# A DEEP DIVE INTO THE DIGITAL DIVIDE

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NISS/WSS WORKSHOP ON INFERENCE FROM NONPROBABILITY SAMPLES

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# “THEY COULDN’T BE ANYMORE DIFFERENT”

- Just what is it exactly that “prevents” people from having the Internet?
- Most Internet panels do not offer solutions to cover non-Internet panelists…can we model them in?
- A range of articles have reported single-survey documentation of the digital divide…what about across “all” surveys?

# THE PROCESS


# STEP 1: FIND DATASETS

| Survey | Year | N | Total Number of Variables |
|---|---|---|---|
| American Identity & Representation Survey | 2012 | 1,702 | ~130 |
| American National Election Survey | 2012 | 5,914 | ~1,100 |
| BRFSS | 2015 | 434,382 | ~300 |
| General Social Survey | 2014 | 1,238 | ~840 |
| National Health Interview Survey | 2015 | 33,672 | ~1,300 |
| Outlook on Life Survey | 2012 | 2,294 | ~400 |
| Survey of Consumer Attitudes | 2013 | 2,013 | ~270 |
| Survey on Public Participation in the Arts | 2012 | 4,708 | ~770 |
| Pew Science Survey | 2014 | 2,002 | ~80 |
| Pew Libraries and Technology Survey | 2015 | 1,003 | ~130 |
| Pew Public Survey | 2014 | 1,501 | ~110 |
| Pew Civic Engagement Survey | 2012 | 2,251 | ~100 |
| Pew Gaming Survey | 2015 | 2,001 | ~120 |
| Pew Gender Survey | 2014 | 1,835 | ~80 |
| Pew Connectivity Survey | 2013 | 1,801 | ~130 |

# STEP 2: FLAG SIGNIFICANT VARIABLES

| Survey | Year | N | Total Number of Variables | Step 1 Sig. Vars. | Final Vars. Step 2 |
|---|---|---|---|---|---|
| American Identity & Representation Survey | 2012 | 1,702 | ~130 | 15 | 5 |
| American National Election Survey | 2012 | 5,914 | ~1,100 | 105 | 11 |
| BRFSS | 2015 | 434,382 | ~300 | 12 | 5 |
| General Social Survey | 2014 | 1,238 | ~840 | 100 | 21 |
| National Health Interview Survey | 2015 | 33,672 | ~1,300 | 70 | 9 |
| Outlook on Life Survey | 2012 | 2,294 | ~400 | 42 | 7 |
| Survey of Consumer Attitudes | 2013 | 2,013 | ~270 | 12 | 5 |
| Survey on Public Participation in the Arts | 2012 | 4,708 | ~770 | 38 | 18 |
| Pew Science Survey | 2014 | 2,002 | ~80 | 28 | 6 |
| Pew Libraries and Technology Survey | 2015 | 1,003 | ~130 | 10 | 5 |
| Pew Public Survey | 2014 | 1,501 | ~110 | 11 | 5 |
| Pew Civic Engagement Survey | 2012 | 2,251 | ~100 | 14 | 5 |
| Pew Gaming Survey | 2015 | 2,001 | ~120 | 9 | 4 |
| Pew Gender Survey | 2014 | 1,835 | ~80 | 6 | 4 |
| Pew Connectivity Survey | 2013 | 1,801 | ~130 | 21 | 6 |

Rules:

