Security Lancaster | Lancaster University

ARTIFACT EVALUATED
usenix ASSOCIATION
PASSED

From Needs to Actions to Secure Apps?
The Effect of Requirements and Developer Practices on App Security

USENIX Security - August 2020

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Paderborn University

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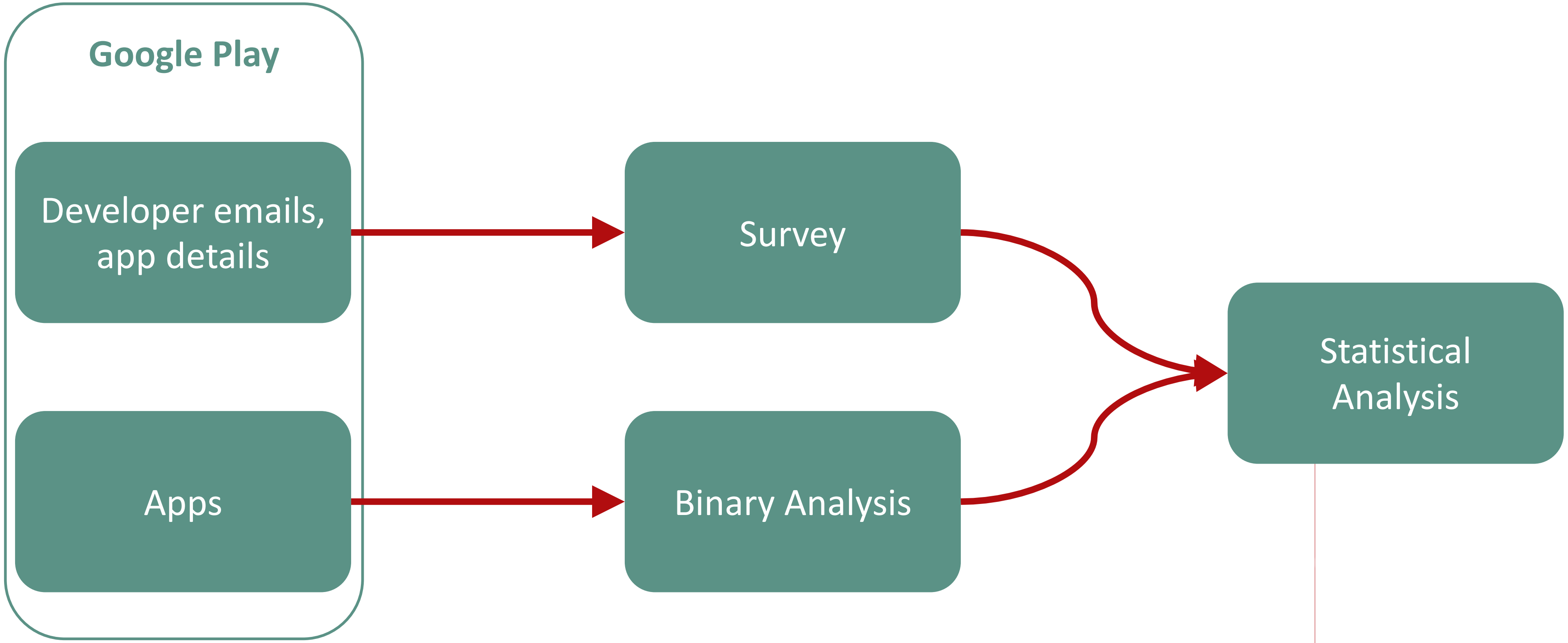
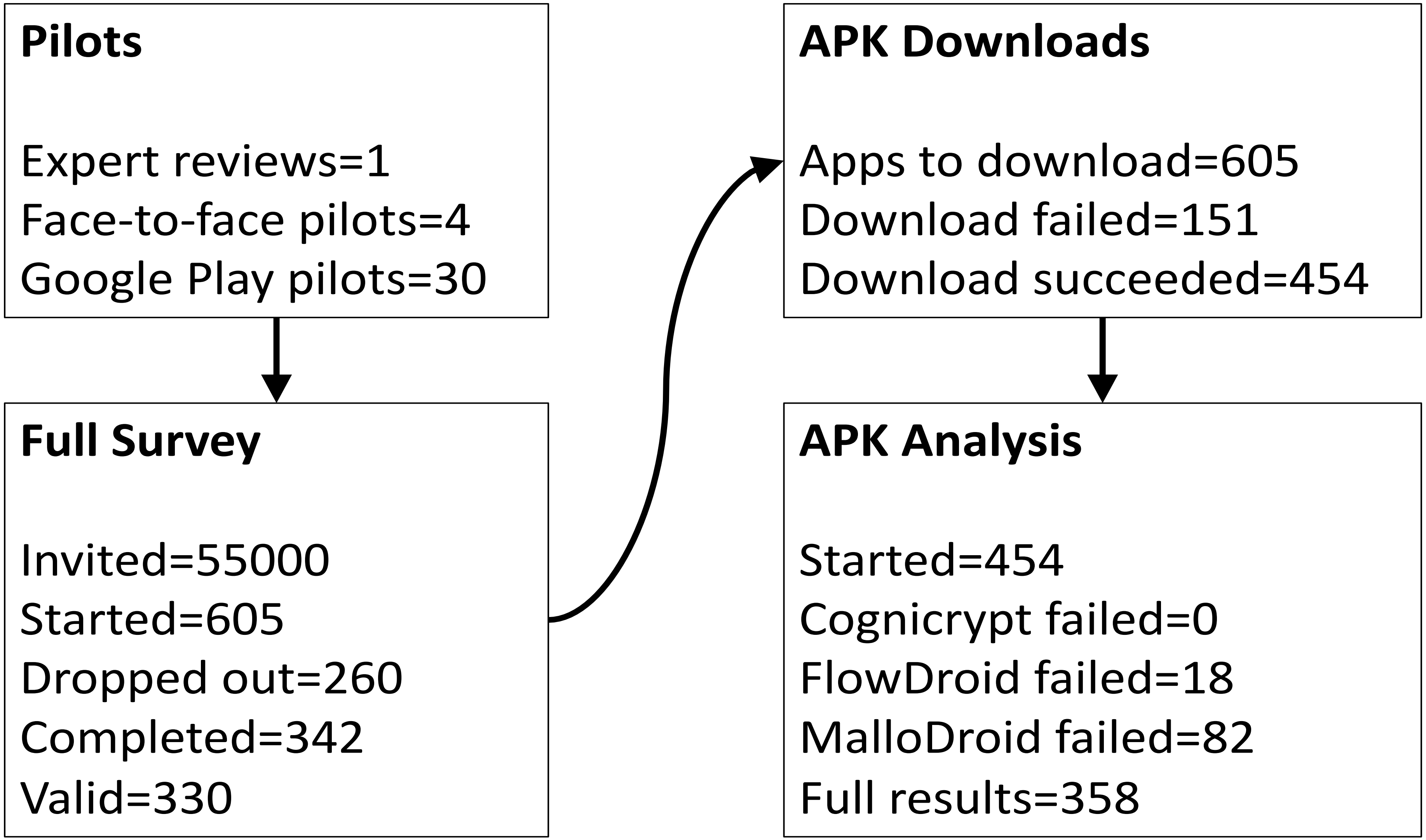
Research Question

