

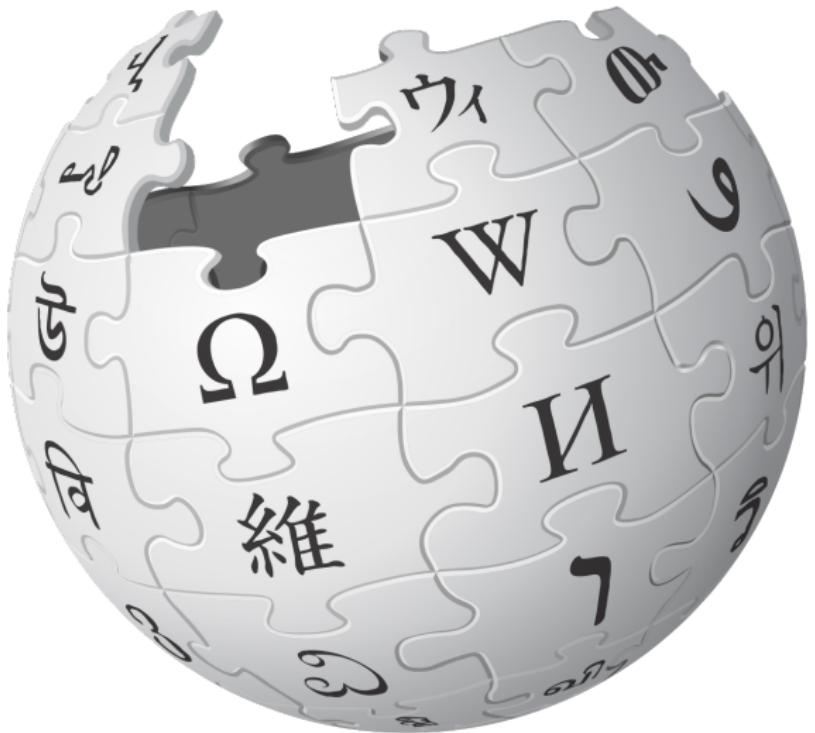
Getting Started Workshop: The Fragile Families Challenge, round 2

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and people from around the world

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Initial sequencing and analysis of the human genome

International Human Genome Sequencing Consortium*

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Combined Measurement of the Higgs Boson Mass in pp Collisions at $\sqrt{s} = 7$ and 8 TeV with the ATLAS and CMS Experiments

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Fragile Families Challenge

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A scientific mass collaboration combining

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- ▶ predictive modeling,

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to improve the lives of disadvantaged children in the US.

FFragile Families

& Child Wellbeing Study
PRINCETON | COLUMBIA



- ▶ Birth cohort panel study
- ▶ ≈ 5,000 children born in 20 U.S. cities
- ▶ Followed from birth through age 15

Key research question: What can be done to improve the life chances of disadvantaged children?

Hundreds of papers and dozens of dissertations

<http://crcw.princeton.edu/publications/publications.asp>

Social Scientists ←→ Data Scientists

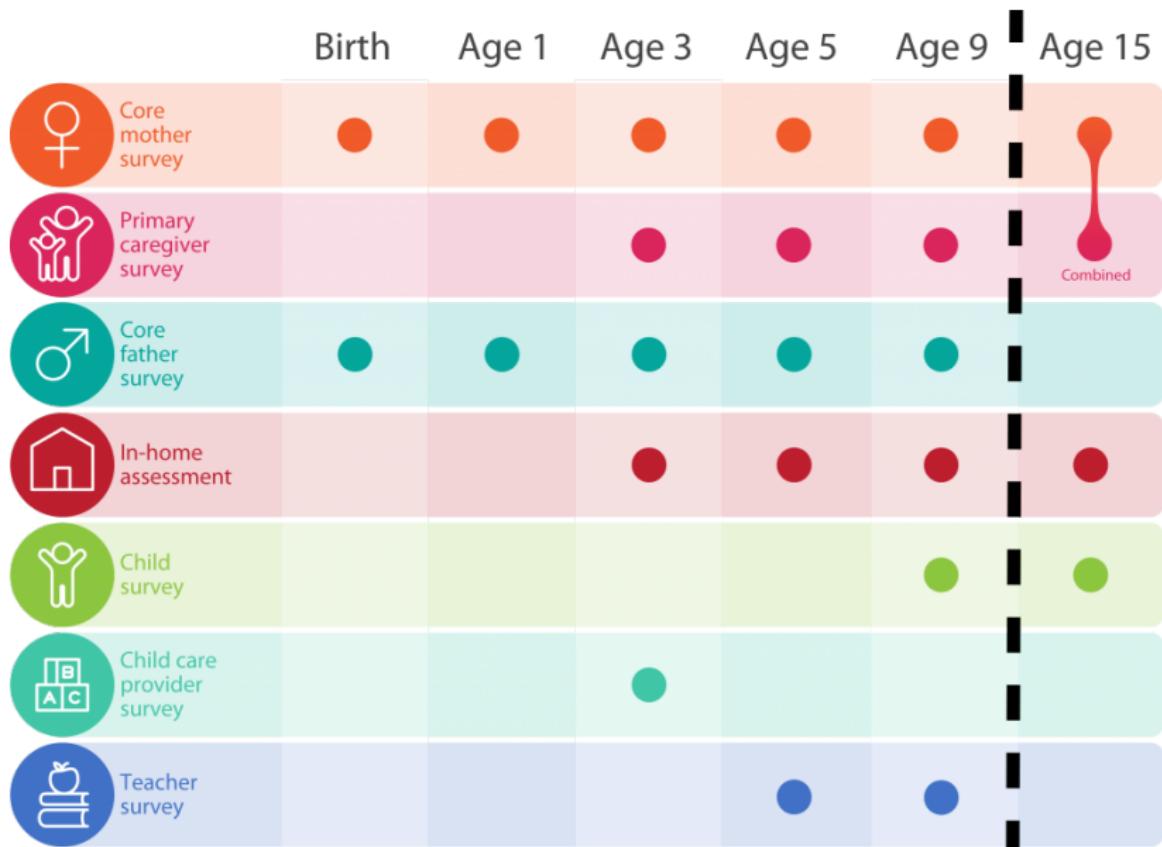
Social Scientists \longleftrightarrow Data Scientists

$$\hat{\beta} \quad \& \quad \hat{y}$$

Mullainathan and Spiess (2017):