1. At least 10% Difference

2. Lower Bound > 10%

3. Non-Demographic

542
Variables Found

# DIMENSIONS OF THE DIGITAL DIVIDE

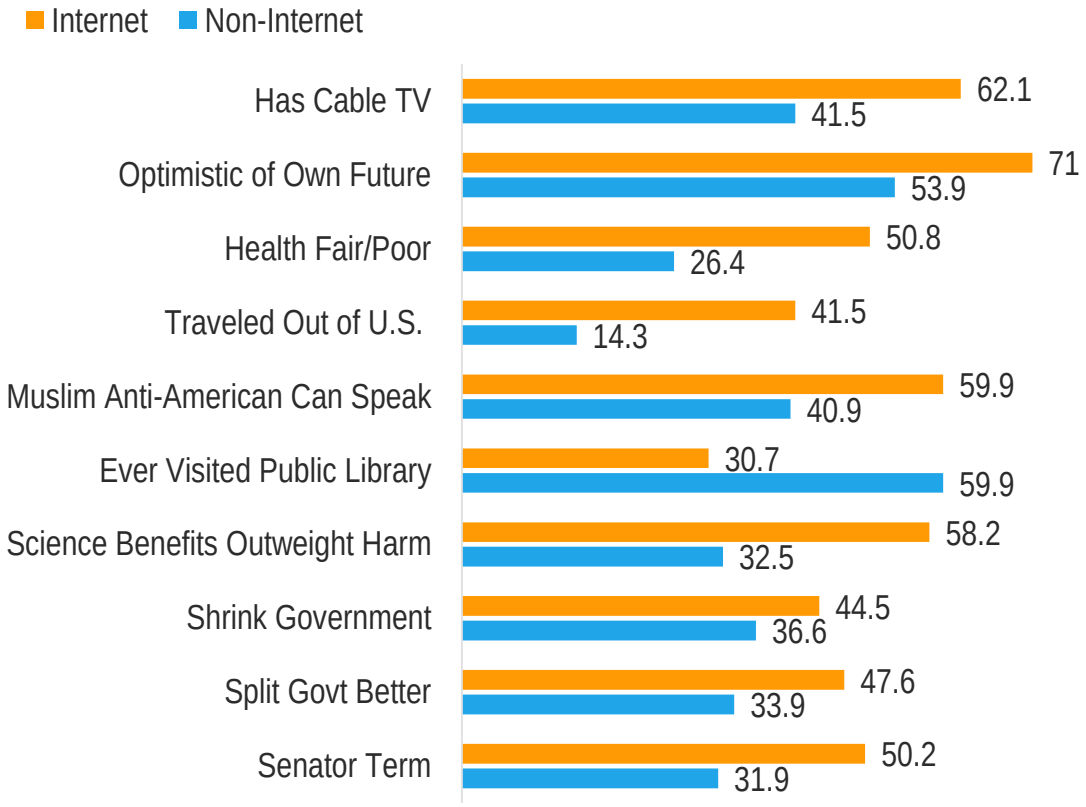
| | |
|---|---|
| Technology Ownership | 6 |
| Technology:  Attitudes Toward | 15 |
| Activities: Community/Membership/Cultural | 52 |
| Americanism | 12 |
| Abortion | 7 |
| Government Role/Setup | 19 |
| Government Financial | 21 |
| Candidate Qualities | 10 |
| Self/Family/HH Financial | 38 |
| Political Knowledge | 19 |
| Knowledge (non-Political) | 23 |

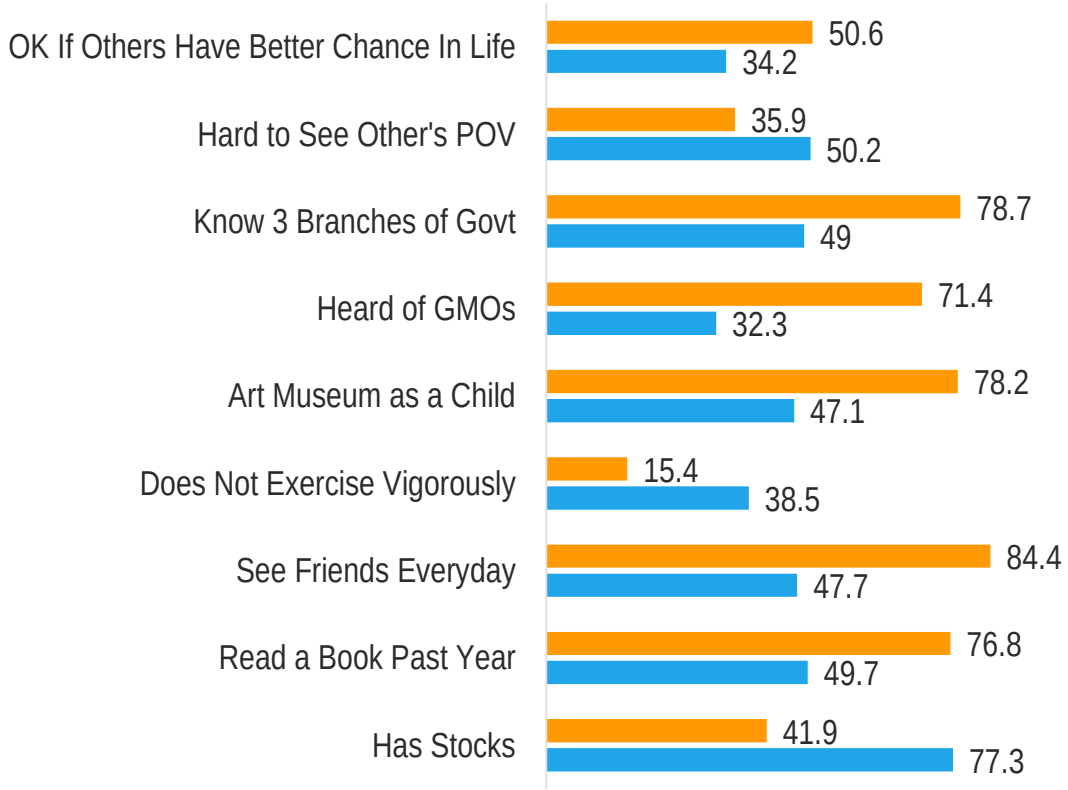
| | |
|---|---|
| Health Care | 21 |
| Self-Health Status Physical | 60 |
| Self-Health Status Mental | 14 |
| Religion | 7 |
| Science | 34 |
| Privacy/Openness | 20 |
| Tolerance of other groups | 62 |
| Trust/Efficacy | 9 |
| Political Participation | 42 |
| Environment/Energy | 11 |

