

# Text as Data Final Paper

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```
# LDA model for debate: debate_LDA_15
# topic names for debate: debate_LDA_15_names
# data frame for twitter: twitter.df
# dfm for twitter: twitter_dfm
# posterior topic distribution (LDA) = @gamma
# LDA model for twitter: use simple_lda_20, simple_lda_15, simple_lda_10
# LDA posterior for twitter using debate topics: twitter.topics$topics
all(nrow(twitter_dfm) == sum(twitter.df$debate_topic != 0),
    nrow(twitter_dfm) == nrow(twitter.topics$topics))
```

```
[1] TRUE
```

```
table(twitter.df$debate_topic)
```

```
 0    1    2    3    4    5    6    7    8    9   10   11   12   13   14
2940 525  937  430  533 1387  618  490  617  622  673  406 2340  480  415
15
456
```

```
debate_LDA_15_names
```

```
[1] "common core" "mods1"      "foreign pol" "social sec"
[5] "mods1"      "immigration" "economics"   "border"
[9] "budget"     "Paul Ryan"   "military"    "mods2"
[13] "gen election" "iran"        "marriage"
```

```
# pos.neg <- dplyr::select(twitter.df[tweet_indices,], -tweet_created)
# pos.neg <- filter(pos.neg, sentiment != "Neutral")
# pos.neg$candidate[pos.neg$candidate == "OTHER"] <- NA
# pos.neg$subject_matter[pos.neg$subject_matter == "None of the above"] <- NA
# pos.neg <- droplevels(pos.neg)
levels(pos.neg$sentiment)
```

```
[1] "Negative" "Positive"
```

```
levels(pos.neg$candidate)
```

```
[1] "Ben Carson"      "Chris Christie" "Donald Trump"   "Jeb Bush"
[5] "John Kasich"     "Marco Rubio"    "Mike Huckabee"  "Rand Paul"
[9] "Scott Walker"    "Ted Cruz"
```

```
levels(pos.neg$subject_matter)
```

```
[1] "Abortion"  
[2] "Foreign Policy"  
[3] "FOX News or Moderators"  
[4] "Gun Control"  
[5] "Healthcare (including Medicare)"  
[6] "Immigration"  
[7] "Jobs and Economy"  
[8] "LGBT issues"  
[9] "Racial issues"  
[10] "Religion"  
[11] "Women's Issues (not abortion though)"
```

```
dropped.rows <- which(twitter.df[tweet_indices, "sentiment"] == "Neutral")  
nrow(pos.neg) + length(dropped.rows) == nrow(twitter.topics$topics)
```

```
[1] TRUE
```

```
all(dim(simple_lda_15@gamma) == dim(twitter.topics$topics),  
    class(simple_lda_15@gamma) == class(twitter.topics$topics))
```

```
[1] TRUE
```

```
dim(simple_lda_25@gamma[-dropped.rows,])
```

```
[1] 8722  25
```

```
dim(twitter.topics$topics[-dropped.rows,])
```

```
[1] 8722  15
```

```
all(abs(rowSums(simple_lda_25@gamma) - 1) < 1e-10)
```

```
[1] TRUE
```

```
all(abs(rowSums(twitter.topics$topics) - 1) < 1e-10)
```

```
[1] TRUE
```

```
# build a logistic regression from lda model parameters, additional predictors as parameter  
glm_lda_model <- function(lda_model_post, modified_data,  
                           predictors = c("candidate", "subject_matter")) {  
  x <- lda_model_post[, -2] # need to drop one of the topics, I drop #2  
  colnames(x) <- paste("topic", 1:(ncol(x)+1), sep=".")[-2]  
  data <- cbind(modified_data, x)  
  formula <- paste("sentiment ~ ",  
                   paste(c(colnames(x), predictors), collapse = " + "))
```

```

fit <- glm(as.formula(formula) , data = data, family = "binomial")
print(summary(fit))
fit
}

# use forward-backward stepwise procedure with AIC criterion to choose best model from full model
stepwise_twitter <- function(lda_model_post, modified_data,
                             predictors = c("candidate", "subject_matter")) {
  x <- lda_model_post # don't drop any topics
  colnames(x) <- paste("topic", 1:(ncol(x)), sep=".")
  data <- cbind(modified_data, x)
  formula <- paste("sentiment ~ ",
                   paste(c(colnames(x), predictors), collapse = " + "))
  fit <- glm(as.formula(formula) , data = data, family = "binomial")
  stepAIC(fit, trace = FALSE) # stops verbose printing
}

```

```

pos.neg.sub <- pos.neg[c("sentiment", "candidate", "subject_matter")]
levels(pos.neg.sub$candidate) <- c(levels(pos.neg.sub$candidate), "other")
pos.neg.sub$candidate <- relevel(pos.neg.sub$candidate, ref = "other")
pos.neg.sub$candidate[is.na(pos.neg.sub$candidate)] <- "other"
levels(pos.neg.sub$subject_matter) <- c(levels(pos.neg.sub$subject_matter), "other")
pos.neg.sub$subject_matter[is.na(pos.neg.sub$subject_matter)] <- "other"
pos.neg.sub$subject_matter <- relevel(pos.neg.sub$subject_matter, ref = "other")

dummy_candidate <- dummy(pos.neg.sub$candidate,
                         levels(pos.neg.sub$candidate)[-1])
dummy_subject_matter <- dummy(pos.neg.sub$subject_matter,
                              levels(pos.neg.sub$subject_matter)[-1])
candidate_only <- cv.glmnet(x = dummy_candidate, y = pos.neg.sub$sentiment,
                           family = "binomial", alpha = 1, nfolds = 10)
candidate_subject_only <- cv.glmnet(x = cbind(dummy_candidate, dummy_subject_matter),
                                   y = pos.neg.sub$sentiment, family = "binomial", alpha = 1, nfolds = 10)
min(candidate_only$cvm)

```

```
[1] 0.8932766
```

```
min(candidate_subject_only$cvm)
```

```
[1] 0.870264
```

```
coef(candidate_only, s="lambda.min")
```

```

11 x 1 sparse Matrix of class "dgCMatrix"
              1
(Intercept)  -2.1069223
Ben Carson    1.9499006
Chris Christie 0.2470594
Donald Trump  1.0670563
Jeb Bush      -0.6819826
John Kasich   2.4153283

```

Marco Rubio	2.1394047
Mike Huckabee	0.6731933
Rand Paul	1.1462626
Scott Walker	0.4891074
Ted Cruz	2.2990564

```
coef(candidate_subject_only, s="lambda.min")
```

```
22 x 1 sparse Matrix of class "dgCMatrix"
1
(Intercept) -1.76434654
Ben Carson 1.97046000
Chris Christie 0.04705098
Donald Trump 0.95949844
Jeb Bush -0.90589523
John Kasich 2.25006755
Marco Rubio 2.00729576
Mike Huckabee 0.60514038
Rand Paul 0.93645986
Scott Walker 0.45021499
Ted Cruz 2.11877680
Abortion -0.70004793
Foreign Policy -0.66439762
FOX News or Moderators -0.49851235
Gun Control -3.94610435
Healthcare (including Medicare) -0.18812993
Immigration 0.22064672
Jobs and Economy -0.63385942
LGBT issues -0.60615088
Racial issues -1.56539634
Religion -1.40575844
Women's Issues (not abortion though) -2.01680222
```