<http://dx.doi.org/10.1257/jep.31.2.87>

	Birth	Age 1	Age 3	Age 5	Age 9
 Core mother survey	●	●	●	●	●
 Primary caregiver survey			●	●	●
 Core father survey	●	●	●	●	●
 In-home assessment			●	●	●
 Child survey					●
 Child care provider survey			●		
 Teacher survey				●	●



5,000 families

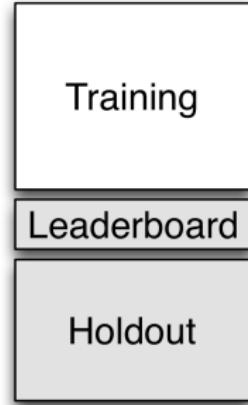
Birth to age 9
12,000 features

Age 15
1,500 features

4,242 families

12,942 features
birth to age 9

6 outcomes
age 15



Continuous outcomes:

- ▶ GPA
- ▶ Grit
- ▶ Material hardship

Binary outcomes:

- ▶ Housing eviction
- ▶ Layoff of a caregiver
- ▶ Job training for a caregiver

Fragile Families Challenge:

1. common task method

Fragile Families Challenge:

1. common task method
2. use submissions to do cool stuff

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Why should we care about the predictability of social outcomes?

- ▶ Scientific reasons

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- ▶ Scientific reasons
- ▶ Policy reasons



We need to understand the strengths *and* weakness of predictive models of social behavior

- ▶ A team of people¹ has spent months making the data easier to use.

¹Alexander Kindel, Vineet Bansal, Kristin Catena, Thomas Hartshorne, Kate Jaeger, Dawn Koffman, Sara McLanahan, Maya Phillips, Shiva Rouhani, Ryan Vinh, Matthew Salganik.

- ▶ A team of people¹ has spent months making the data easier to use.
- ▶ Is it possible to do better than last time? Or, is there a fundamental limit with this data and this task?

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- ▶ Let's see if it improves performance,

¹Alexander Kindel, Vineet Bansal, Kristin Catena, Thomas Hartshorne, Kate Jaeger, Dawn Koffman, Sara McLanahan, Maya Phillips, Shiva Rouhani, Ryan Vinh, Matthew Salganik.

- ▶ A team of people¹ has spent months making the data easier to use.
- ▶ Is it possible to do better than last time? Or, is there a fundamental limit with this data and this task?
- ▶ Let's see if it improves performance, and let's see if you can help make this easier for future researchers.

¹Alexander Kindel, Vineet Bansal, Kristin Catena, Thomas Hartshorne, Kate Jaeger, Dawn Koffman, Sara McLanahan, Maya Phillips, Shiva Rouhani, Ryan Vinh, Matthew Salganik.

How to participate

<https://codalab.fragilefamilieschallenge.org/competitions/23>

Introducing the outcome variables

GPA²

²Learn more at <http://www.fragilefamilieschallenge.org/gpa/>

GPA²

How do kids beat the odds academically?

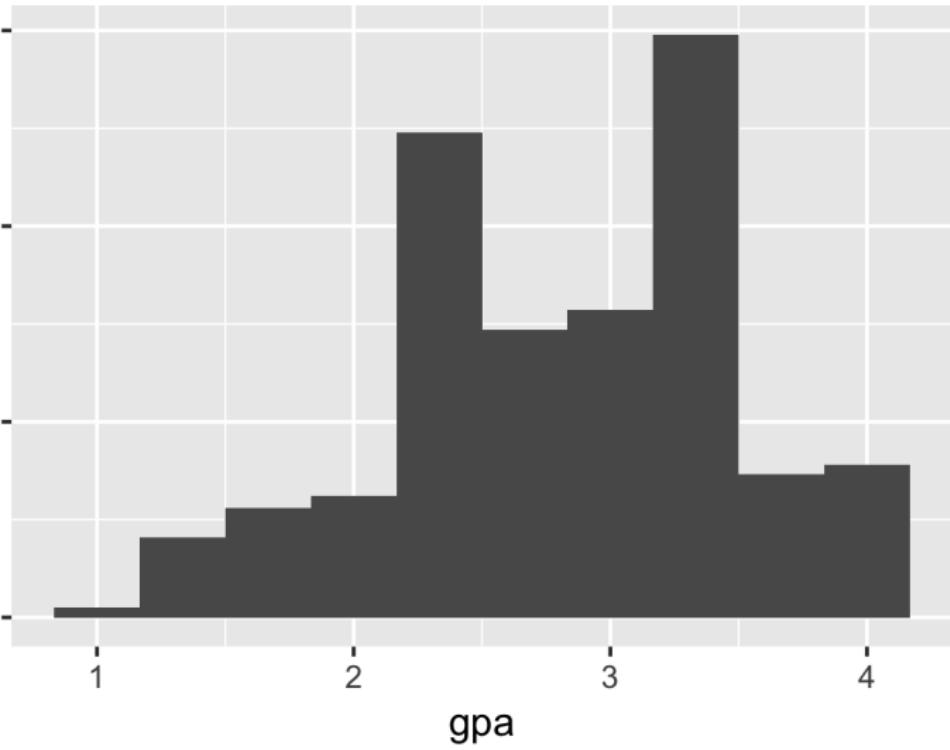
²Learn more at <http://www.fragilefamilieschallenge.org/gpa/>

GPA³

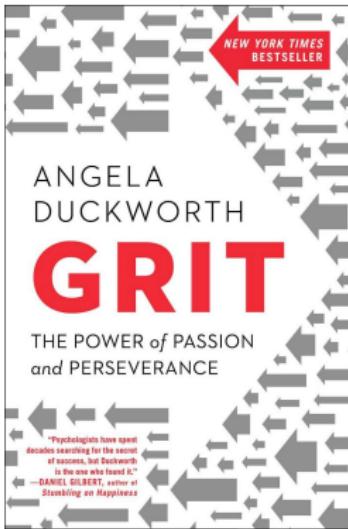
B20. At the {most recent grading period/last grading period in the spring} what was your grade in ...