- Variables coded for topic
- Krippendorf's alpha = .76
- Of course, number of variables in each content category confounded with topics of the source surveys
- Still a number of dimensions seem apparent:
  - Fear of technology
  - Isolationism/Fear of other groups
  - Conservativism
  - Age
  - SES
  - American-centric
  - Low political knowledge
  - Religiosity/Distrust of science

# A FEW DIFFERENCES OF NOTE

## INTERNET/NON-INTERNET HOUSEHOLDS



# STEP 3: DATA REDUCTION ROUND 2

| Survey | Year | N | Total Number of Variables | Step 1 Sig. Vars. | Final Vars. Step 2 |
|---|---|---|---|---|---|
| American Identity & Representation Survey | 2012 | 1,702 | ~130 | 15 | 5 |
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# RANDOM FOREST DATA REDUCTION DETAILS

- As a second step of data reduction we applied a recursive feature elimination step using fuzzy random forests to select the top 20% of the Final Subset of Variables remaining after step 1.
- The forests used 2500 trees and the default number of variables randomly selected at each node for tree branching.
- The importance of each variable was based on the mean decrease in the accuracy of predicting non-internet households.

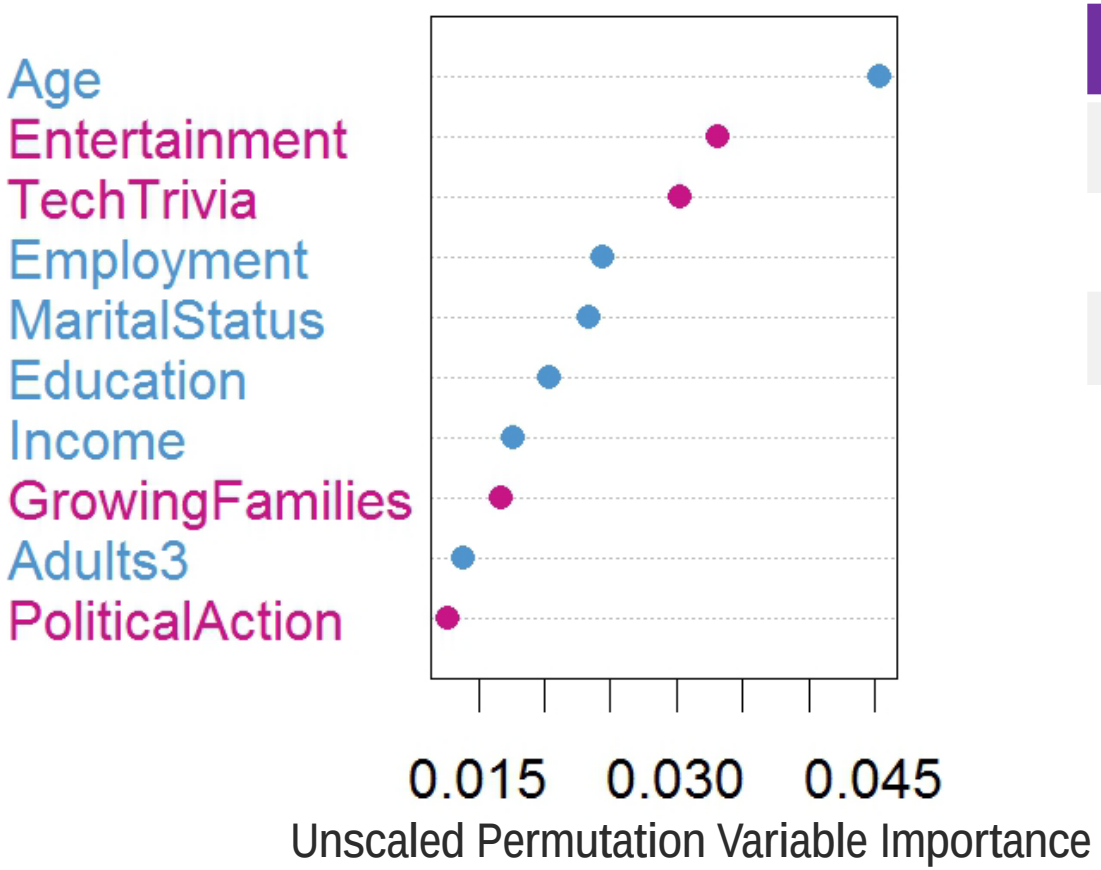
# COMBINING VARIABLES FROM SEPARATE DATASETS

- 26 Candidate variables concurrently administered in the SSRS Omnibus in April, 2017
- Oversample waves interviewed only those without Internet utilization
- Baseline Internet measure plus smartphone/tablet follow-up
- N = 1,373 with Internet, 1,058 without
- Dataset thus “balanced” with respect to outcome of interest to facilitate predictive models and variable selection.
- Wanted to identify half dozen “non-demographic” variables that were important for predicting non-internet households while including standard demographic variables.