```
sentiment_twitter_candidate_10 <- glm_lda_model(simple_lda_10@gamma[-dropped.rows,] ,
  modified_data = pos.neg.sub, predictors = "candidate")
sentiment_twitter_candidate_15 <- glm_lda_model(simple_lda_15@gamma[-dropped.rows,] ,
  modified_data = pos.neg.sub, predictors = "candidate")
sentiment_twitter_candidate_20 <- glm_lda_model(simple_lda_20@gamma[-dropped.rows,] ,
  modified_data = pos.neg.sub, predictors = "candidate")
sentiment_twitter_candidate_25 <- glm_lda_model(simple_lda_25@gamma[-dropped.rows,] ,
  modified_data = pos.neg.sub, predictors = "candidate")
sentiment_twitter_candidate_30 <- glm_lda_model(simple_lda_30@gamma[-dropped.rows,] ,
  modified_data = pos.neg.sub, predictors = "candidate")
sentiment_twitter_candidate_50 <- glm_lda_model(simple_lda_50@gamma[-dropped.rows,] ,
  modified_data = pos.neg.sub, predictors = "candidate")
```

```
which.max(c(k10 = simple_lda_10@loglikelihood, k15 = simple_lda_15@loglikelihood,
  k20 = simple_lda_20@loglikelihood, k25 = simple_lda_25@loglikelihood,
  k30 = simple_lda_30@loglikelihood, k50 = simple_lda_50@loglikelihood))
```

k25  
4

```
sort(c(k10 = AIC(sentiment_twitter_candidate_10), k15 = AIC(sentiment_twitter_candidate_15),
      k20 = AIC(sentiment_twitter_candidate_20), k25 = AIC(sentiment_twitter_candidate_25),
      k30 = AIC(sentiment_twitter_candidate_30), k50 = AIC(sentiment_twitter_candidate_50)))
```

k50	k25	k20	k30	k15	k10
7629.618	7634.541	7676.793	7688.978	7744.306	7780.977

```
sort(c(k10 = BIC(sentiment_twitter_candidate_10), k15 = BIC(sentiment_twitter_candidate_15),
      k20 = BIC(sentiment_twitter_candidate_20), k25 = BIC(sentiment_twitter_candidate_25),
      k30 = BIC(sentiment_twitter_candidate_30), k50 = BIC(sentiment_twitter_candidate_50)))
```

k25	k20	k15	k10	k30	k50
7882.117	7889.001	7921.147	7922.449	7971.922	8054.034

```
anova(sentiment_twitter_candidate_20, sentiment_twitter_candidate_25, test="Chisq")
```

#### Analysis of Deviance Table

Model 1: sentiment ~ topic.1 + topic.3 + topic.4 + topic.5 + topic.6 +  
 topic.7 + topic.8 + topic.9 + topic.10 + topic.11 + topic.12 +  
 topic.13 + topic.14 + topic.15 + topic.16 + topic.17 + topic.18 +  
 topic.19 + topic.20 + candidate

Model 2: sentiment ~ topic.1 + topic.3 + topic.4 + topic.5 + topic.6 +  
 topic.7 + topic.8 + topic.9 + topic.10 + topic.11 + topic.12 +  
 topic.13 + topic.14 + topic.15 + topic.16 + topic.17 + topic.18 +  
 topic.19 + topic.20 + topic.21 + topic.22 + topic.23 + topic.24 +  
 topic.25 + candidate

	Resid. Df	Resid. Dev	Df	Deviance	Pr(>Chi)
1	8692	7616.8			
2	8687	7564.5	5	52.253	4.788e-10 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

```
anova(sentiment_twitter_candidate_25, sentiment_twitter_candidate_50, test="Chisq")
```

#### Analysis of Deviance Table

Model 1: sentiment ~ topic.1 + topic.3 + topic.4 + topic.5 + topic.6 +  
 topic.7 + topic.8 + topic.9 + topic.10 + topic.11 + topic.12 +  
 topic.13 + topic.14 + topic.15 + topic.16 + topic.17 + topic.18 +  
 topic.19 + topic.20 + topic.21 + topic.22 + topic.23 + topic.24 +  
 topic.25 + candidate

Model 2: sentiment ~ topic.1 + topic.3 + topic.4 + topic.5 + topic.6 +  
 topic.7 + topic.8 + topic.9 + topic.10 + topic.11 + topic.12 +  
 topic.13 + topic.14 + topic.15 + topic.16 + topic.17 + topic.18 +  
 topic.19 + topic.20 + topic.21 + topic.22 + topic.23 + topic.24 +  
 topic.25 + topic.26 + topic.27 + topic.28 + topic.29 + topic.30 +  
 topic.31 + topic.32 + topic.33 + topic.34 + topic.35 + topic.36 +  
 topic.37 + topic.38 + topic.39 + topic.40 + topic.41 + topic.42 +  
 topic.43 + topic.44 + topic.45 + topic.46 + topic.47 + topic.48 +  
 topic.49 + topic.50 + candidate

```

      Resid. Df Resid. Dev Df Deviance Pr(>Chi)
1         8687      7564.5
2         8662      7509.6 25   54.923 0.0005038 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

sentiment_debate_candidate <- glm_lda_model(twitter.topics$topics[-dropped.rows,] ,
      modified_data = pos.neg.sub, predictors = "candidate")

```

```

Call:
glm(formula = as.formula(formula), family = "binomial", data = data)

```

```

Deviance Residuals:
      Min       1Q   Median       3Q      Max
-1.4777  -0.6838  -0.4776  -0.3470   2.5639

```

```

Coefficients:
              Estimate Std. Error z value Pr(>|z|)
(Intercept)    -2.17259    0.25615  -8.482 < 2e-16 ***
topic.1         0.16577    0.43132   0.384  0.70073
topic.3        -0.80692    0.49785  -1.621  0.10506
topic.4        -1.33005    0.45888  -2.898  0.00375 **
topic.5        -0.35243    0.32379  -1.088  0.27640
topic.6         0.39584    0.37422   1.058  0.29016
topic.7         0.49704    0.40951   1.214  0.22484
topic.8         0.43118    0.38629   1.116  0.26433
topic.9         0.71632    0.36074   1.986  0.04707 *
topic.10        0.10242    0.35992   0.285  0.77597
topic.11       -0.22551    0.40652  -0.555  0.57908
topic.12        0.10558    0.29100   0.363  0.71674
topic.13        0.05758    0.37514   0.153  0.87802
topic.14        0.36952    0.38745   0.954  0.34022
topic.15       -0.17283    0.38117  -0.453  0.65026
candidateBen Carson    2.02421    0.13584  14.901 < 2e-16 ***
candidateChris Christie 0.37805    0.20229   1.869  0.06165 .
candidateDonald Trump  1.14454    0.07596  15.067 < 2e-16 ***
candidateJeb Bush    -0.77960    0.19278  -4.044 5.25e-05 ***
candidateJohn Kasich  2.52487    0.16882  14.956 < 2e-16 ***
candidateMarco Rubio  2.17908    0.15288  14.254 < 2e-16 ***
candidateMike Huckabee 0.86048    0.16767   5.132 2.87e-07 ***
candidateRand Paul    1.19318    0.18081   6.599 4.14e-11 ***
candidateScott Walker  0.52126    0.20184   2.583 0.00981 **
candidateTed Cruz     2.33548    0.11218  20.818 < 2e-16 ***

```