	A	B	C	D OR LOWE R	NO GRADE OR PASS/FAIL	REF	DK	N/A HOMESCHOoled
B20A English or language arts? ..	1	2	3	4	5	-1	-2	7 → GO TO B22A
B20B Math?	1	2	3	4	5	-1	-2	7 → GO TO B22A
B20C History or social studies? ..	1	2	3	4	5	-1	-2	7 → GO TO B22A
B20D Science?	1	2	3	4	5	-1	-2	7 → GO TO B22A

³This variable is reverse-coded in the data file so that higher values represent higher GPAs.

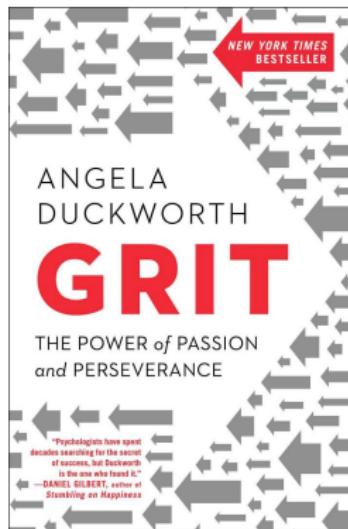


“Grit” predicts success, possibly more than IQ.⁴



⁴Learn more at <http://www.fragilefamilieschallenge.org/grit/>

“Grit” predicts success, possibly more than IQ.⁴



What makes some kids gritty?

⁴Learn more at <http://www.fragilefamilieschallenge.org/grit/>

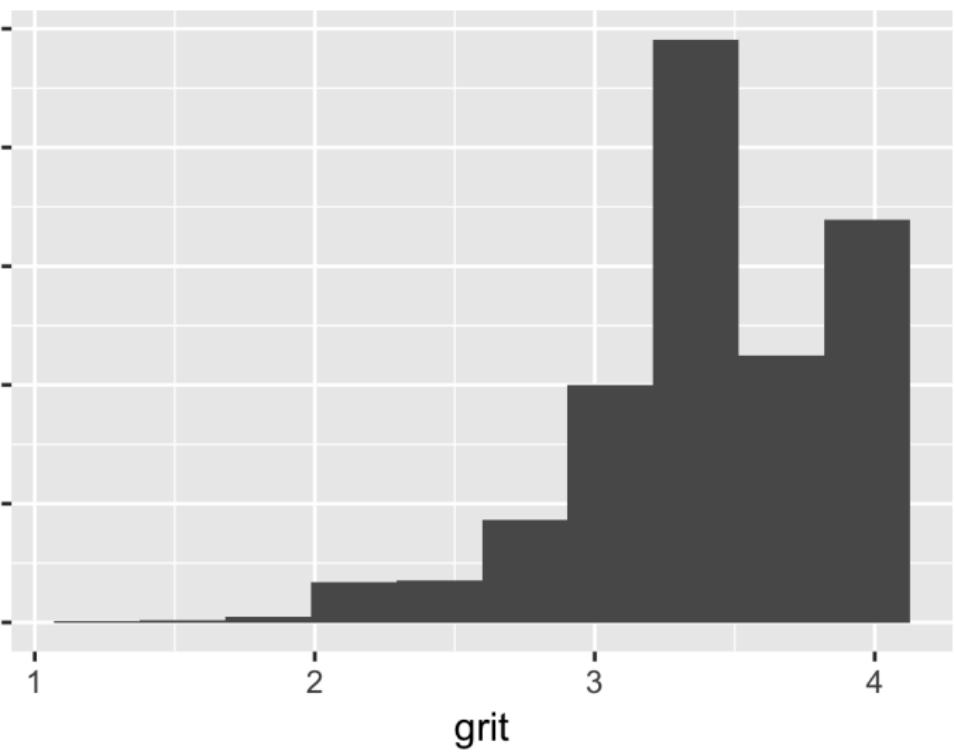
Grit⁵

- D2. Thinking about how you have behaved or felt during the past four weeks, please tell me whether you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with the following statements.

PROBE: Thinking about the past four weeks, do you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with this statement?

	STRONGLY AGREE	SOMEWHAT AGREE	SOMEWHAT DISAGREE	STRONGLY DISAGREE	REF	DK
D2I. I keep at my schoolwork until I am done with it.....	1	2	3	4	-1	-2
D2K. Once I make a plan to get something done, I stick to it.....	1	2	3	4	-1	-2
D2M. I finish whatever I begin.....	1	2	3	4	-1	-2
D2V. I am a hard worker	1	2	3	4	-1	-2

⁵This variable is reverse-coded in the data file so that higher values represent more grit.



Material hardship⁶

⁶Learn more at

<http://www.fragilefamilieschallenge.org/material-hardship/>

Material hardship⁶

What unmeasured predictors are associated with families unexpectedly escaping severe deprivation?

⁶Learn more at

<http://www.fragilefamilieschallenge.org/material-hardship/>

Material hardship⁶

What unmeasured predictors are associated with families unexpectedly escaping severe deprivation?

What sends families unexpectedly into deep poverty?