# USING ALL 38 VARIABLES TAKEN TOGETHER AS ONE MODULE, WE APPLIED:

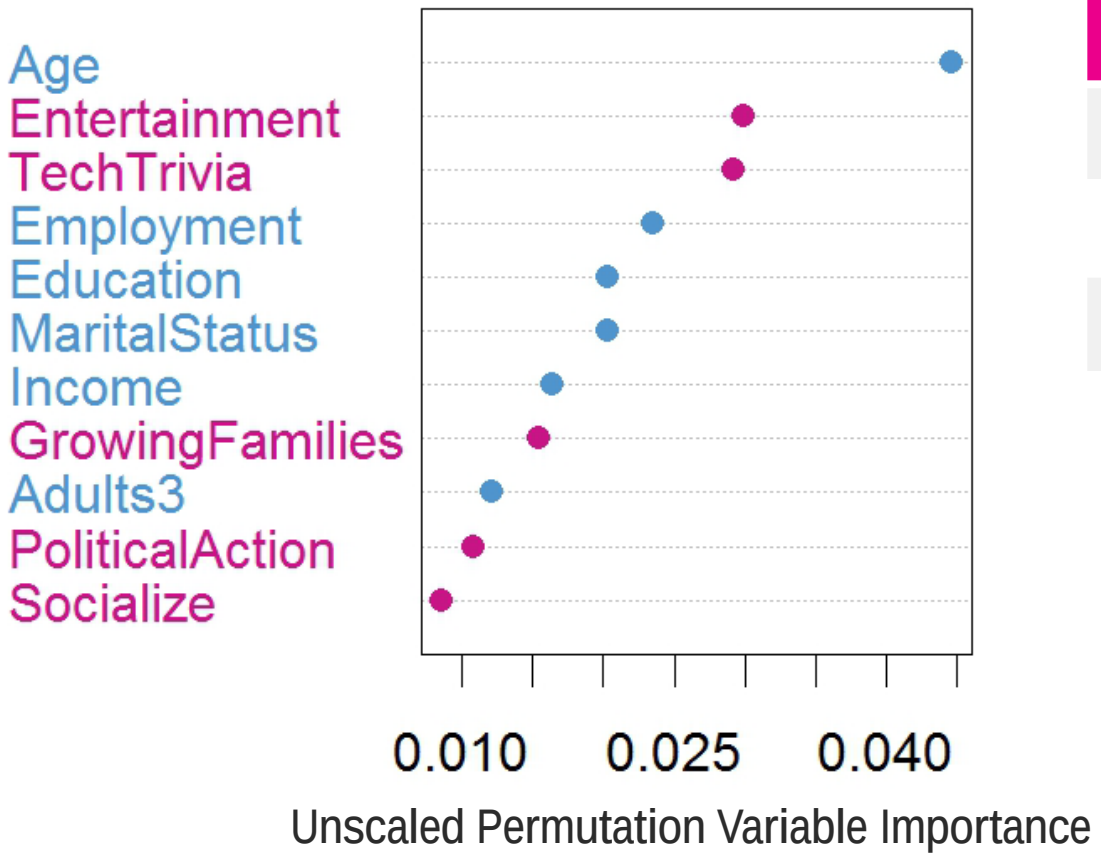
- A recursive feature elimination procedure based on random forest models to identify the top 10, 11 and 12 predictors.
- The number of predictors varied as we wanted to identify the top 5 or 6 “non-demographic predictors” to use in our propensity models for predicting NON-INTERNET Households
- The recursive feature elimination was performed using Fuzzy Forests which iterate a series of classification-based random forests to identify the top-most important features.
- The estimates of variable importance for this method are less biased in the presence of correlated predictors when compared to using a single random forest model (see Conn et al., 2015)
- The tuning parameters for the fuzzy forest method were determined using a grid search that was based on testing overall model misclassification error across a series of 4 levels of forest size and three levels of the “mtry” parameter that controls the number of variables considered for splitting each node in the trees. For tractability the nodesize was set to 5 for all forests.
- A total of 10 independent iterations were conducted per combination of forest size, mtry and number of variables to be selected.
- The combination of forest size and mtry that produced the smallest error, per number selected, were used to create the final models to determine the best variables for predicting non-internet status.

