under 15K	0.019510	8

Table: Top 10 entropy values for demographic distributions over topics relative the population distribution

DEMOGRAPHIC DISTRIBUTIONS

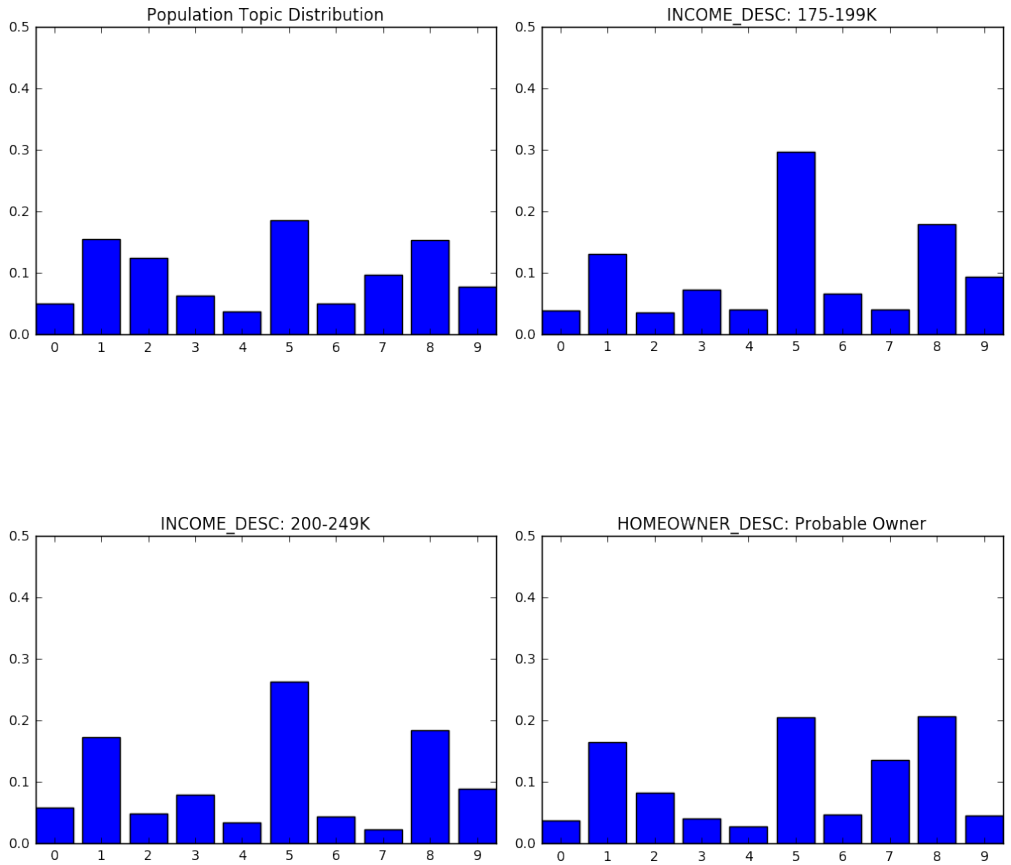


Figure: LDA distribution of all documents over topics and the 1st, 2nd, and 5th most different demographic distributions.