⁶Learn more at

<http://www.fragilefamilieschallenge.org/material-hardship/>

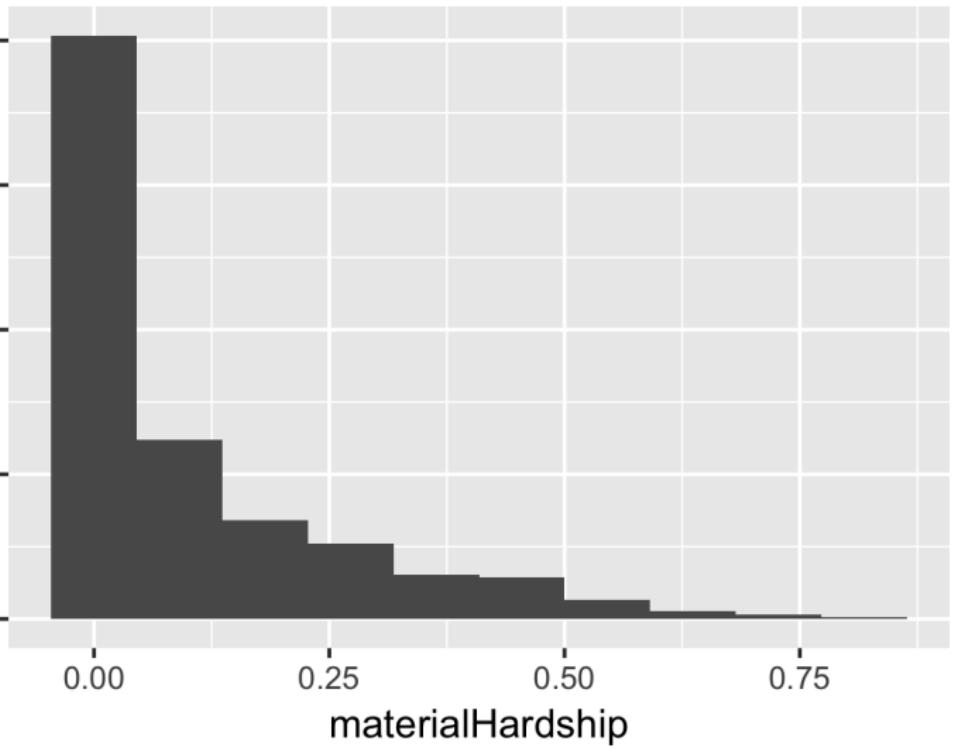
Material hardship

We are also interested in some of the problems that families face making ends meet. In the past twelve months, did you do any of the following because there wasn't enough money?

		YES	NO	REF	DK
J37.	In the past twelve months, did you receive free food or meals?	1	2	-1	-2
J38.	In the past twelve months, were you ever hungry, but didn't eat because you couldn't afford enough food?	1	2	-1	-2
J39.	In the past twelve months, did you ever not pay the full amount of rent or mortgage payments?	1	2	-1	-2
J40.	In the past twelve months, were you evicted from your home or apartment for not paying the rent or mortgage?	1	2	-1	-2
J41.	In the past twelve months, did you not pay the full amount of gas, oil, or electricity bill?	1	2	-1	-2
J42.	In the past twelve months, was your gas or electric services ever turned off, or the heating oil company did not deliver oil, because there wasn't enough money to pay the bills?	1	2	-1	-2
J43.	In the past twelve months, did you borrow money from friends or family to help pay bills?	1	2	-1	-2
J44.	In the past twelve months, did you move in with other people even for a little while because of financial problems?	1	2	-1	-2

Material hardship

J45.	In the past twelve months, did you stay at a shelter, in an abandoned building, an automobile or any other place not meant for regular housing, even for one night?	1	2	-1	-2
J46.	In the past twelve months, was there anyone in your household who needed to see a doctor or go to the hospital but couldn't go because of the cost?	1	2	-1	-2
J47.	In the past twelve months, was your telephone service (mobile or land line) cancelled or disconnected by the telephone company because there wasn't enough money to pay the bill?	1	2	-1	-2



Eviction⁷

⁷Learn more at <http://www.fragilefamilieschallenge.org/eviction/>

⁸Note: You will just create propensity scores for eviction given background variables; causal inference comes in the second stage of the Challenge when outcomes are measured several years from now.

Eviction⁷

Does housing eviction **cause** worse outcomes as kids transition to adulthood?⁸

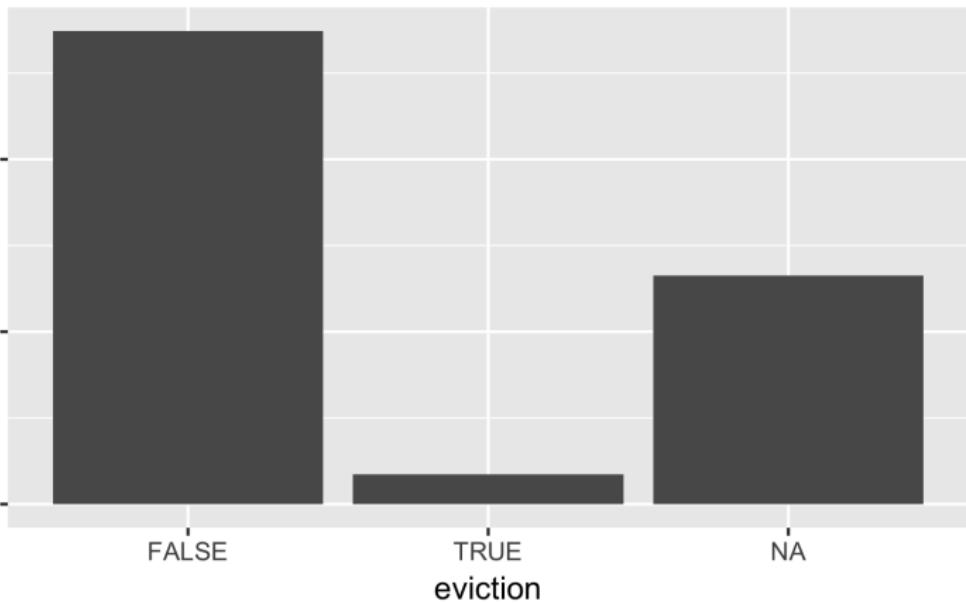
⁷Learn more at <http://www.fragilefamilieschallenge.org/eviction/>

⁸Note: You will just create propensity scores for eviction given background variables; causal inference comes in the second stage of the Challenge when outcomes are measured several years from now.

Eviction

J51. Since {MONTH AND YEAR COHORT CITY FIELDDED IN YR 9}, were you evicted from your home or apartment for not paying the rent or mortgage?