# SELECTION OF THE 10 MOST IMPORTANT PREDICTORS



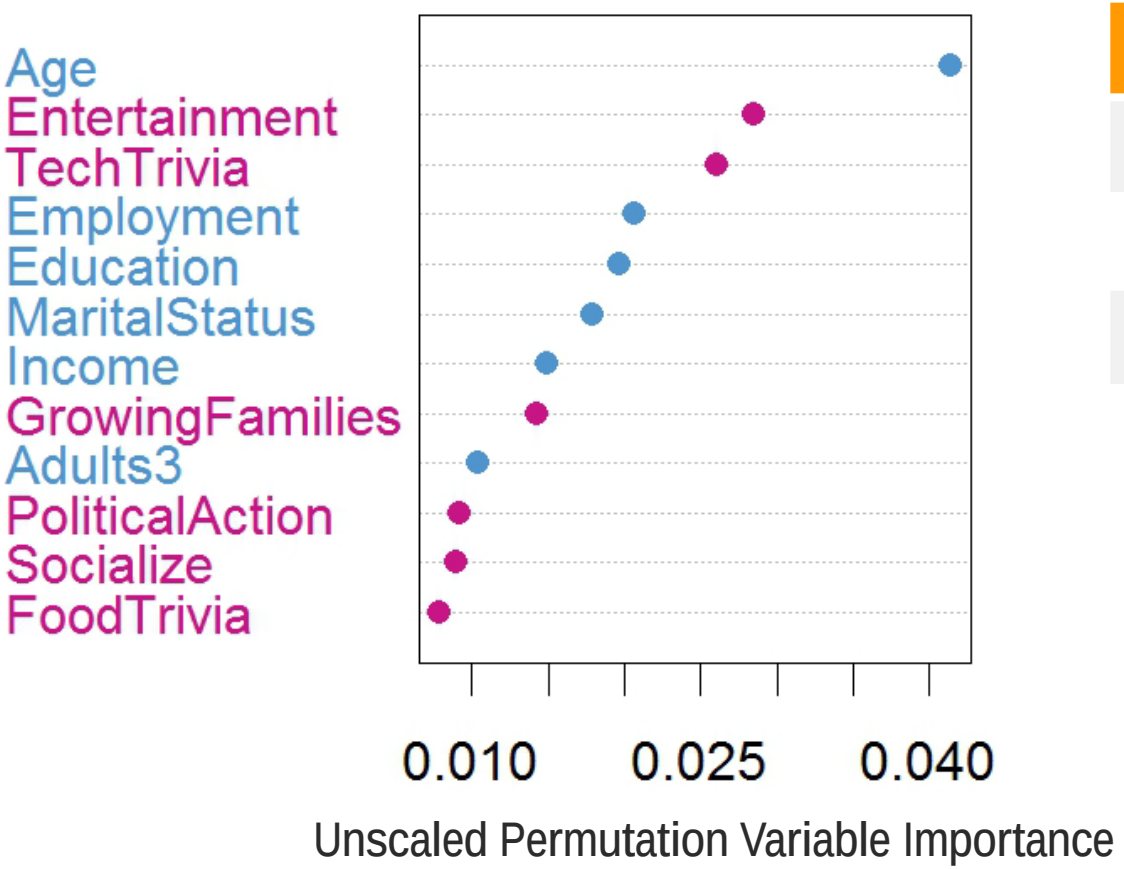

| Statistic | Estimate |
|---|---|
| Overall Accuracy | 79.6% |
| True Positive Rate | 79.8% |
| True Negative Rate | 79.5% |

# SELECTION OF THE 11 MOST IMPORTANT PREDICTORS




| Statistic | Estimate |
|---|---|
| Overall Accuracy | 80.1% |
| True Positive Rate | 80.5% |
| True Negative Rate | 79.8% |

# SELECTION OF THE 12 MOST IMPORTANT PREDICTORS




| Statistic | Estimate |
|---|---|
| Overall Accuracy | 80.2% |
| True Positive Rate | 80.9% |
| True Negative Rate | 79.6% |

# TOP 6 NON-DEMS

If we just used the top 6 Non-Dems to Predict Non-Internet Households…

based on a random forest model with 1000 tree and mtry=2

Entertainment
Tech Trivia
Growing Families
Political Action
Socialize
Food Trivia

| Statistic | Estimate |
|---|---|
| Overall Accuracy | 75.4% |
| True Positive Rate | 70.5% |
| True Negative Rate | 79.2% |

Age
Employment
Education
Marital Status
Income
Adults

| Statistic | Estimate |
|---|---|
| Overall Accuracy | 75.6% |
| True Positive Rate | 74.0% |
| True Negative Rate | 76.8% |

# LOOKING FORWARD TO A REGRESSION MODEL

| Variable Ranking | Forest | Regression 6 | Regression 7 |
|---|---|---|---|
| Tech Ownership | | 3 | 1 |
| Tech Trivia | 2 | 1 | 5 |
| Growing Families | 3 | 2 | 4 |
| Political Action | 4 | | |
| Entertainment | 1 | 4 | 2 |
| Food Trivia | 6 | | 7 |
| Socialize | 5 | 5 | 3 |
| Political Trivia | | 6 | 6 |

| | |
|---|---|
| Cases Correctly Classified | 80% |
| $R^2$, Demographics | .41 |
| $R^2$, Full Model | .55 |
| $R^2$, Final Model | .54 |