AT WITH LOW-ENTROPY NAMING

AT PIPELINE

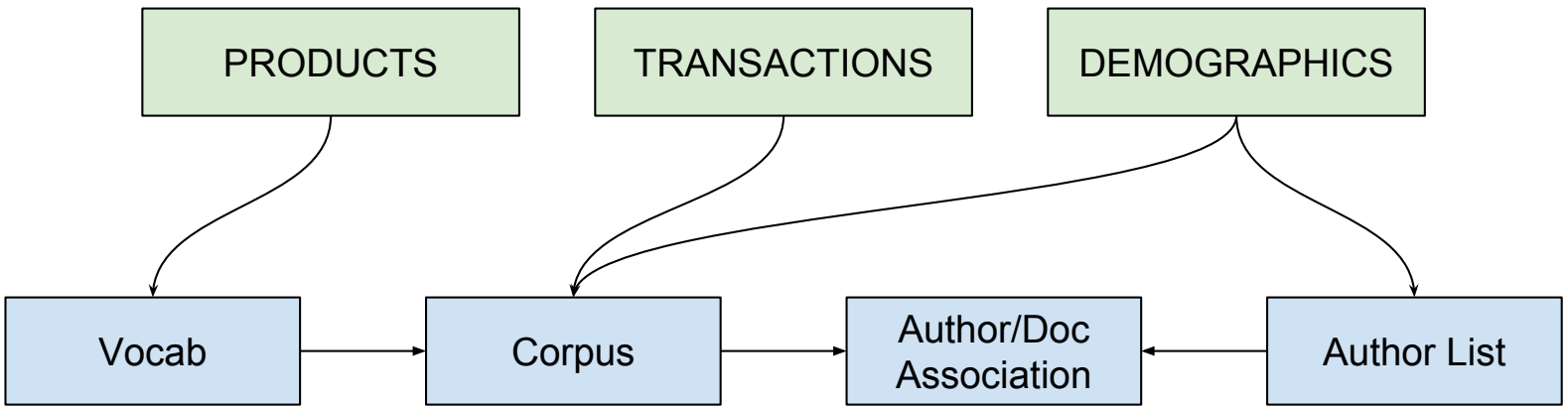


Figure: Pipeline for preparing documents and fitting the AT.

EXPERIMENTS

- Number of documents: 140,339
- Number of unique words: 18,620
- 41 Demographic Authors
- 801 Household Key Authors
- Topics: 10, 15, 20, 25, 30, 40, 50
- Gibbs Sampling Iterations 10, 50

MANUAL TOPIC EVALUATION

Low-Entropy Word	p(w|z)
incl liter: 2 LTR	0.0435400775017
white bun: 20 OZ	0.0194244916306
ramen cup: 3 OZ	0.0168338102399
srv sngl: 20 OZ	0.0165095036903
pasta stabl: 15 OZ	0.0142959229387
15pk car: 12 OZ	0.013945219344s
lean beef:	0.0110867964999
cigarett: CTN	0.010113876851
economi entre: 8 OZ	0.0100610827615
white fluid:	0.00906176606788