YES	1
NO	2
REFUSED	-1
DON'T KNOW	-2



Caregiver layoff⁹

⁹Learn more at <http://www.fragilefamilieschallenge.org/layoff/>

¹⁰Note: You will just create propensity scores for caregiver layoff given background variables; causal inference comes in the second stage of the Challenge when outcomes are measured several years from now.

Caregiver layoff⁹

Does layoff of a caregiver **cause** collateral damage for kids?¹⁰

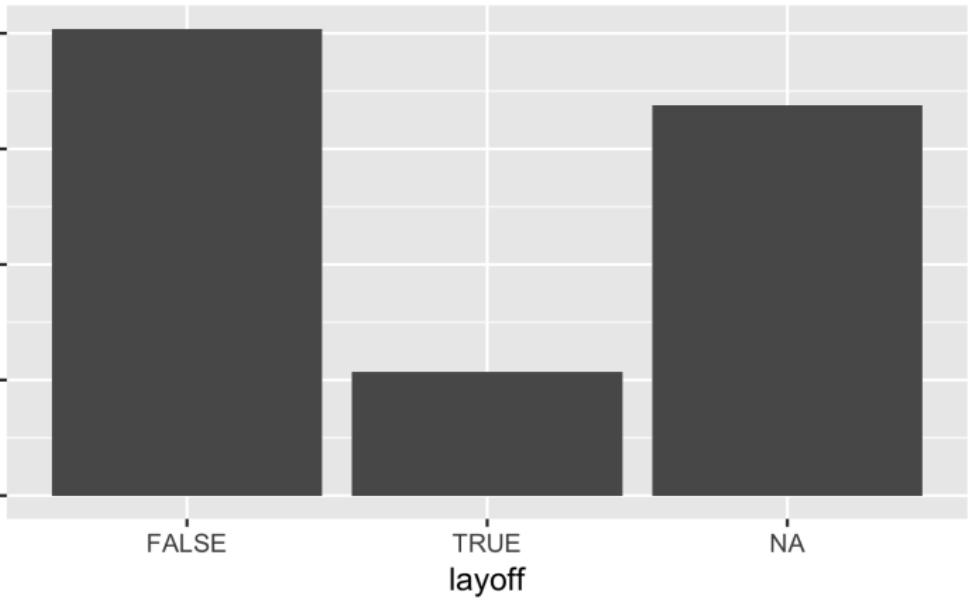
⁹Learn more at <http://www.fragilefamilieschallenge.org/layoff/>

¹⁰Note: You will just create propensity scores for caregiver layoff given background variables; causal inference comes in the second stage of the Challenge when outcomes are measured several years from now.

Caregiver layoff

K13. Since {MONTH AND YEAR COHORT CITY FIELDDED IN YR 9}, have you been laid off from your employer for any time?

- | | |
|------------------|----|
| YES | 1 |
| NO..... | 2 |
| REFUSED..... | -1 |
| DON'T KNOW | -2 |



Job training¹¹

¹¹Learn more at

<http://www.fragilefamilieschallenge.org/job-training/>

¹²Note: You will just create propensity scores for job training given background variables; causal inference comes in the second stage of the Challenge when outcomes are measured several years from now.

Job training¹¹

Does job training for a caregiver **cause** collateral benefits for children?¹²

¹¹Learn more at

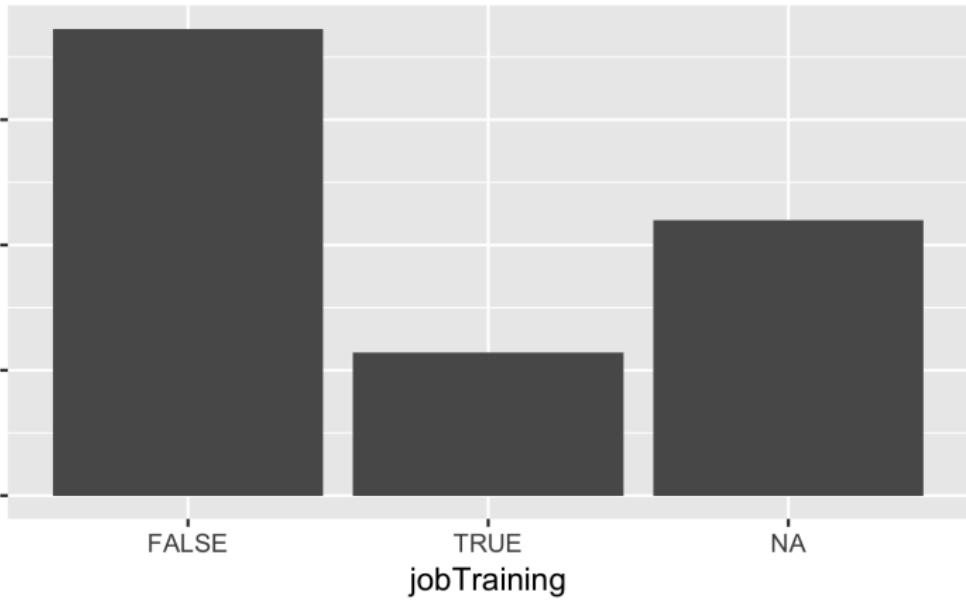
<http://www.fragilefamilieschallenge.org/job-training/>

¹²Note: You will just create propensity scores for job training given background variables; causal inference comes in the second stage of the Challenge when outcomes are measured several years from now.

Caregiver job training

K4. Since {MONTH AND YEAR COHORT CITY FIELDDED IN YR 9}, have you taken any classes to improve your job skills, such as computer training or literacy classes?