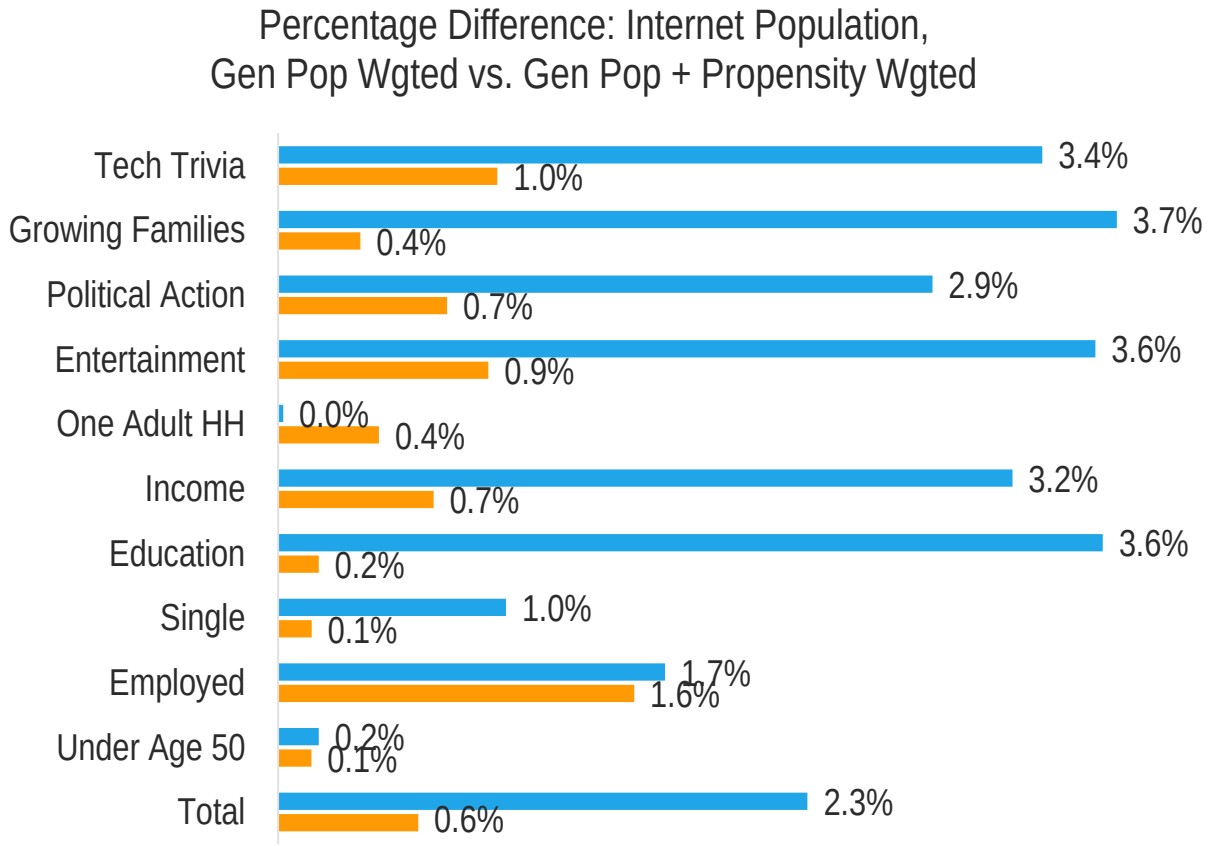
# METHOD TO ASSESS THE EFFECTIVENESS OF THE MODEL

- Random Forest model allows using a master dataset for modelling and testing.
- Development of testing weights:

1. Single full omnibus wave weighted using Burskirk and Best (2012) and raking by agexgender, ethnicityxforeignborn, education, phone status, genderxregion, marital status, and population density. Deff = 1.75. This establishes the non-internet estimate: 15.8%
2. Full data to the same procedures as #1, with the addition of internet/non-internet. This provides “gold standard” estimates of test measures.
3. Internet respondents only, weighted to the same procedure as #1. This provides impact of raking the internet-only population to full population parameters.
4. Internet respondents only, weighted as #1 with non-Internet propensity weight as part of the baseweight. This compares to #3 above in a test of bias reduction.