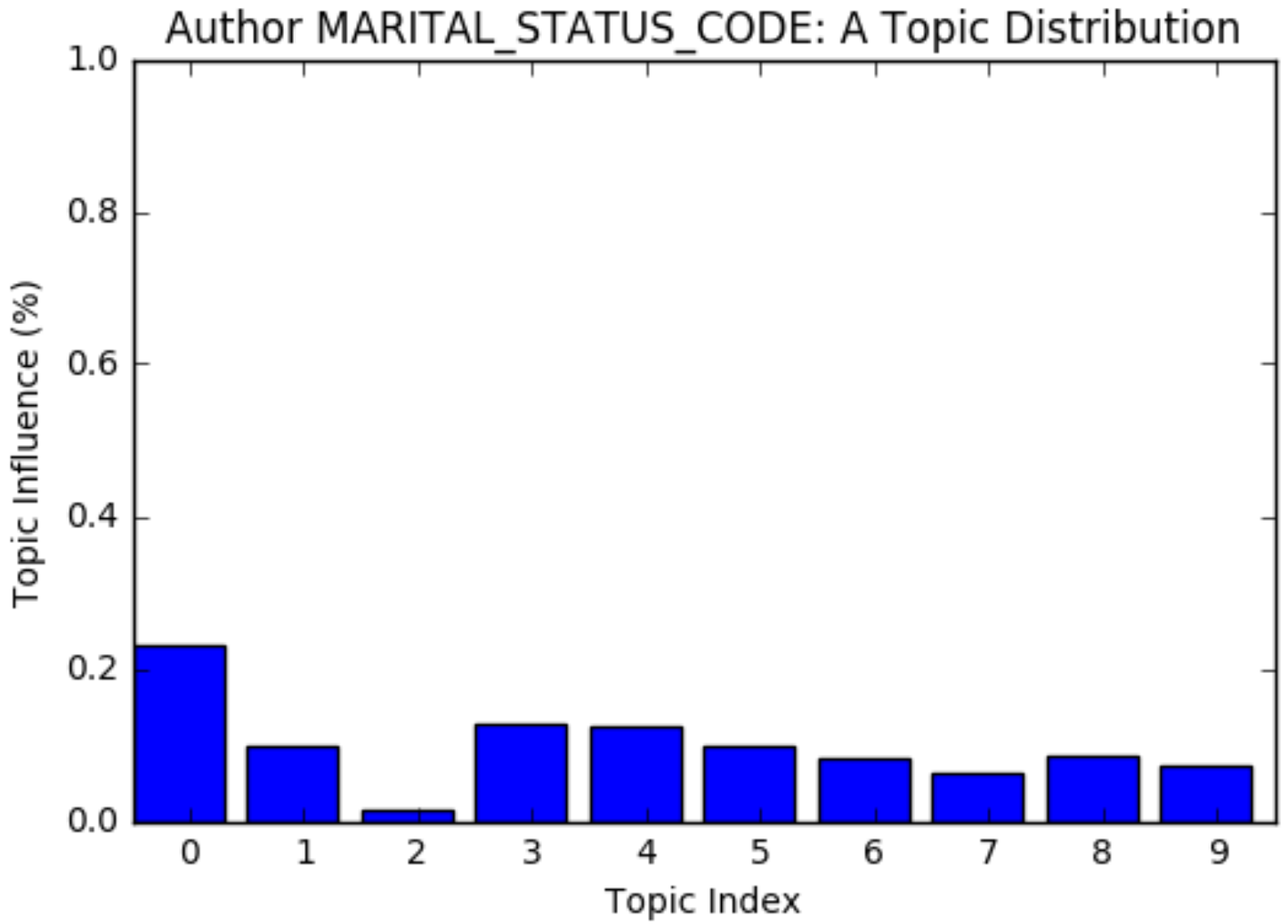
Table: Topic 2 top ten words

MANUAL TOPIC EVALUATION

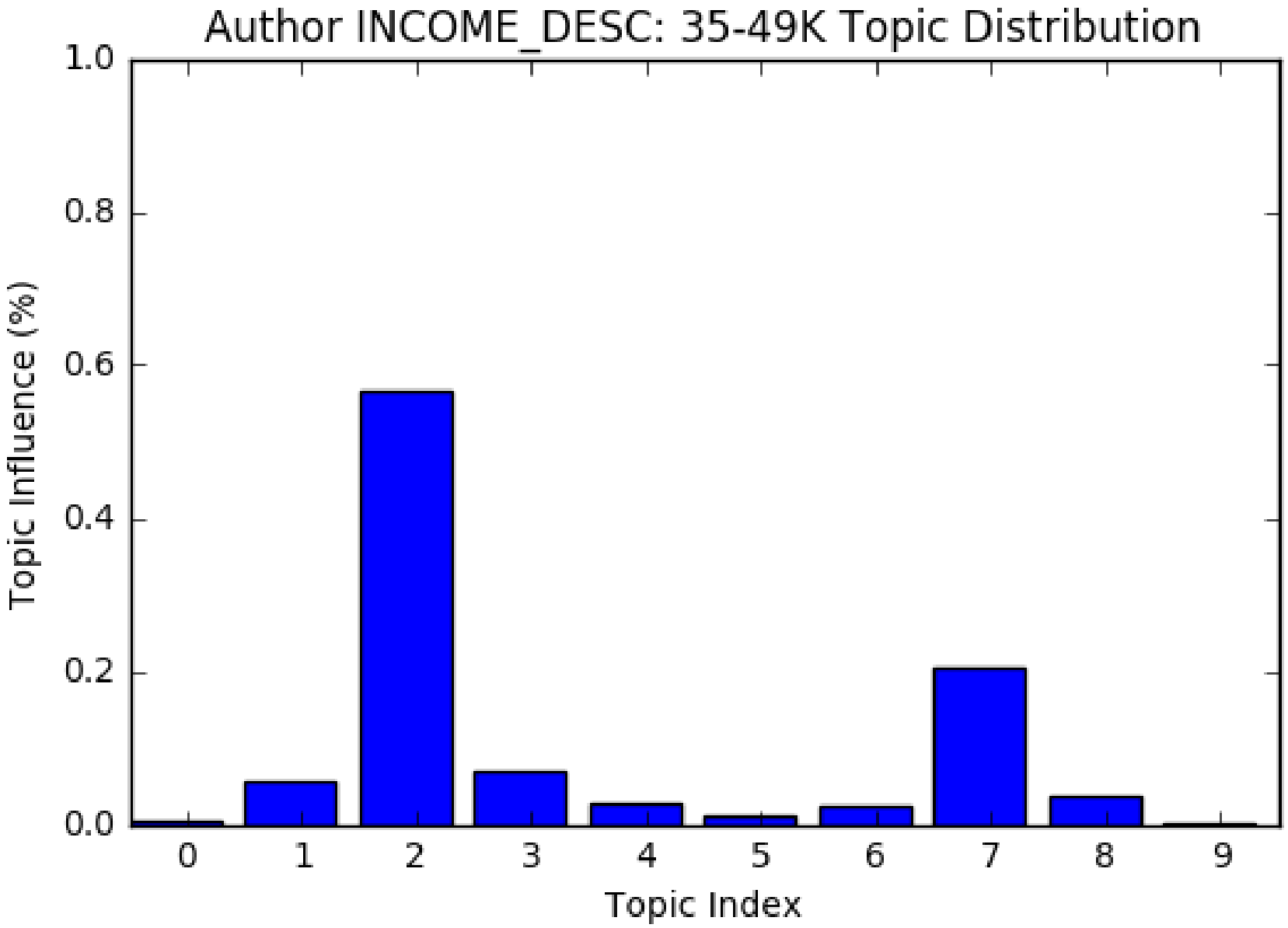
Low-Entropy Word	p(w|z)
not yogurt: 6 OZ	0.0556582883036
strawberri berri: 16 OZ	0.0160711494707
lemon citru:	0.0138042548419
banana tropic: 40 LB	0.0128796004538
bun roll: 24 OZ	0.0128080143077
lime citru: 36CT	0.011400153433
italian french:	0.0112092570432
crown cauliflow:	0.0103740853378
boneless breast:	0.00962243080304
homestyl chunki: 18.8 OZ	0.00896622446313