- | | |
|-----------------|-----|
| YES | .1 |
| NO..... | .2 |
| REFUSED..... | -.1 |
| DON'T KNOW..... | -.2 |



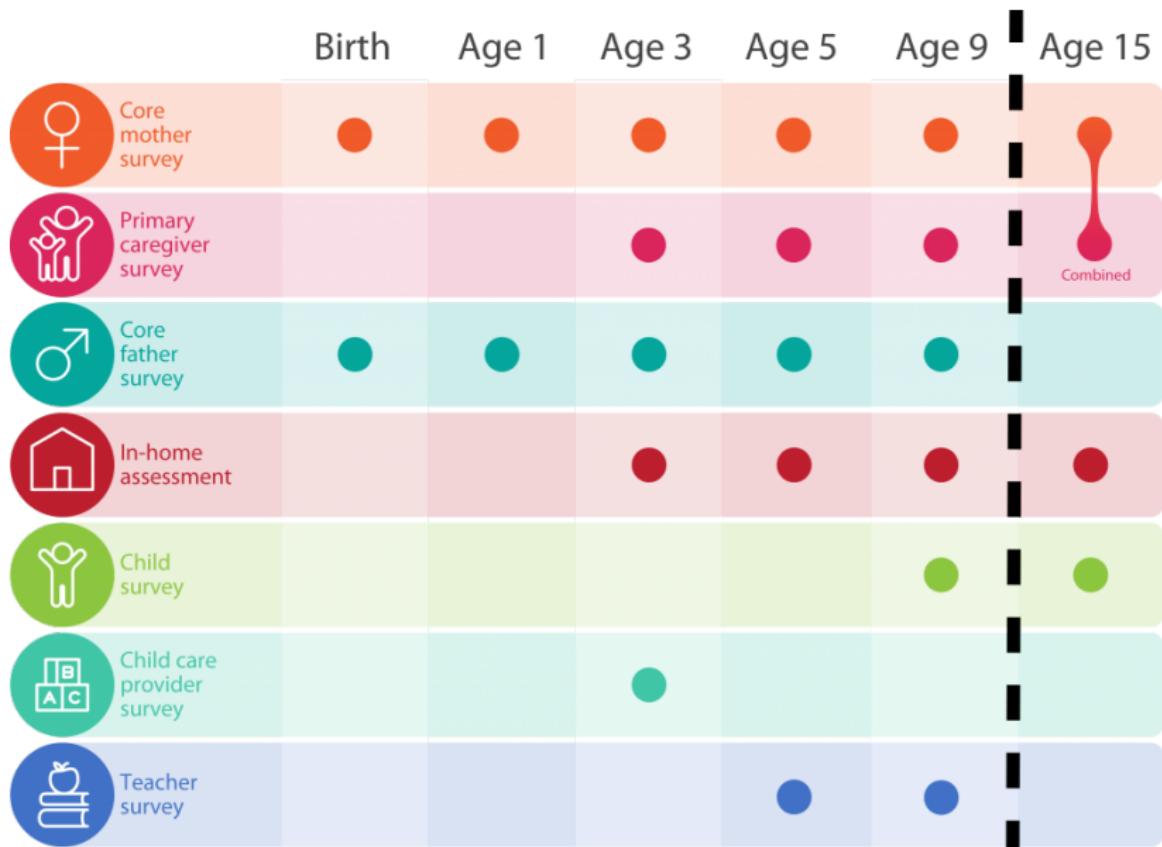
Introducing the data

The Fragile Families and Child Wellbeing Study is a dataset of real people who have selflessly opened up their lives to us for the last 15 years so that their experiences can contribute to scientific research. By participating in the Fragile Families Challenge, you become a collaborator in this project. It is of the utmost importance that you respect the families in the data by using what they have told us responsibly.

- ▶ Before you have access to the data, you will sign a data use agreement

- ▶ Before you have access to the data, you will sign a data use agreement
- ▶ After this activity you will delete the data from your computer

- ▶ Before you have access to the data, you will sign a data use agreement
- ▶ After this activity you will delete the data from your computer
- ▶ If you want to keep working with the data afterwards, you can apply for access through the Fragile Families website



RStudio Source Editor

fsf x Filter

	fsf1	fsf1a	fsf2	fsf3	fsf3a	fsf3b	fsf3b1	fsf4	fsf4a	fsf4b	fsf5	fsf6	fsf7a	fsf7b	fsf7c	fsf8a1	fsf8b1	fsf8c1	fsf8a2	fsf8b2	fsf8c2	fsf8a3
1	-9	-9	-9	-9.00	-9.00	-9.000000	-3	-9.00000	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	
2	-9	-9	-9	-9.00	-9.00	-9.000000	-3	-9.00000	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	
3	-9	-9	-9	-9.00	-9.00	-9.000000	-3	-9.00000	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	
4	-6	-6	-6	-6.00	-6.00	-6.000000	-3	-6.00000	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	
5	-6	-6	-6	-6.00	-6.00	-6.000000	-3	-6.00000	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	
6	2	-6	-6	-6.00	-6.00	-6.000000	-3	-6.00000	-6	-6	-6	-6	2	2	2	2	-6	-6	1	12	600	
7	-6	-6	-6	-6.00	-6.00	-6.000000	-3	-6.00000	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	
8	1	3	2	-6.00	-6.00	-6.000000	-3	196.26903	1	2	2	2	2	2	2	-6	-6	2	-6	-6	-6	
9	-6	-6	-6	-6.00	-6.00	-6.000000	-3	-6.00000	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	
10	1	1	1	-6.00	-6.00	-6.000000	-3	1310.50458	-10	2	2	2	2	2	2	-6	-6	2	-6	-6	-6	
11	1	5	4	149734....	11087.07	1.271596	-3	-6.00000	-6	-6	-6	-6	1	2	2	-6	-6	2	-6	-6	-6	
12	-9	-9	-9	-9.00	-9.00	-9.000000	-3	-9.00000	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	
13	1	2	1	-6.00	-6.00	-6.000000	-3	1024.43600	3	2	2	2	2	2	2	-6	-6	2	-6	-6	-6	
14	-6	-6	-6	-6.00	-6.00	-6.000000	-3	-6.00000	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	
15	1	5	3	-6.00	-6.00	-6.000000	-3	-6.00000	-6	-6	2	-6	2	2	2	-6	-6	2	-6	-6	-6	
16	2	-6	-6	-6.00	-6.00	-6.000000	-3	-6.00000	-6	-6	-6	-6	2	2	2	-6	-6	2	-6	-6	-6	
17	-6	-6	-6	-6.00	-6.00	-6.000000	-3	-6.00000	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	
18	1	3	1	-6.00	-6.00	-6.000000	-3	877.82490	1	2	2	2	1	1	2	1	3	176	2	-6	-6	
19	-9	-9	-9	-9.00	-9.00	-9.000000	-3	-9.00000	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	
20	-6	-6	-6	-6.00	-6.00	-6.000000	-3	-6.00000	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	
21	-9	-9	-9	-9.00	-9.00	-9.000000	-3	-9.00000	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	
22	1	1	1	-6.00	-6.00	-6.000000	-3	720.26305	1	2	2	2	1	2	2	-6	-6	2	-6	-6	-6	

Showing 1 to 24 of 4,242 entries



How do I know what these variables are?