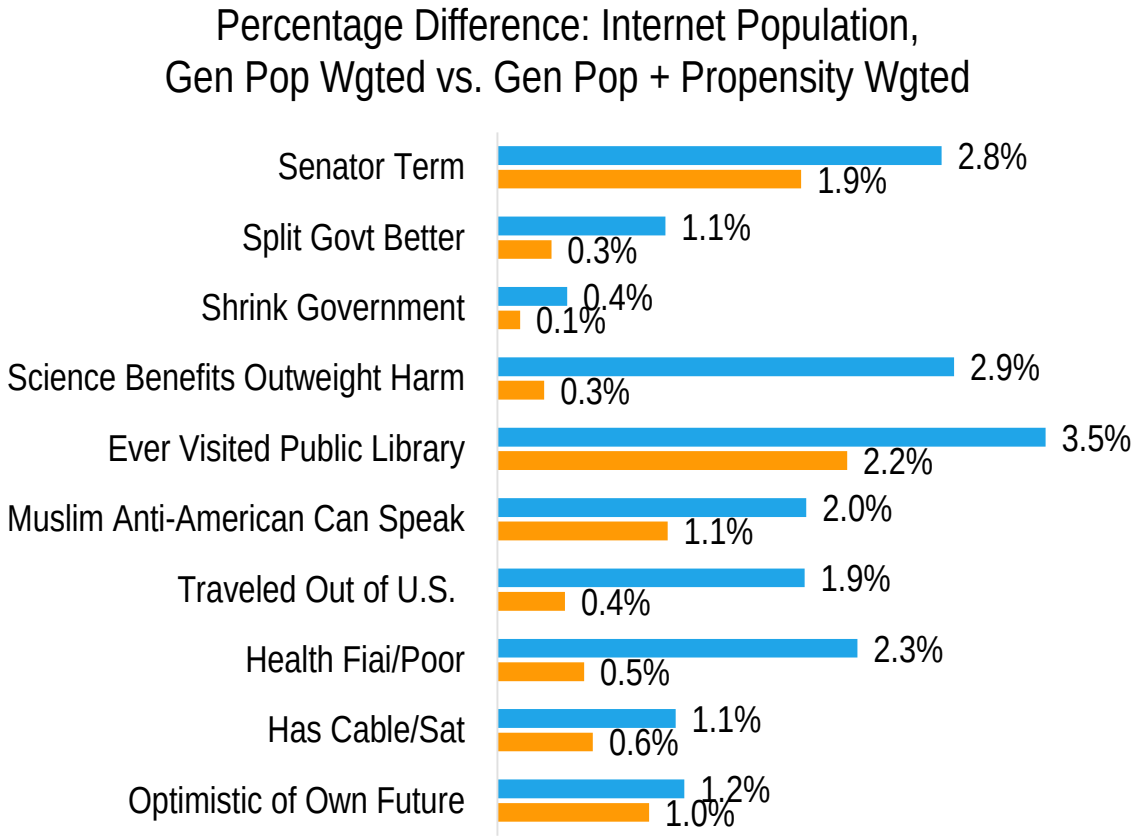
# ASSESSING THE EFFECTIVENESS OF THE MODEL

| Propensity Weight Variables | Full Pop | Int Pop | Int Pop w/ Propensity | Int Pop Diff | Int Pop Prop Diff | Int Pop % Diff | Int Pop % Diff |
|---|---|---|---|---|---|---|---|
| Tech Trivia | 64% | 68% | 63% | 5% | 1% | 3% | 1% |
| Growing Families | 79% | 82% | 79% | 5% | 0% | 4% | 0% |
| Political Action | 32% | 34% | 32% | 9% | 2% | 3% | 1% |
| Entertainment | 64% | 67% | 63% | 6% | 1% | 4% | 1% |
| One Adult HH | 20% | 20% | 21% | 0% | 2% | 0% | 0% |
| Income | 37% | 34% | 38% | 9% | 2% | 3% | 1% |
| Education | 35% | 31% | 34% | 10% | 1% | 4% | 0% |
| Single | 29% | 30% | 29% | 3% | 1% | 1% | 0% |
| Employed | 59% | 61% | 57% | 3% | 3% | 2% | 2% |
| Under Age 50 | 54% | 54% | 54% | 0% | 0% | 0% | 0% |
| Total | | | | 5.0% | 1.4% | 2.3% | 0.6% |



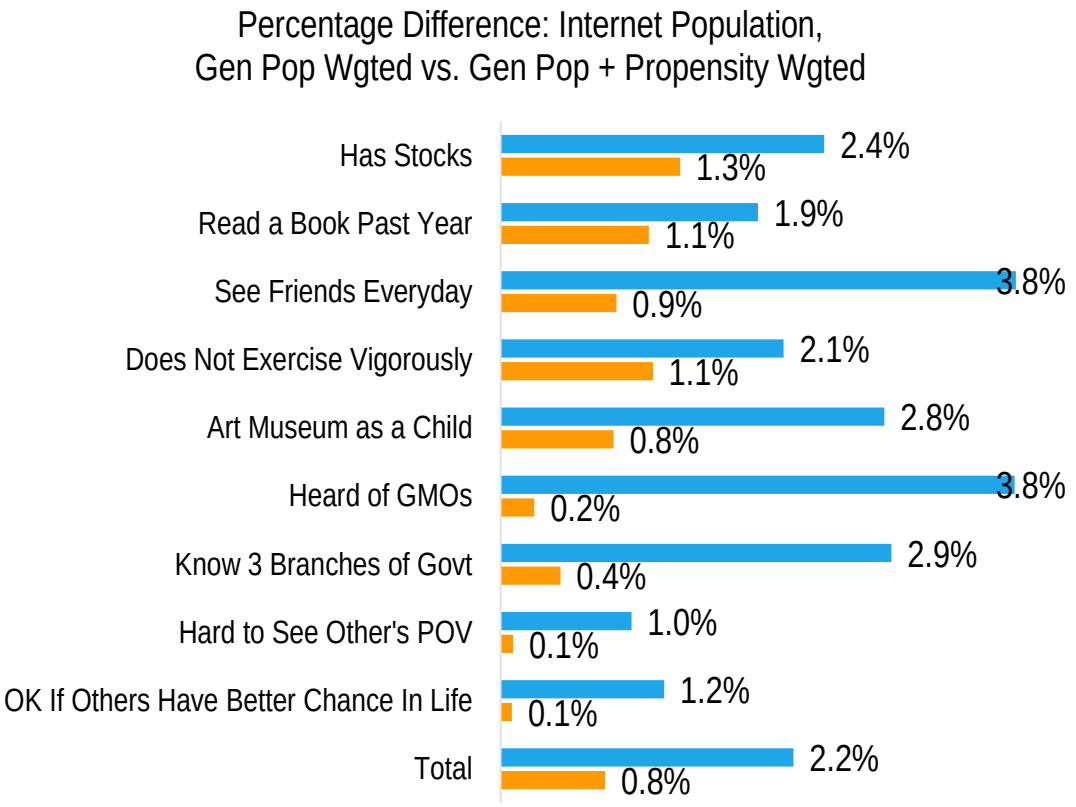
# ASSESSING THE EFFECTIVENESS OF THE MODEL