Table: Topic 9 top ten words

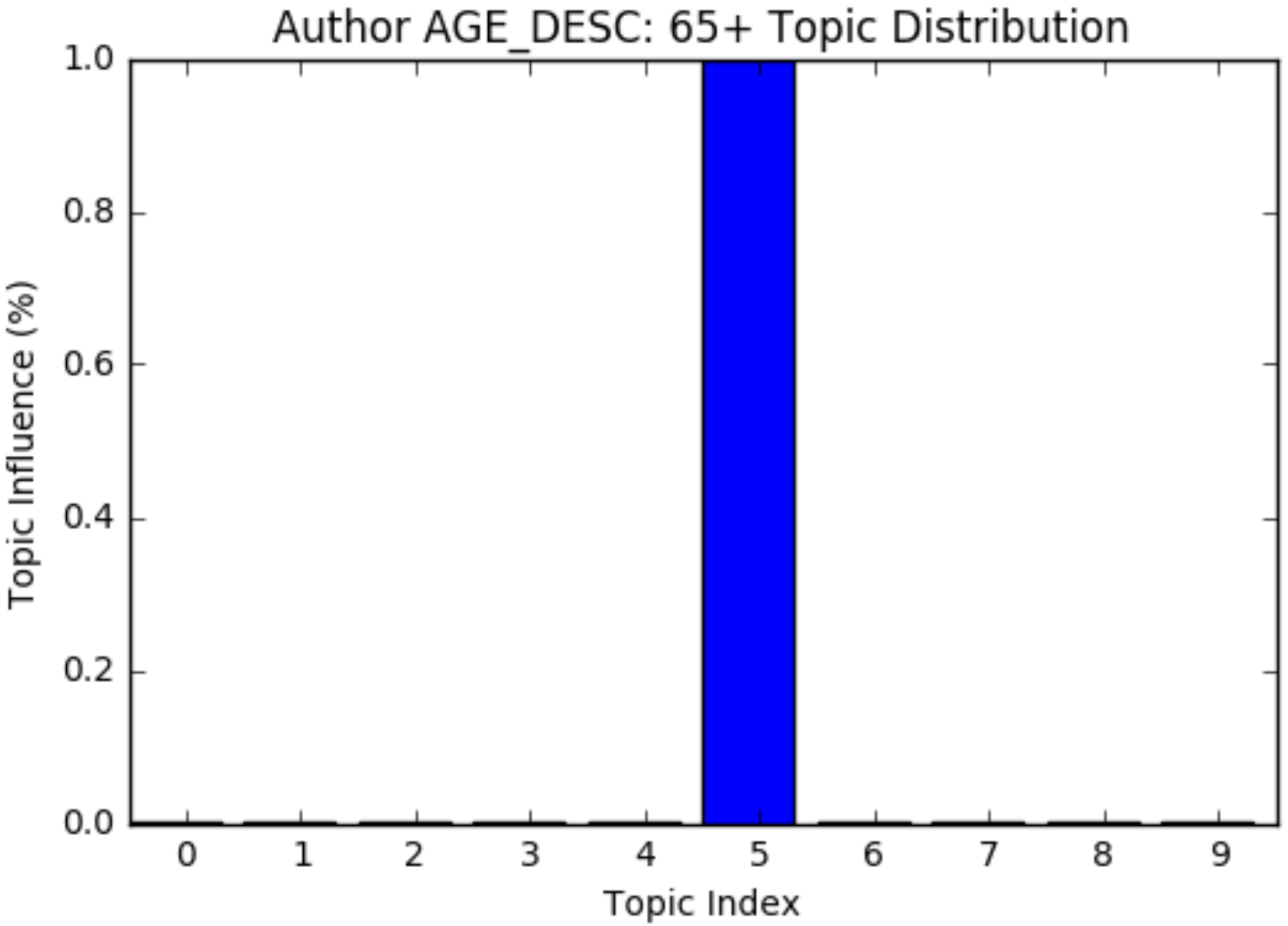
SINGLE AUTHOR TOPIC DISTRIBUTIONS



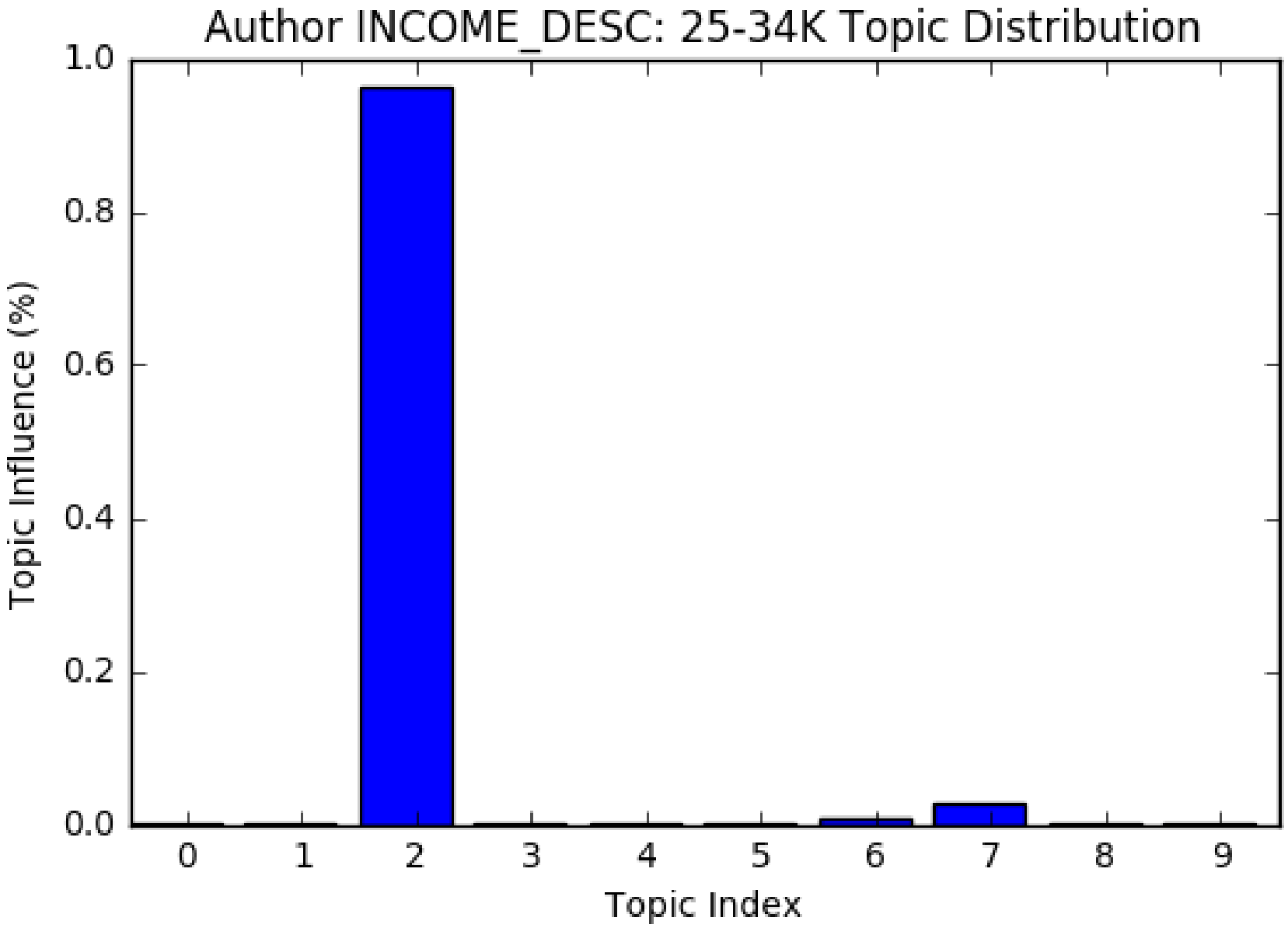
SINGLE AUTHOR TOPIC DISTRIBUTIONS



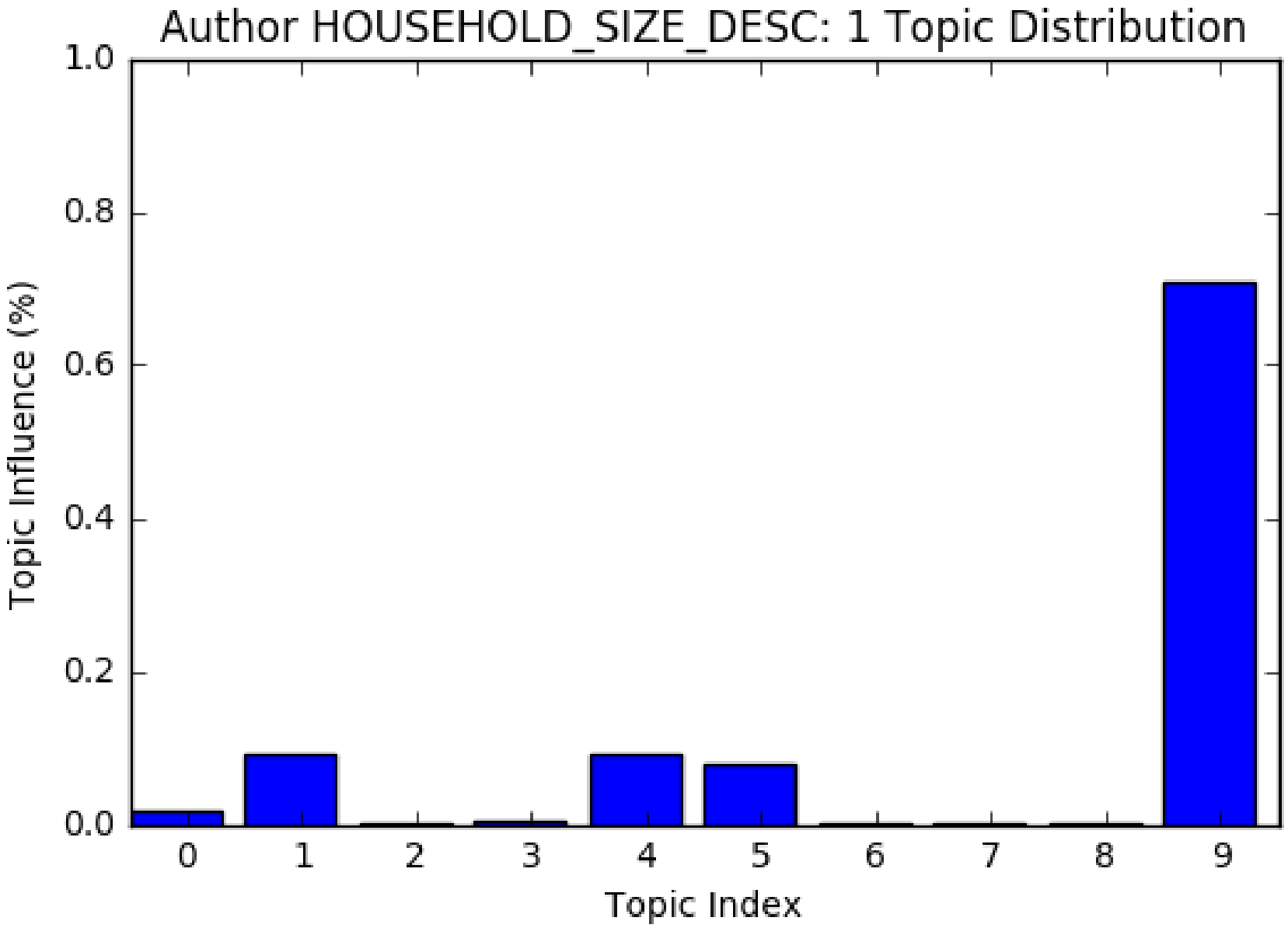
SINGLE AUTHOR TOPIC DISTRIBUTIONS