The screenshot shows a web browser window with the title bar "FFCWS Metadata | Variables". The address bar contains the URL "browse.fragilefamiliesmetadata.org/variables". The main content area features the "Fragile Families & Child Wellbeing Study" logo with "PRINCETON | COLUMBIA" below it. To the right of the logo is a grid of nine small photographs depicting various family and child scenarios. Below the logo is a navigation bar with links: "FFCWS Metadata", "Browse variables", "Download metadata", "Feedback", and "About FFCWS". The main section is titled "Search variables" and includes a search bar with "Search for..." and a "Search »" button, followed by a "Filter" section with dropdown menus for "Topic", "Wave", and "Respondent".

http:

//metadata.fragilefamilies.princeton.edu/variables

Introducing cm1relf

metadata.fragilefamilies.princeton.edu/variables/cm1relf

You can filter variables by:

- ▶ Topic
- ▶ Wave
- ▶ Respondent
- ▶ Variable Type (e.g., continuous, ordered categorical, unordered categorical, etc).

Why cm1relf?

Why cm1relf?

Response type	Respondent	Wave	Leaf
(blank): questionnaire c: constructed	m - mother f - father p - primary caregiver k - child t - teacher h - home o - observations n - non parental caregiver d - child care center r - family care center u - post center observations q - couple	1 - baseline 2 - year 1 3 - year 3 4 - year 5 5 - year 9 6 - year 15	(letter): survey section + (number): question number OR (string): Constructed variable ID OR (string): national or city weight

Want direct access to the metadata?

Want direct access to the metadata? No problem

- ▶ API: `api.metadata.fragilefamilies.princeton.edu`
- ▶ Python package:
`github.com/fragilefamilieschallenge/ffmetadata-py`
- ▶ R package:
`github.com/fragilefamilieschallenge/ffmetadata`
- ▶ Raw metadata:
`api.fragilefamiliesmetadata.org/get_metadata`

FF Fragile Families & Child Wellbeing Study PRINCETON | COLUMBIA



Search... 

Home

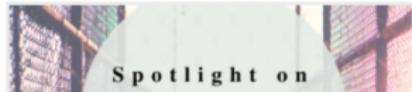
About

People

Publications

Data and Documentation

Contact



Spotlight on

Spotlight on FFCWS and Incarceration
Research

Recent publications using the Fragile Families & Child
Wellbeing Study provide a broader understanding of the effects

General Documentation

Baseline

Year 1

[Links to](#)

Year 3

[documentation
for each wave](#)

Year 5

Year 9

Year 15

FAQ

Data and Documentation

Data

Data are free to download from Princeton University's [Office of Population Research \(OPR\) data archive](#).

Currently, there are five waves of publicly available data including baseline and Year 1, Year 3, Year 5, and Year 9 follow-ups. In order to protect the confidentiality of survey respondents, geographic identifiers, medical records data, contextual data (i.e., census tract characteristics), macroeconomic indicators, and genetic biomarkers are not available in the public use data files. Researchers may apply for these data via a [restricted use contract](#).

Documentation

General Documentation

Baseline

Year 1

Year 3

Year 5

Year 9

Year 15

FAQ

Data Alerts

Contract Data

Year 9

The Year 9 follow-up wave of data collection took place from 2007 to 2010, which makes the data useful for researchers interested in the effects of the Great Recession on children and families. It is different from previous waves because the home visit was integral to the wave procedures. In previous waves, we conducted core interviews before proceeding to the in-home components. At year 9, our initial interview was with the child's primary caregiver (usually the mother) and we scheduled a home visit at the time of that initial interview. As part of the home visit, we interviewed focal children for the first time. We attempted teacher surveys through the mail. Similar to previous waves, we have core interviews with mothers and fathers. Restricted Data at this wave include [census tract characteristics](#) of mother and father residences, [macroeconomic indicators](#), administrative data on children's [school characteristics](#), and [genetic](#) data from saliva samples from the mother and focal child.

PRIMARY CAREGIVER

[Primary Caregiver Survey](#)

[Primary Caregiver Self-Administered](#)

SCALES

[Scales documentation](#)

MOTHER

[Questionnaire](#)

[Codebook](#)

**Each survey has
a questionnaire
and
a codebook**

FATHER

[Questionnaire](#)

[Codebook](#)

CHILD

[Child Survey](#)

[Home Visit Workbook](#)

[Interviewer Observations](#)

[Codebook](#)

TEACHER

[Questionnaire](#)

[Codebook](#)

Questionnaire:

BOX A3A2

IF PCG=BIOFATHER IN THE PCG IDENTIFIER IN THE SCREENER,
GO TO A3C.

ELSE IF PCG= NON-PARENT AND RELATIONSHIP = MATERNAL
GRANDPARENT(S), PATERNAL GRANDPARENT(S), OTHER
RELATIVES OR FRIEND IN THE PCG IDENTIFIER IN THE
SCREENER, GO TO A3B1A.

ELSE IF PCG=NON-PARENT AND RELATIONSHIP=FOSTER CARE
IN THE PCG IDENTIFIER IN THE SCREENER, GO TO A3B.

ELSE IF PCG=NON-PARENT AND RELATIONSHIP = OTHER,
SPECIFY IN THE PCG IDENTIFIER IN THE SCREENER, GO TO
A3B1A.

ELSE IF PCG= "NOT MOTHER" IN THE PCG IDENTIFIER GO TO
A3D.

A3B. Are {CHILD}'s foster parents related to you?