| Propensity Weight Variables | Full Pop | Int Pop | Int Pop w/ Propensity | Int Pop Diff | Int Pop Prop Diff | Int Pop % Diff | Int Pop % Diff |
|---|---|---|---|---|---|---|---|
| Senator Term | 47% | 50% | 49% | 6% | 4% | 3% | 2% |
| Split Govt Better | 45% | 46% | 46% | 2% | 1% | 1% | 0% |
| Shrink Government | 43% | 44% | 43% | 1% | 0% | 0% | 0% |
| Science Benefits > Harm | 55% | 58% | 55% | 5% | 1% | 3% | 0% |
| Ever Visited Public Library | 35% | 32% | 33% | 10% | 6% | 3% | 2% |
| Muslim Anti-American Can Speak | 57% | 59% | 58% | 3% | 2% | 2% | 1% |
| Traveled Out of U.S. | 63% | 61% | 62% | 3% | 1% | 2% | 0% |
| Health Fair/Poor | 22% | 20% | 22% | 10% | 2% | 2% | 1% |
| Has Cable/Sat | 67% | 68% | 67% | 2% | 1% | 1% | 1% |
| Optimistic of Own Future | 68% | 69% | 67% | 2% | 1% | 1% | 1% |
| Senator Term | 47% | 50% | 49% | 6% | 4% | 3% | 2% |



# ASSESSING THE EFFECTIVENESS OF THE MODEL

| Propensity Weight Variables | Full Pop | Int Pop | Int Pop w/ Propensity | Int Pop Diff | Int Pop Prop Diff | Int Pop % Diff | Int Pop % Diff |
|---|---|---|---|---|---|---|---|
| Has Stocks | 53% | 55% | 51% | 4.5% | 2.5% | 2.4% | 1.3% |
| Read a Book Past Year | 73% | 74% | 71% | 2.6% | 1.5% | 1.9% | 1.1% |
| See Friends Everyday | 79% | 82% | 79% | 4.8% | 1.1% | 3.8% | 0.9% |
| Does Not Exercise Vigorously | 19% | 17% | 18% | 10.9% | 5.9% | 2.1% | 1.1% |
| Art Museum as a Child | 73% | 76% | 74% | 3.8% | 1.1% | 2.8% | 0.8% |
| Heard of GMOs | 65% | 69% | 65% | 5.8% | 0.4% | 3.8% | 0.2% |
| Know 3 Branches of Govt | 74% | 77% | 74% | 3.9% | 0.6% | 2.9% | 0.4% |
| Hard to See Other's POV | 38% | 37% | 38% | 2.5% | 0.2% | 1.0% | 0.1% |
| OK If Others Have Better Chance In Life | 31% | 30% | 31% | 3.9% | 0.3% | 1.2% | 0.1% |
| Total | | | | 4.6% | 1.7% | 2.2% | 0.8% |
| Has Stocks | 53% | 55% | 51% | 4.5% | 2.5% | 2.4% | 1.3% |



# CONCLUSIONS


# CONCLUSIONS

- Age and economic status go a long way in explaining who does not have the Internet. But the story is much richer than that…
- Non-Internet households are at some level, ISOLATED households, be it socially, media-connectedness, etc. They are isolated behaviorally, attitudinally, and in worldly knowledge.
- Many, many variables strong relationships to non-Internet use. Making a model both fully specified and parsimonious means choosing among a range of variables that all serve well in discriminating by Internet use.
- "Signal strength" for predicting non-internet households is not limited to one content category specifically; meaningful variables from across a wide array of content areas were identified.

# CONCLUSIONS

- Variables tested on average had point estimates where the non-internet population was 74% off (benchmark / test estimate) from the estimates of the internet population.
- Just taking the internet population, weighted to the full population, bias is reduced to 21%
- Standard raking the internet population to full population targets reduces this bias to 5%.
- Adding the propensity weight reduces this to 1.4%
- The propensity weight does not add significant bias at a 1.17 propensity design effect.

# CONTACT US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