```

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

(Dispersion parameter for binomial family taken to be 1)

```

```

      Null deviance: 8774.8  on 8721  degrees of freedom
Residual deviance: 7726.9  on 8697  degrees of freedom
AIC: 7776.9

```

```

Number of Fisher Scoring iterations: 5

```

```
AIC(sentiment_debate_candidate); AIC(sentiment_twitter_candidate_25);
```

```
[1] 7776.886
```

```
[1] 7634.541
```

```
BIC(sentiment_debate_candidate); BIC(sentiment_twitter_candidate_25)
```

```
[1] 7953.726
```

```
[1] 7882.117
```

```
anova(sentiment_debate_candidate, sentiment_twitter_candidate_25, test="Chisq")
```

Analysis of Deviance Table

Model 1: sentiment ~ topic.1 + topic.3 + topic.4 + topic.5 + topic.6 +  
topic.7 + topic.8 + topic.9 + topic.10 + topic.11 + topic.12 +  
topic.13 + topic.14 + topic.15 + candidate

Model 2: sentiment ~ topic.1 + topic.3 + topic.4 + topic.5 + topic.6 +  
topic.7 + topic.8 + topic.9 + topic.10 + topic.11 + topic.12 +  
topic.13 + topic.14 + topic.15 + topic.16 + topic.17 + topic.18 +  
topic.19 + topic.20 + topic.21 + topic.22 + topic.23 + topic.24 +  
topic.25 + candidate

	Resid. Df	Resid. Dev	Df	Deviance	Pr(>Chi)
1	8697	7726.9			
2	8687	7564.5	10	162.34	< 2.2e-16 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

```
require(MASS)
```

Loading required package: MASS

Attaching package: 'MASS'

The following object is masked from 'package:dplyr':

select

```
step_25_candidate_subject <- stepwise_twitter(simple_lda_25@gamma[~dropped.rows,],  
pos.neg.sub, predictors = c("candidate", "subject_matter"))  
step_25_candidate_subject$anova
```

Stepwise Model Path

Analysis of Deviance Table

Initial Model:

```
sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 + topic.5 +
  topic.6 + topic.7 + topic.8 + topic.9 + topic.10 + topic.11 +
  topic.12 + topic.13 + topic.14 + topic.15 + topic.16 + topic.17 +
  topic.18 + topic.19 + topic.20 + topic.21 + topic.22 + topic.23 +
  topic.24 + topic.25 + candidate + subject_matter
```

Final Model:

```
sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 + topic.6 +
  topic.8 + topic.11 + topic.13 + topic.14 + topic.15 + topic.16 +
  topic.17 + topic.19 + topic.22 + topic.23 + topic.24 + candidate +
  subject_matter
```

	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				8676	7371.464	7463.464
2	- topic.25	0	0.00000000	8676	7371.464	7463.464
3	- topic.5	1	0.04248644	8677	7371.506	7461.506
4	- topic.10	1	0.06326254	8678	7371.570	7459.570
5	- topic.9	1	0.06924882	8679	7371.639	7457.639
6	- topic.21	1	0.16682058	8680	7371.806	7455.806
7	- topic.7	1	0.49511827	8681	7372.301	7454.301
8	- topic.18	1	0.72221103	8682	7373.023	7453.023
9	- topic.20	1	1.08137289	8683	7374.104	7452.104
10	- topic.12	1	1.47842730	8684	7375.583	7451.583

```
summary(step_25_candidate_subject)
```

Call:

```
glm(formula = sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 +
  topic.6 + topic.8 + topic.11 + topic.13 + topic.14 + topic.15 +
  topic.16 + topic.17 + topic.19 + topic.22 + topic.23 + topic.24 +
  candidate + subject_matter, family = "binomial", data = data)
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.9741	-0.6583	-0.4530	-0.2559	2.8157

Coefficients:

	Estimate	Std. Error
(Intercept)	-6.65511	1.34959
topic.1	13.71110	4.04975
topic.2	-11.62051	5.94830
topic.3	10.87861	4.87992
topic.4	10.57973	3.77652
topic.6	11.55361	4.85279
topic.8	8.86800	5.84793
topic.11	-8.92579	5.47661
topic.13	9.72193	5.51191
topic.14	27.27840	4.88334
topic.15	30.94867	4.90200
topic.16	-13.84200	7.14444
topic.17	-11.05920	5.43271
topic.19	22.45160	4.80179



topic.22	15.04853	3.70397
topic.23	-19.98853	6.33607
topic.24	24.27808	5.17896
candidateBen Carson	2.11072	0.13688
candidateChris Christie	0.55694	0.22785
candidateDonald Trump	0.93028	0.07821
candidateJeb Bush	-0.46331	0.23543
candidateJohn Kasich	2.42913	0.17562
candidateMarco Rubio	1.90885	0.16544
candidateMike Huckabee	1.11084	0.19592
candidateRand Paul	1.05870	0.18290
candidateScott Walker	0.48071	0.20487
candidateTed Cruz	1.98748	0.12833
subject_matterAbortion	-0.73770	0.23606
subject_matterForeign Policy	-0.59055	0.19643
subject_matterFOX News or Moderators	-0.44444	0.08223
subject_matterGun Control	-13.93138	215.21526
subject_matterHealthcare (including Medicare)	-0.25037	0.37166
subject_matterImmigration	0.17490	0.22028
subject_matterJobs and Economy	-0.73950	0.22430
subject_matterLGBT issues	-0.58931	0.28809
subject_matterRacial issues	-1.56566	0.25429
subject_matterReligion	-1.44906	0.25492
subject_matterWomen's Issues (not abortion though)	-2.04455	0.33195
z value Pr(> z )		
(Intercept)	-4.931	8.17e-07 ***
topic.1	3.386	0.000710 ***
topic.2	-1.954	0.050750 .
topic.3	2.229	0.025797 *
topic.4	2.801	0.005087 **
topic.6	2.381	0.017274 *
topic.8	1.516	0.129410
topic.11	-1.630	0.103143
topic.13	1.764	0.077765 .
topic.14	5.586	2.32e-08 ***
topic.15	6.313	2.73e-10 ***
topic.16	-1.937	0.052690 .
topic.17	-2.036	0.041783 *
topic.19	4.676	2.93e-06 ***
topic.22	4.063	4.85e-05 ***
topic.23	-3.155	0.001607 **
topic.24	4.688	2.76e-06 ***
candidateBen Carson	15.420	< 2e-16 ***
candidateChris Christie	2.444	0.014512 *
candidateDonald Trump	11.895	< 2e-16 ***
candidateJeb Bush	-1.968	0.049070 *
candidateJohn Kasich	13.832	< 2e-16 ***
candidateMarco Rubio	11.538	< 2e-16 ***
candidateMike Huckabee	5.670	1.43e-08 ***
candidateRand Paul	5.788	7.10e-09 ***
candidateScott Walker	2.346	0.018957 *
candidateTed Cruz	15.488	< 2e-16 ***
subject_matterAbortion	-3.125	0.001778 **
subject_matterForeign Policy	-3.006	0.002644 **

```

subject_matterFOX News or Moderators      -5.405 6.48e-08 ***
subject_matterGun Control                  -0.065 0.948387
subject_matterHealthcare (including Medicare) -0.674 0.500531
subject_matterImmigration                   0.794 0.427200
subject_matterJobs and Economy             -3.297 0.000977 ***
subject_matterLGBT issues                  -2.046 0.040796 *
subject_matterRacial issues                -6.157 7.42e-10 ***
subject_matterReligion                    -5.684 1.31e-08 ***
subject_matterWomen's Issues (not abortion though) -6.159 7.31e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

(Dispersion parameter for binomial family taken to be 1)