YES	1
NO	2
REFUSED.....	-1
DON'T KNOW.....	-2



Building a submission

Submissions include:

1. Predictions
2. Code
3. Narrative explanation

Submission preparation instructions:

www.fragilefamilieschallenge.org/upload-your-contribution/

Get on the leaderboard

← → ⌂ codalab.fragilefamilieschallenge.org/#results

 Fragile Families CHALLENGE

Help Sign Up Sign In



Results							
#	User	GPA ▲	Grit ▲	Material hardship ▲	Eviction ▲	Layoff ▲	Job training ▲
1	wjlei1990	0.36854 (1)	0.21896 (3)	0.02436 (1)	0.05341 (7)	0.17435 (5)	0.20224 (3)
2	OldDriver.ffc	0.37099 (2)	0.22979 (18)	0.02471 (2)	0.05341 (7)	0.17435 (5)	0.20224 (3)
3	yjpeng	0.37120 (3)	0.21759 (2)	0.02493 (3)	0.05223 (2)	0.17048 (1)	0.20169 (2)
4	hamidrezaomidvar	0.37136 (4)	0.22191 (13)	0.02523 (5)	0.05227 (3)	0.18784 (7)	0.21409 (7)
5	t.f.schaffner	0.37143 (5)	0.21755 (1)	0.02499 (4)	0.05660 (8)	0.22453 (9)	0.27736 (9)
6	andrewor	0.37143 (5)	0.21755 (1)	0.02499 (4)	0.06038 (10)	0.26792 (13)	0.30755 (13)
7	pc12	0.37583 (6)	6.18762 (29)	0.03536 (24)	0.94340 (18)	0.77547 (19)	0.72264 (18)
8	mannyg	0.37789 (7)	0.21997 (7)	0.02880 (17)	0.05341 (7)	0.17435 (5)	0.20224 (3)
9	ppz	0.37810 (8)	0.23896 (19)	0.02859 (14)	0.12830 (16)	0.30755 (15)	0.36981 (16)
10	lazs	0.38407 (9)	0.22054 (9)	0.02877 (16)	0.05660 (8)	0.22453 (9)	0.27736 (9)
11	mloyola	0.38644 (10)	0.21969 (4)	0.02880 (17)	0.05341 (7)	0.17435 (5)	0.20224 (3)
12	agalle	0.38846 (11)	0.22137 (11)	0.02740 (8)	0.05341 (7)	0.17435 (5)	0.20224 (3)
13	weggert	0.38868 (12)	0.24682 (21)	0.02546 (6)	0.05660 (8)	0.24528 (12)	0.29245 (11)
14	ieremvfreese	0.39077 (13)	0.22060 (10)	0.02803 (12)	0.05295 (5)	0.17379 (4)	0.20132 (1)

Powered by Codalab v0.1.1

Advice

Most good approaches will likely involve

Most good approaches will likely involve

- ▶ careful data preparation

Most good approaches will likely involve

- ▶ careful data preparation
- ▶ flexible models that avoid overfitting

Common missing codes¹³

Not all missing data is the same

- ▶ -9 Not in wave - Did not participate in survey/data collection component
- ▶ -6 Valid skip - Intentionally not asked question; question does not apply to respondent or response known based on prior information.
- ▶ -2 Don't know - Respondent asked question; responded "Don't Know".
- ▶ -1 Refuse - Respondent asked question; refused to answer question
- ▶ NA also used occasionally

¹³For more complete list and explanation, see
<http://www.fragilefamilieschallenge.org/missing-data/>

How can you optimally combine human and machine effort?

How can you optimally combine human and machine effort?

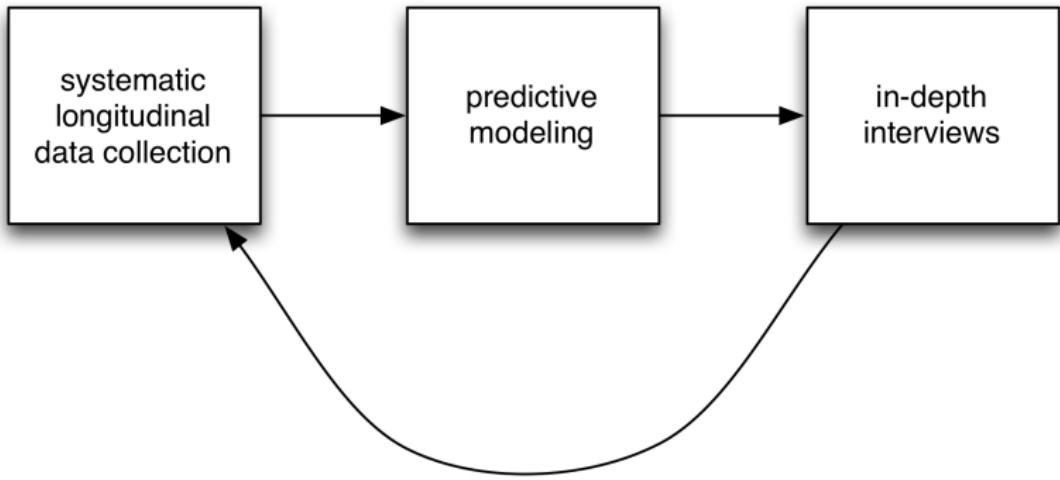
- ▶ automatic feature selection
- ▶ human-assisted automatic feature selection
- ▶ computer-assisted human feature selection
- ▶ human feature selection
- ▶ some other hybrid

Fragile Families Challenge:

1. common task method

Fragile Families Challenge:

1. common task method
2. use submissions to do cool stuff



Next steps:

- ▶ One big paper with hundreds of authors

Next steps:

- ▶ One big paper with hundreds of authors
- ▶ Special issue of *Socius*

Next steps:

- ▶ One big paper with hundreds of authors
- ▶ Special issue of *Socius*
- ▶ Our papers:

Next steps:

- ▶ One big paper with hundreds of authors
- ▶ Special issue of *Socius*
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- ▶ We are currently conducting in-depth interviews in three cities

Questions