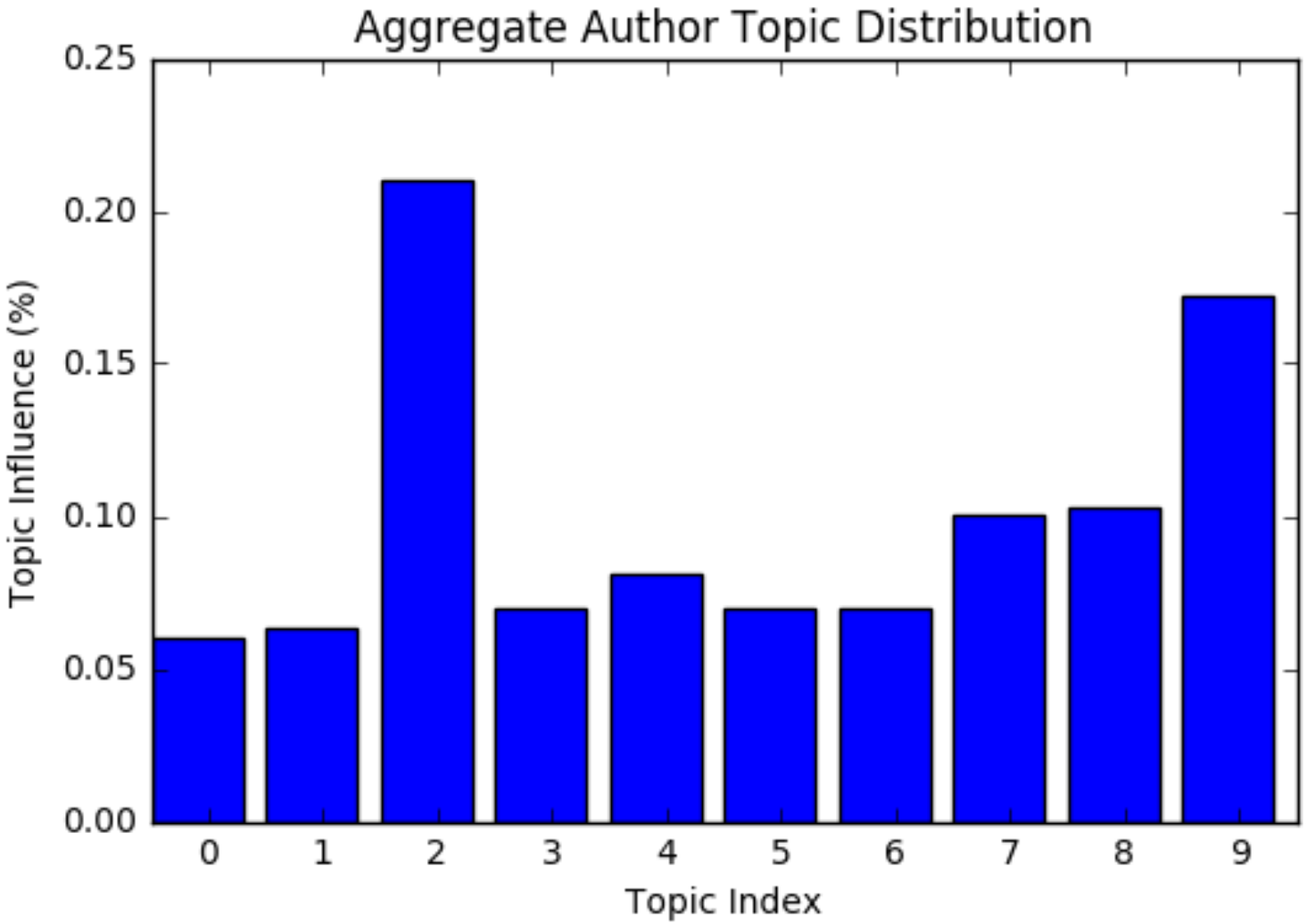
SINGLE AUTHOR TOPIC DISTRIBUTIONS



SINGLE AUTHOR TOPIC DISTRIBUTIONS



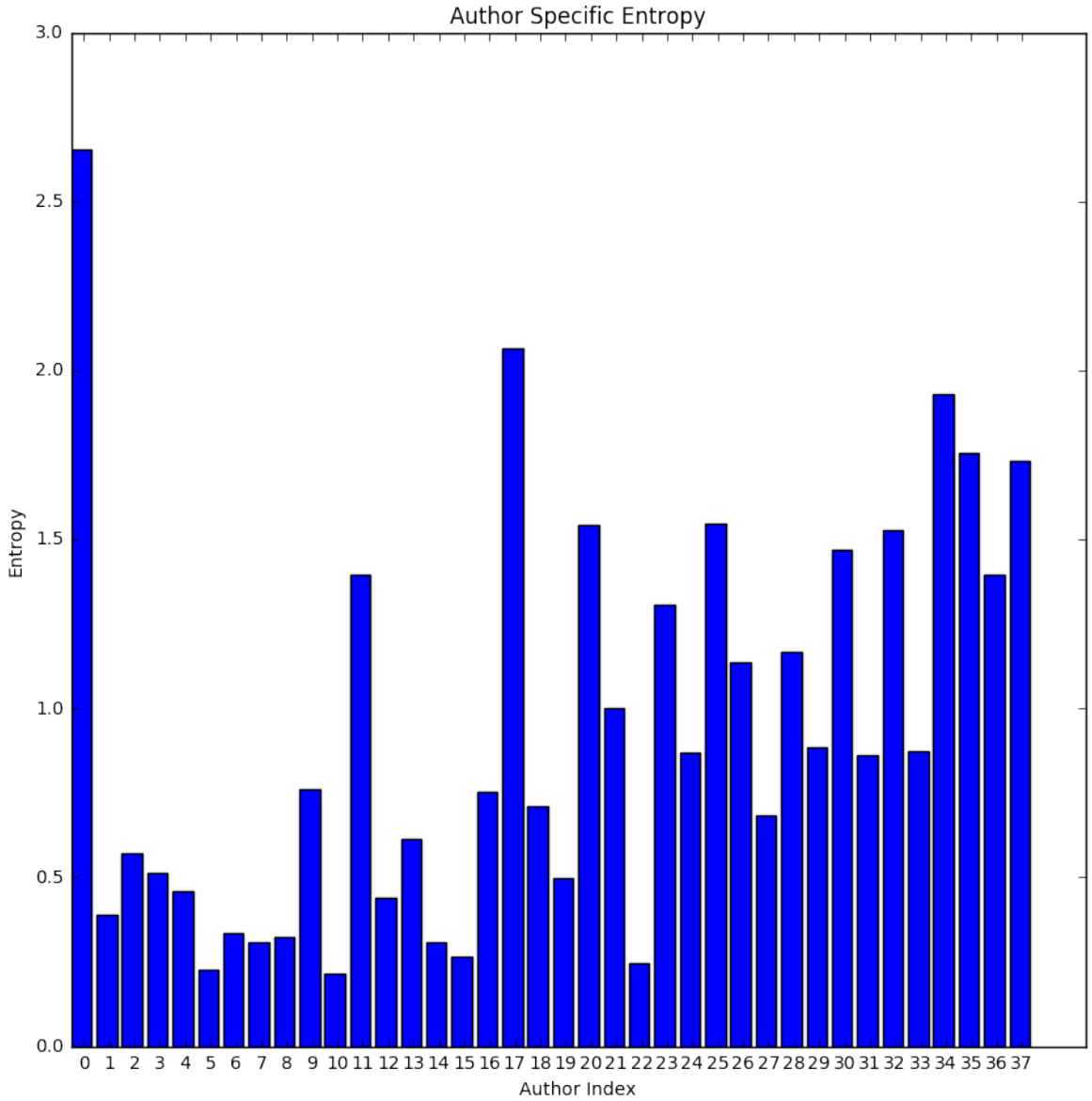
AGGREGATE AUTHOR DISTRIBUTION



ENTROPY

Author	Entropy
AGE_DESC: 65+	2.65500
HOUSEHOLD_SIZE_DESC: 4	2.064694
AGE_DESC: 19-24	1.928755
AGE_DESC: 55-64	1.753791
HOMEOWNER_DESC: Probable Owner	1.731984
INCOME_DESC: 15-24K	1.548079
HH_COMP_DESC: Single Female	1.544354
KID_CATEGORY_DESC: 3+	1.525487
HH_COMP_DESC: Single Male	1.469682
INCOME_DESC: 25-34K	1.397155

AGGREGATE AUTHOR DISTRIBUTION



FUTURE WORK

FUTURE WORK

- Model incorporating temporal data - HMM, LSTM
- Question: Does a demographic's topical preference change over time?
- Question: Do coupons and advertising campaigns create a change in topical interest?