```

Null deviance: 8774.8 on 8721 degrees of freedom
Residual deviance: 7375.6 on 8684 degrees of freedom
AIC: 7451.6

```

Number of Fisher Scoring iterations: 14

```

step_debate_topics <- stepwise_twitter(twitter.topics$topics[-dropped.rows,],
                                         pos.neg.sub, predictors = c("candidate", "subject_matter"))
step_debate_topics$anova

```

Stepwise Model Path  
Analysis of Deviance Table

Initial Model:  
 sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 + topic.5 +  
 topic.6 + topic.7 + topic.8 + topic.9 + topic.10 + topic.11 +  
 topic.12 + topic.13 + topic.14 + topic.15 + candidate + subject\_matter

Final Model:  
 sentiment ~ topic.3 + topic.4 + topic.5 + topic.9 + candidate +  
 subject\_matter

	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				8686	7506.915	7578.915
2	- topic.15	0	0.0000000	8686	7506.915	7578.915
3	- topic.11	1	0.0361263	8687	7506.951	7576.951
4	- topic.13	1	0.1544666	8688	7507.105	7575.105
5	- topic.2	1	0.1144348	8689	7507.220	7573.220
6	- topic.1	1	0.1522128	8690	7507.372	7571.372
7	- topic.10	1	1.0886845	8691	7508.461	7570.461
8	- topic.12	1	1.2258320	8692	7509.687	7569.687
9	- topic.6	1	0.8967099	8693	7510.583	7568.583
10	- topic.14	1	0.9235075	8694	7511.507	7567.507
11	- topic.8	1	0.9577672	8695	7512.465	7566.465
12	- topic.7	1	1.3343270	8696	7513.799	7565.799

```
summary(step_debate_topics)
```

```
Call:
glm(formula = sentiment ~ topic.3 + topic.4 + topic.5 + topic.9 +
     candidate + subject_matter, family = "binomial", data = data)
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.4871	-0.6432	-0.4516	-0.2665	3.0724

Coefficients:

	Estimate	Std. Error
(Intercept)	-1.65379	0.07114
topic.3	-0.84461	0.44540
topic.4	-1.38034	0.39837
topic.5	-0.54730	0.20716
topic.9	0.44076	0.26667
candidateBen Carson	1.97076	0.13278
candidateChris Christie	0.13934	0.20448
candidateDonald Trump	1.01733	0.07611
candidateJeb Bush	-0.98970	0.18763
candidateJohn Kasich	2.28566	0.17181
candidateMarco Rubio	2.00820	0.15789
candidateMike Huckabee	0.69399	0.16685
candidateRand Paul	0.95132	0.18006
candidateScott Walker	0.42488	0.20248
candidateTed Cruz	2.11554	0.11252
subject_matterAbortion	-0.69955	0.23190
subject_matterForeign Policy	-0.66643	0.19212
subject_matterFOX News or Moderators	-0.51114	0.07579
subject_matterGun Control	-13.10766	131.77497
subject_matterHealthcare (including Medicare)	-0.19179	0.36892
subject_matterImmigration	0.23802	0.19145
subject_matterJobs and Economy	-0.63648	0.22177
subject_matterLGBT issues	-0.61507	0.28052
subject_matterRacial issues	-1.59946	0.25355
subject_matterReligion	-1.46172	0.25159
subject_matterWomen's Issues (not abortion though)	-2.02505	0.32657

	z value	Pr(> z )
(Intercept)	-23.246	< 2e-16 ***
topic.3	-1.896	0.057922 .
topic.4	-3.465	0.000530 ***
topic.5	-2.642	0.008245 **
topic.9	1.653	0.098367 .
candidateBen Carson	14.843	< 2e-16 ***
candidateChris Christie	0.681	0.495610
candidateDonald Trump	13.366	< 2e-16 ***
candidateJeb Bush	-5.275	1.33e-07 ***
candidateJohn Kasich	13.303	< 2e-16 ***
candidateMarco Rubio	12.719	< 2e-16 ***
candidateMike Huckabee	4.159	3.19e-05 ***
candidateRand Paul	5.283	1.27e-07 ***
candidateScott Walker	2.098	0.035871 *
candidateTed Cruz	18.802	< 2e-16 ***
subject_matterAbortion	-3.017	0.002557 **

```

subject_matterForeign Policy          -3.469 0.000523 ***
subject_matterFOX News or Moderators  -6.744 1.54e-11 ***
subject_matterGun Control              -0.099 0.920765
subject_matterHealthcare (including Medicare) -0.520 0.603152
subject_matterImmigration              1.243 0.213774
subject_matterJobs and Economy         -2.870 0.004105 **
subject_matterLGBT issues              -2.193 0.028339 *
subject_matterRacial issues            -6.308 2.82e-10 ***
subject_matterReligion                 -5.810 6.25e-09 ***
subject_matterWomen's Issues (not abortion though) -6.201 5.61e-10 ***

```

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

```

Null deviance: 8774.8 on 8721 degrees of freedom
Residual deviance: 7513.8 on 8696 degrees of freedom
AIC: 7565.8

```

Number of Fisher Scoring iterations: 13

```
anova(step_debate_topics, step_25_candidate_subject, test="Chisq")
```

Analysis of Deviance Table

Model 1: sentiment ~ topic.3 + topic.4 + topic.5 + topic.9 + candidate + subject\_matter

Model 2: sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 + topic.6 + topic.8 + topic.11 + topic.13 + topic.14 + topic.15 + topic.16 + topic.17 + topic.19 + topic.22 + topic.23 + topic.24 + candidate + subject\_matter

	Resid. Df	Resid. Dev	Df	Deviance	Pr(>Chi)
1	8696	7513.8			
2	8684	7375.6	12	138.22	< 2.2e-16 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

```

step_25_candidate <- stepwise_twitter(simple_lda_25@gamma[-dropped.rows,],
                                     pos.neg.sub, predictors = c("candidate"))
step_25_candidate$anova

```

Stepwise Model Path

Analysis of Deviance Table

Initial Model:

```

sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 + topic.5 +
  topic.6 + topic.7 + topic.8 + topic.9 + topic.10 + topic.11 +
  topic.12 + topic.13 + topic.14 + topic.15 + topic.16 + topic.17 +
  topic.18 + topic.19 + topic.20 + topic.21 + topic.22 + topic.23 +
  topic.24 + topic.25 + candidate

```

Final Model:

```

sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 + topic.6 +

```

```
topic.10 + topic.13 + topic.14 + topic.15 + topic.17 + topic.19 +
topic.20 + topic.22 + topic.23 + topic.24 + candidate
```

	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				8687	7564.541	7634.541
2	- topic.25	0	0.000000000	8687	7564.541	7634.541
3	- topic.21	1	0.007555184	8688	7564.548	7632.548
4	- topic.18	1	0.064860190	8689	7564.613	7630.613
5	- topic.7	1	0.057461514	8690	7564.670	7628.670
6	- topic.5	1	0.221742597	8691	7564.892	7626.892
7	- topic.8	1	0.196456490	8692	7565.089	7625.089
8	- topic.9	1	0.240554715	8693	7565.329	7623.329
9	- topic.12	1	0.788789524	8694	7566.118	7622.118
10	- topic.16	1	1.148051505	8695	7567.266	7621.266
11	- topic.11	1	1.175723099	8696	7568.442	7620.442

```
summary(step_25_candidate)
```

Call:

```
glm(formula = sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 +
  topic.6 + topic.10 + topic.13 + topic.14 + topic.15 + topic.17 +
  topic.19 + topic.20 + topic.22 + topic.23 + topic.24 + candidate,
  family = "binomial", data = data)
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.9562	-0.6544	-0.4419	-0.3167	2.6099

Coefficients:

	Estimate	Std. Error	z value	Pr(> z )	
(Intercept)	-9.03446	1.19640	-7.551	4.31e-14	***
topic.1	13.80048	3.87768	3.559	0.000372	***
topic.2	-8.60373	5.68267	-1.514	0.130018	
topic.3	16.81774	4.77665	3.521	0.000430	***
topic.4	10.47045	3.65772	2.863	0.004202	**
topic.6	16.45911	4.85769	3.388	0.000703	***
topic.10	-9.32921	5.79380	-1.610	0.107353	
topic.13	14.43949	4.77699	3.023	0.002505	**
topic.14	29.69177	4.75588	6.243	4.29e-10	***
topic.15	34.93382	4.77433	7.317	2.54e-13	***
topic.17	-11.08486	5.24679	-2.113	0.034627	*
topic.19	23.95011	4.65096	5.149	2.61e-07	***
topic.20	9.29034	5.03864	1.844	0.065210	.
topic.22	17.96145	3.61984	4.962	6.98e-07	***
topic.23	-17.66470	6.21845	-2.841	0.004502	**
topic.24	30.67275	5.09394	6.021	1.73e-09	***
candidateBen Carson	2.10995	0.12793	16.493	< 2e-16	***
candidateChris Christie	0.62827	0.21100	2.978	0.002905	**
candidateDonald Trump	0.99441	0.07994	12.439	< 2e-16	***
candidateJeb Bush	-0.56764	0.19197	-2.957	0.003108	**
candidateJohn Kasich	2.60234	0.16782	15.507	< 2e-16	***
candidateMarco Rubio	2.02145	0.16007	12.629	< 2e-16	***

candidateMike Huckabee	1.19364	0.19337	6.173	6.70e-10	***
candidateRand Paul	1.24053	0.17967	6.904	5.04e-12	***
candidateScott Walker	0.52249	0.20098	2.600	0.009330	**
candidateTed Cruz	2.10374	0.12610	16.683	< 2e-16	***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 8774.8 on 8721 degrees of freedom  
 Residual deviance: 7568.4 on 8696 degrees of freedom  
 AIC: 7620.4

Number of Fisher Scoring iterations: 5

```
step_debate_candidate_topics <- stepwise_twitter(twitter.topics$topics[-dropped.rows,],
  pos.neg.sub, predictors = c("candidate"))
step_debate_candidate_topics$anova
```

Stepwise Model Path  
 Analysis of Deviance Table

Initial Model:

sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 + topic.5 +  
 topic.6 + topic.7 + topic.8 + topic.9 + topic.10 + topic.11 +  
 topic.12 + topic.13 + topic.14 + topic.15 + candidate

Final Model:

sentiment ~ topic.3 + topic.4 + topic.9 + candidate

	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				8697	7726.886	7776.886
2	- topic.15	0	0.0000000	8697	7726.886	7776.886
3	- topic.11	1	0.0144929	8698	7726.900	7774.900
4	- topic.5	1	0.2962551	8699	7727.196	7773.196
5	- topic.2	1	0.9019338	8700	7728.098	7772.098
6	- topic.13	1	0.8188439	8701	7728.917	7770.917
7	- topic.1	1	0.8072849	8702	7729.725	7769.725
8	- topic.10	1	0.7991876	8703	7730.524	7768.524
9	- topic.12	1	1.8884422	8704	7732.412	7768.412
10	- topic.14	1	1.6095061	8705	7734.022	7768.022
11	- topic.8	1	1.9694914	8706	7735.991	7767.991
12	- topic.7	1	1.8863938	8707	7737.878	7767.878
13	- topic.6	1	1.7458130	8708	7739.623	7767.623

```
summary(step_debate_candidate_topics)
```

Call:

```
glm(formula = sentiment ~ topic.3 + topic.4 + topic.9 + candidate,
  family = "binomial", data = data)
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.4762	-0.6914	-0.4795	-0.3339	2.5343

Coefficients:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	-2.05743	0.06233	-33.011	< 2e-16 ***
topic.3	-0.89249	0.43612	-2.046	0.040714 *
topic.4	-1.40060	0.39048	-3.587	0.000335 ***
topic.9	0.61697	0.26169	2.358	0.018392 *
candidateBen Carson	1.97682	0.12298	16.075	< 2e-16 ***
candidateChris Christie	0.30507	0.20043	1.522	0.127994
candidateDonald Trump	1.08617	0.07184	15.119	< 2e-16 ***
candidateJeb Bush	-0.76441	0.18657	-4.097	4.18e-05 ***
candidateJohn Kasich	2.44788	0.16325	14.995	< 2e-16 ***
candidateMarco Rubio	2.17735	0.15183	14.341	< 2e-16 ***
candidateMike Huckabee	0.79585	0.16158	4.925	8.42e-07 ***
candidateRand Paul	1.18491	0.17640	6.717	1.85e-11 ***
candidateScott Walker	0.50484	0.19810	2.548	0.010823 *
candidateTed Cruz	2.31882	0.10956	21.165	< 2e-16 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 8774.8 on 8721 degrees of freedom  
Residual deviance: 7739.6 on 8708 degrees of freedom  
AIC: 7767.6

Number of Fisher Scoring iterations: 5

```
anova(step_debate_candidate_topics, step_25_candidate, test="Chisq")
```

Analysis of Deviance Table

Model 1: sentiment ~ topic.3 + topic.4 + topic.9 + candidate  
Model 2: sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 + topic.6 +  
topic.10 + topic.13 + topic.14 + topic.15 + topic.17 + topic.19 +  
topic.20 + topic.22 + topic.23 + topic.24 + candidate  
Resid. Df Resid. Dev Df Deviance Pr(>Chi)  
1 8708 7739.6  
2 8696 7568.4 12 171.18 < 2.2e-16 \*\*\*

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

```
BIC(step_debate_candidate_topics); BIC(step_25_candidate)
```

[1] 7866.654

[1] 7804.355

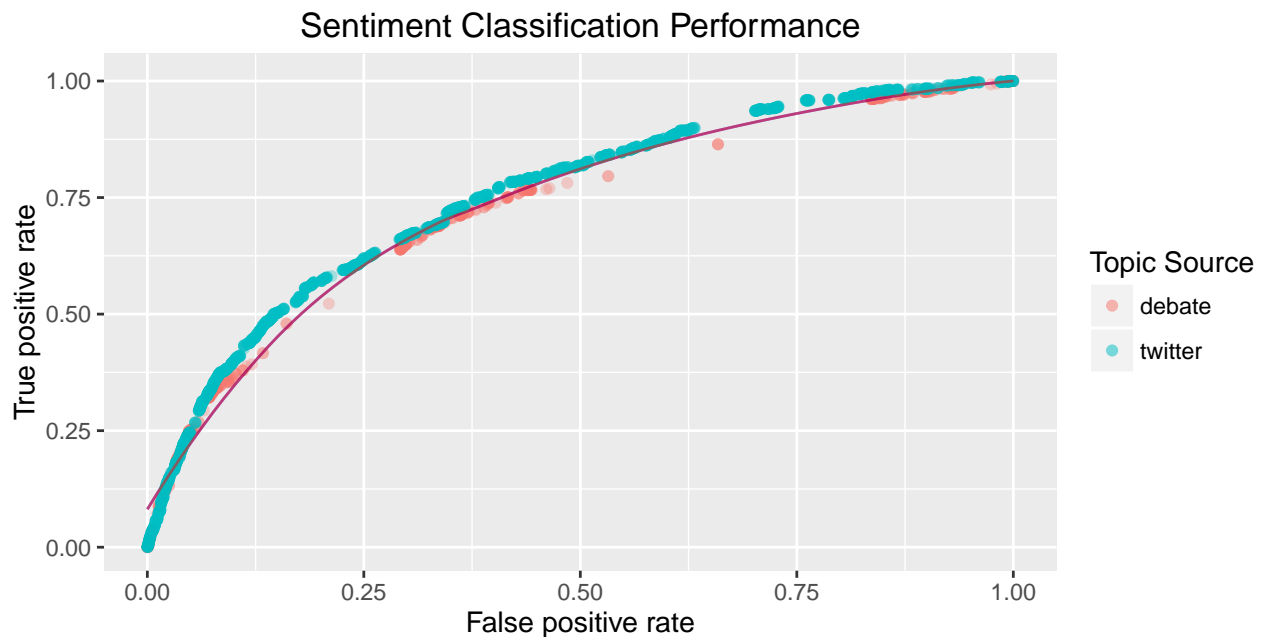
```

pred.prob.debates <- predict(step_debate_candidate_topics, type="response")
pred.prob.twitter25 <- predict(step_25_candidate, type="response")

require(ROCR)
pred.debates <- prediction(predictions = pred.prob.debates, labels = pos.neg.sub$sentiment)
pred.twitter <- prediction(predictions = pred.prob.twitter25, labels = pos.neg.sub$sentiment)
roc.debates <- performance(pred.debates, "tpr", "fpr")
roc.twitter <- performance(pred.twitter, "tpr", "fpr")

ggplot(data = NULL, aes(x=roc.debates@x.values[[1]], y=roc.debates@y.values[[1]], color = "debate")) +
  geom_point(alpha = 0.3) + xlab(roc.debates@x.name) + ylab(roc.debates@y.name) +
  geom_line(stat = "smooth", method = "auto", color = "blue", alpha = 0.5) +
  geom_point(aes(x=roc.twitter@x.values[[1]], y=roc.twitter@y.values[[1]], color = "twitter"), alpha = 0.3) +
  geom_line(stat = "smooth", method = "auto", color = "red", alpha = 0.5) +
  labs(color = "Topic Source", title = "Sentiment Classification Performance")

```



```

auc.debates <- performance(pred.debates, "auc")@y.values[[1]]
auc.twitter <- performance(pred.twitter, "auc")@y.values[[1]]
auc.debates; auc.twitter

```

```
[1] 0.7253047
```

```
[1] 0.7540908
```

```

step_25_no <- stepwise_twitter(simple_lda_25@gamma[-dropped.rows,],
                              pos.neg.sub, predictors = c())
step_25_no$anova

```

Stepwise Model Path



## Analysis of Deviance Table

Initial Model:

```
sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 + topic.5 +  
  topic.6 + topic.7 + topic.8 + topic.9 + topic.10 + topic.11 +  
  topic.12 + topic.13 + topic.14 + topic.15 + topic.16 + topic.17 +  
  topic.18 + topic.19 + topic.20 + topic.21 + topic.22 + topic.23 +  
  topic.24 + topic.25
```

Final Model:

```
sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 + topic.5 +  
  topic.6 + topic.10 + topic.13 + topic.14 + topic.15 + topic.16 +  
  topic.17 + topic.18 + topic.19 + topic.20 + topic.21 + topic.22 +  
  topic.23 + topic.24
```

	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				8697	8241.469	8291.469
2	- topic.25	0	0.00000000	8697	8241.469	8291.469
3	- topic.9	1	0.04218738	8698	8241.511	8289.511
4	- topic.12	1	0.19400289	8699	8241.705	8287.705
5	- topic.7	1	0.72845481	8700	8242.434	8286.434
6	- topic.11	1	0.67347449	8701	8243.107	8285.107
7	- topic.8	1	0.75802864	8702	8243.865	8283.865

```
summary(step_25_no)
```

Call:

```
glm(formula = sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 +  
  topic.5 + topic.6 + topic.10 + topic.13 + topic.14 + topic.15 +  
  topic.16 + topic.17 + topic.18 + topic.19 + topic.20 + topic.21 +  
  topic.22 + topic.23 + topic.24, family = "binomial", data = data)
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.7784	-0.7186	-0.5879	-0.3875	2.4967

Coefficients:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	-12.098	1.580	-7.658	1.89e-14 ***
topic.1	16.802	3.970	4.232	2.32e-05 ***
topic.2	-13.730	5.386	-2.549	0.010797 *
topic.3	15.525	4.645	3.342	0.000832 ***
topic.4	15.121	3.744	4.039	5.37e-05 ***
topic.5	22.681	4.215	5.381	7.42e-08 ***
topic.6	26.613	4.635	5.742	9.37e-09 ***
topic.10	-8.936	5.502	-1.624	0.104361
topic.13	14.609	4.647	3.144	0.001669 **
topic.14	28.969	4.588	6.314	2.71e-10 ***
topic.15	36.327	4.587	7.920	2.37e-15 ***
topic.16	-25.977	5.578	-4.657	3.21e-06 ***
topic.17	-17.054	5.128	-3.326	0.000881 ***
topic.18	30.577	4.059	7.533	4.96e-14 ***

```

topic.19      23.466      4.513   5.200 1.99e-07 ***
topic.20      23.461      4.806   4.882 1.05e-06 ***
topic.21      11.302      4.865   2.323 0.020161 *
topic.22      45.032      3.317  13.575 < 2e-16 ***
topic.23      -8.634      5.415  -1.594 0.110832
topic.24      29.819      4.886   6.104 1.04e-09 ***

```

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

```

Null deviance: 8774.8 on 8721 degrees of freedom
Residual deviance: 8243.9 on 8702 degrees of freedom
AIC: 8283.9

```

Number of Fisher Scoring iterations: 5

```

step_debate_no <- stepwise_twitter(twitter.topics$topics[-dropped.rows,],
                                   pos.neg.sub, predictors = c())
step_debate_no$anova

```

Stepwise Model Path  
Analysis of Deviance Table

Initial Model:

```

sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 + topic.5 +
  topic.6 + topic.7 + topic.8 + topic.9 + topic.10 + topic.11 +
  topic.12 + topic.13 + topic.14 + topic.15

```

Final Model:

```

sentiment ~ topic.2 + topic.3 + topic.4 + topic.8 + topic.12

```

	Step	Df	Deviance	Resid. Df	Resid. Dev	AIC
1				8707	8713.049	8743.049
2	- topic.15	0	0.000000000	8707	8713.049	8743.049
3	- topic.14	1	0.005092863	8708	8713.055	8741.055
4	- topic.9	1	0.022668551	8709	8713.077	8739.077
5	- topic.5	1	0.102591424	8710	8713.180	8737.180
6	- topic.10	1	0.055106167	8711	8713.235	8735.235
7	- topic.6	1	0.355949307	8712	8713.591	8733.591
8	- topic.1	1	0.550401211	8713	8714.141	8732.141
9	- topic.7	1	0.542246561	8714	8714.684	8730.684
10	- topic.13	1	1.169931785	8715	8715.853	8729.853
11	- topic.11	1	0.986007144	8716	8716.839	8728.839

```
summary(step_debate_no)
```

Call:

```

glm(formula = sentiment ~ topic.2 + topic.3 + topic.4 + topic.8 +
  topic.12, family = "binomial", data = data)

```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-0.8307	-0.7023	-0.6672	-0.5391	2.2719

Coefficients:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	-1.27714	0.05453	-23.420	< 2e-16 ***
topic.2	0.56358	0.21849	2.580	0.00989 **
topic.3	-1.02588	0.41054	-2.499	0.01246 *
topic.4	-1.74391	0.38087	-4.579	4.68e-06 ***
topic.8	-0.89292	0.27923	-3.198	0.00138 **
topic.12	0.29732	0.13883	2.142	0.03222 *

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 8774.8 on 8721 degrees of freedom  
Residual deviance: 8716.8 on 8716 degrees of freedom  
AIC: 8728.8

Number of Fisher Scoring iterations: 4

```
anova(step_debate_no, step_25_no, test="Chisq")
```

Analysis of Deviance Table

Model 1: sentiment ~ topic.2 + topic.3 + topic.4 + topic.8 + topic.12  
Model 2: sentiment ~ topic.1 + topic.2 + topic.3 + topic.4 + topic.5 +  
topic.6 + topic.10 + topic.13 + topic.14 + topic.15 + topic.16 +  
topic.17 + topic.18 + topic.19 + topic.20 + topic.21 + topic.22 +  
topic.23 + topic.24

	Resid. Df	Resid. Dev	Df	Deviance	Pr(>Chi)
1	8716	8716.8			
2	8702	8243.9	14	472.97	< 2.2e-16 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

```
dummy_candidate <- dummy(pos.neg.sub$candidate,  
                           levels(pos.neg.sub$candidate)[-1])  
dummy_subject_matter <- dummy(pos.neg.sub$subject_matter,  
                               levels(pos.neg.sub$subject_matter)[-1])  
candidate_only <- cv.glmnet(x = dummy_candidate, y = pos.neg.sub$sentiment,  
                           family = "binomial", alpha = 1, nfolds = 10)  
candidate_subject_only <- cv.glmnet(x = cbind(dummy_candidate, dummy_subject_matter),  
                                   y = pos.neg.sub$sentiment, family = "binomial", alpha = 1, nfolds = 10)  
min(candidate_only$cvm)
```

```
[1] 0.893932
```

```
min(candidate_subject_only$cvm)
```

```
[1] 0.8688909
```

```
coef(candidate_only, s="lambda.min")
```

```
11 x 1 sparse Matrix of class "dgCMatrix"
      1
(Intercept) -2.1069223
Ben Carson   1.9499006
Chris Christie 0.2470594
Donald Trump  1.0670563
Jeb Bush      -0.6819826
John Kasich   2.4153283
Marco Rubio   2.1394047
Mike Huckabee 0.6731933
Rand Paul     1.1462626
Scott Walker  0.4891074
Ted Cruz      2.2990564
```

```
coef(candidate_subject_only, s="lambda.min")
```

```
22 x 1 sparse Matrix of class "dgCMatrix"
      1
(Intercept) -1.76380655
Ben Carson   1.96841918
Chris Christie 0.04446841
Donald Trump  0.95836625
Jeb Bush      -0.90440262
John Kasich   2.24777913
Marco Rubio   2.00529504
Mike Huckabee 0.60256605
Rand Paul     0.93444710
Scott Walker  0.44740034
Ted Cruz      2.11728825
Abortion      -0.69735251
Foreign Policy -0.66187811
FOX News or Moderators -0.49796323
Gun Control   -3.85199554
Healthcare (including Medicare) -0.18456509
Immigration   0.21963432
Jobs and Economy -0.63133633
LGBT issues   -0.60277641
Racial issues -1.56186113
Religion      -1.40245488
Women's Issues (not abortion though) -2.01149524
```

```
require(coefplot)
candidate_only2 <- glm(sentiment ~ candidate, data = pos.neg.sub, family = "binomial")
candidate_subject_only2 <- glm(sentiment ~ candidate + subject_matter, data = pos.neg.sub,
                               family = "binomial")
summary(candidate_only2)
```

Call:

```
glm(formula = sentiment ~ candidate, family = "binomial", data = pos.neg.sub)
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.3197	-0.6612	-0.4739	-0.3375	2.4057

Coefficients:

	Estimate	Std. Error	z value	Pr(> z )
(Intercept)	-2.12999	0.05077	-41.951	< 2e-16 ***
candidateBen Carson	1.98733	0.12258	16.213	< 2e-16 ***
candidateChris Christie	0.30648	0.20011	1.532	0.125636
candidateDonald Trump	1.09666	0.07140	15.359	< 2e-16 ***
candidateJeb Bush	-0.70679	0.18616	-3.797	0.000147 ***
candidateJohn Kasich	2.45849	0.16269	15.112	< 2e-16 ***
candidateMarco Rubio	2.18076	0.15131	14.412	< 2e-16 ***
candidateMike Huckabee	0.72081	0.16007	4.503	6.69e-06 ***
candidateRand Paul	1.19349	0.17603	6.780	1.20e-11 ***
candidateScott Walker	0.54509	0.19772	2.757	0.005835 **
candidateTed Cruz	2.33440	0.10924	21.369	< 2e-16 ***

---

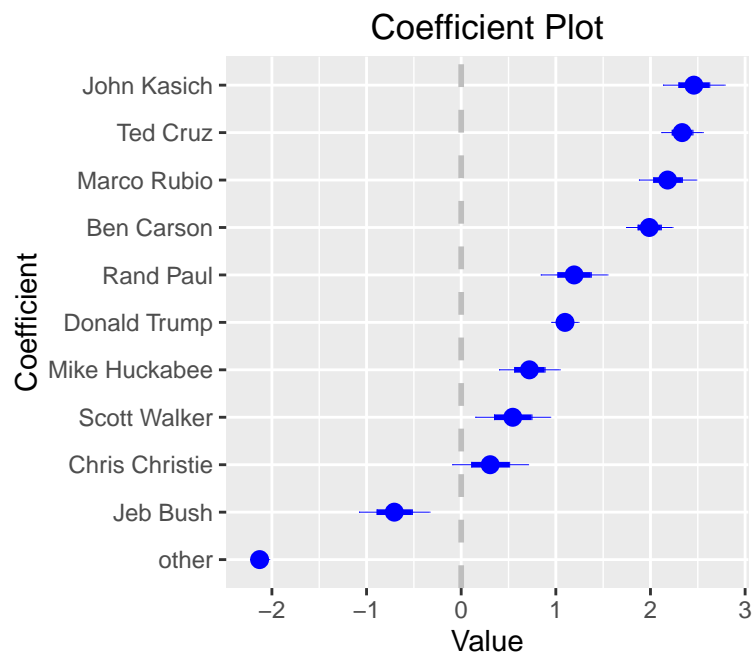
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 8774.8 on 8721 degrees of freedom  
 Residual deviance: 7765.0 on 8711 degrees of freedom  
 AIC: 7787

Number of Fisher Scoring iterations: 5

```
rename_candidate <- c("other", gsub("candidate*", "", names(coef(candidate_only2))[2:11]))
names(rename_candidate) <- names(coef(candidate_only2))
coefplot::coefplot(candidate_only2, sort="magnitude", newNames = rename_candidate)
```



```
summary(candidate_subject_only2)
```

Call:

```
glm(formula = sentiment ~ candidate + subject_matter, family = "binomial",
     data = pos.neg.sub)
```

Deviance Residuals:

Min	1Q	Median	3Q	Max
-1.4383	-0.6698	-0.4426	-0.2631	3.0895

Coefficients:

	Estimate	Std. Error
(Intercept)	-1.76996	0.05836
candidateBen Carson	1.99153	0.13236
candidateChris Christie	0.07349	0.20268
candidateDonald Trump	0.97118	0.07272
candidateJeb Bush	-0.92140	0.18712
candidateJohn Kasich	2.27370	0.17085
candidateMarco Rubio	2.02796	0.15731
candidateMike Huckabee	0.63158	0.16539
candidateRand Paul	0.95716	0.17968
candidateScott Walker	0.47909	0.20199
candidateTed Cruz	2.13415	0.11210
subject_matterAbortion	-0.72792	0.23120
subject_matterForeign Policy	-0.69038	0.19146
subject_matterFOX News or Moderators	-0.50414	0.07554
subject_matterGun Control	-13.11555	132.43277
subject_matterHealthcare (including Medicare)	-0.22495	0.36744
subject_matterImmigration	0.23104	0.19125
subject_matterJobs and Economy	-0.65994	0.21996
subject_matterLGBT issues	-0.64097	0.27913
subject_matterRacial issues	-1.60209	0.25292
subject_matterReligion	-1.44012	0.25163
subject_matterWomen's Issues (not abortion though)	-2.07271	0.32617

	z value	Pr(> z )
(Intercept)	-30.327	< 2e-16 ***
candidateBen Carson	15.046	< 2e-16 ***
candidateChris Christie	0.363	0.716921
candidateDonald Trump	13.355	< 2e-16 ***
candidateJeb Bush	-4.924	8.47e-07 ***
candidateJohn Kasich	13.308	< 2e-16 ***
candidateMarco Rubio	12.891	< 2e-16 ***
candidateMike Huckabee	3.819	0.000134 ***
candidateRand Paul	5.327	9.99e-08 ***
candidateScott Walker	2.372	0.017703 *
candidateTed Cruz	19.038	< 2e-16 ***
subject_matterAbortion	-3.148	0.001642 **
subject_matterForeign Policy	-3.606	0.000311 ***
subject_matterFOX News or Moderators	-6.674	2.49e-11 ***
subject_matterGun Control	-0.099	0.921110
subject_matterHealthcare (including Medicare)	-0.612	0.540398
subject_matterImmigration	1.208	0.227023

```

subject_matterJobs and Economy          -3.000 0.002698 **
subject_matterLGBT issues                -2.296 0.021657 *
subject_matterRacial issues              -6.334 2.38e-10 ***
subject_matterReligion                   -5.723 1.05e-08 ***
subject_matterWomen's Issues (not abortion though) -6.355 2.09e-10 ***

```

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

```

Null deviance: 8774.8 on 8721 degrees of freedom
Residual deviance: 7540.6 on 8700 degrees of freedom
AIC: 7584.6

```

Number of Fisher Scoring iterations: 13

```

rename_subject <- c("other", gsub("subject_matter*", "", names(coef(candidate_subject_only2))[12:22]))
names(rename_subject) <- names(coef(candidate_subject_only2))[c(1,12:22)]
#coefplot::coefplot(candidate_subject_only2, predictors = "subject_matter", sort="magnitude", newNames = rename_subject)
anova(candidate_only2, candidate_subject_only2, test = "Chisq")

```

Analysis of Deviance Table

```

Model 1: sentiment ~ candidate
Model 2: sentiment ~ candidate + subject_matter
  Resid. Df Resid. Dev Df Deviance Pr(>Chi)
1      8711      7765.0
2      8700      7540.6 11    224.32 < 2.2e-16 ***

```

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

```

require(dplyr)
require(reshape2)

```

Loading required package: reshape2

```

require(ggplot2)
debate_LDA_15_names[2] <- "mods3"
topic_theta_by_speaker <- data.frame(debate_LDA_15@gamma, speaker = debate_corpus$documents$speaker)
# come up with descriptive names for topics
colnames(topic_theta_by_speaker) <- c(debate_LDA_15_names, "speaker")
grouped <- group_by(topic_theta_by_speaker, speaker)
topic_means_by_speaker <- as.data.frame(grouped %>% summarize_each(funs(mean)))
melted <- reshape2::melt(topic_means_by_speaker, id.vars = "speaker")
melted.candidate <- filter(melted, speaker != "OTHER" & speaker != "MODERATOR")
p <- ggplot(melted.candidate, aes(x = speaker, y = value, fill = variable))
p <- p + geom_bar(stat="identity")
p <- p + theme(axis.text.x=element_text(angle = 90, vjust = 0.5))
p <- p + labs(fill = "Topic", x = "Candidate", y = "Mean Theta by Topic")
p

```