To what extent, and how,
does a perceived need for security and privacy
lead to security-enhancing activities …
in the development team?

Survey Concept





Developer Questionnaire

Pilots

Expert reviews=1
Face-to-face pilots=4
Google Play pilots=30

Full Survey

Invited=55000
Started=605
Dropped out=260
Completed=342
Valid=330

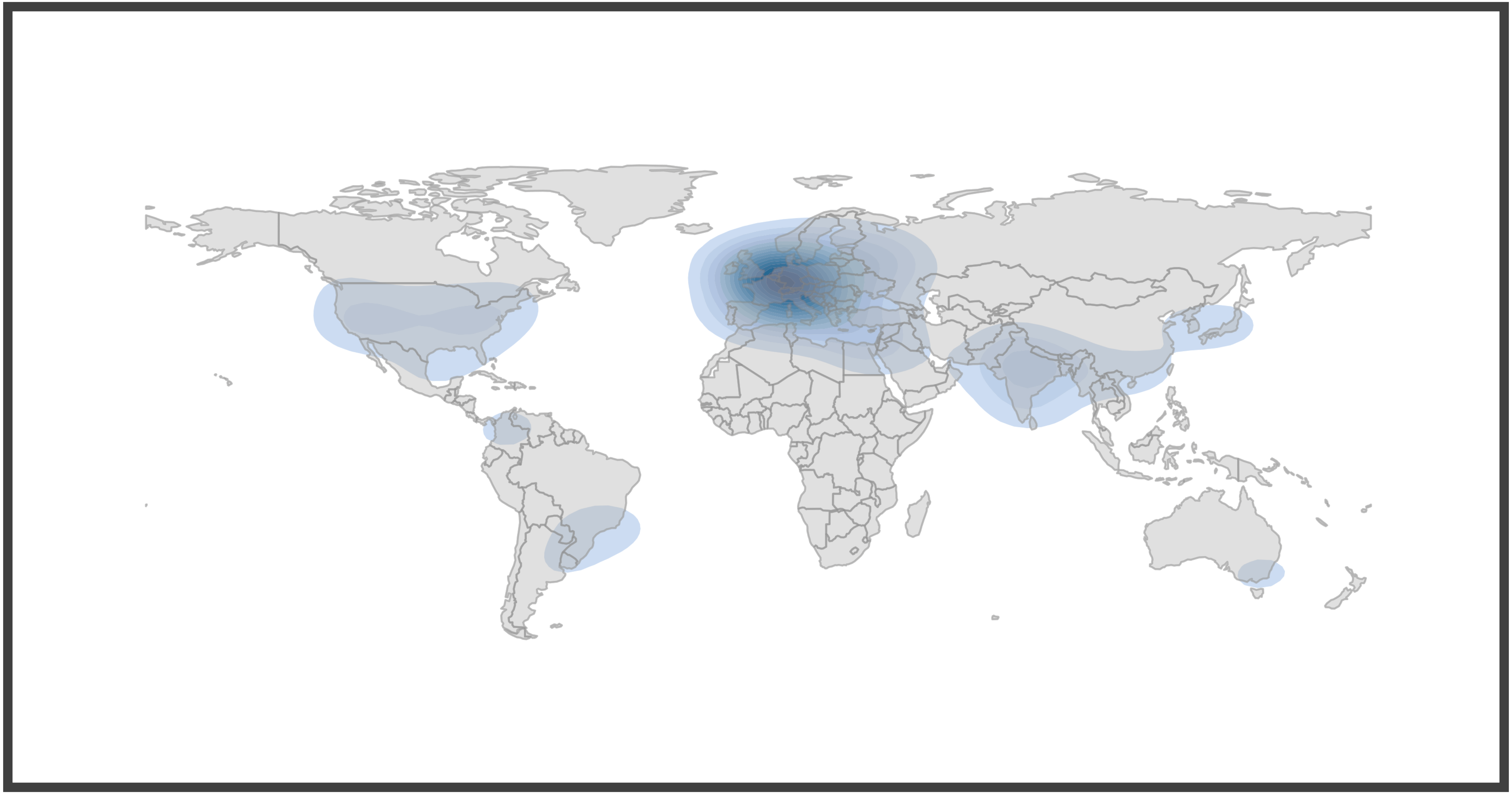
App Analysis

APK Downloads

Apps to download=605
Download failed=151
Download succeeded=454

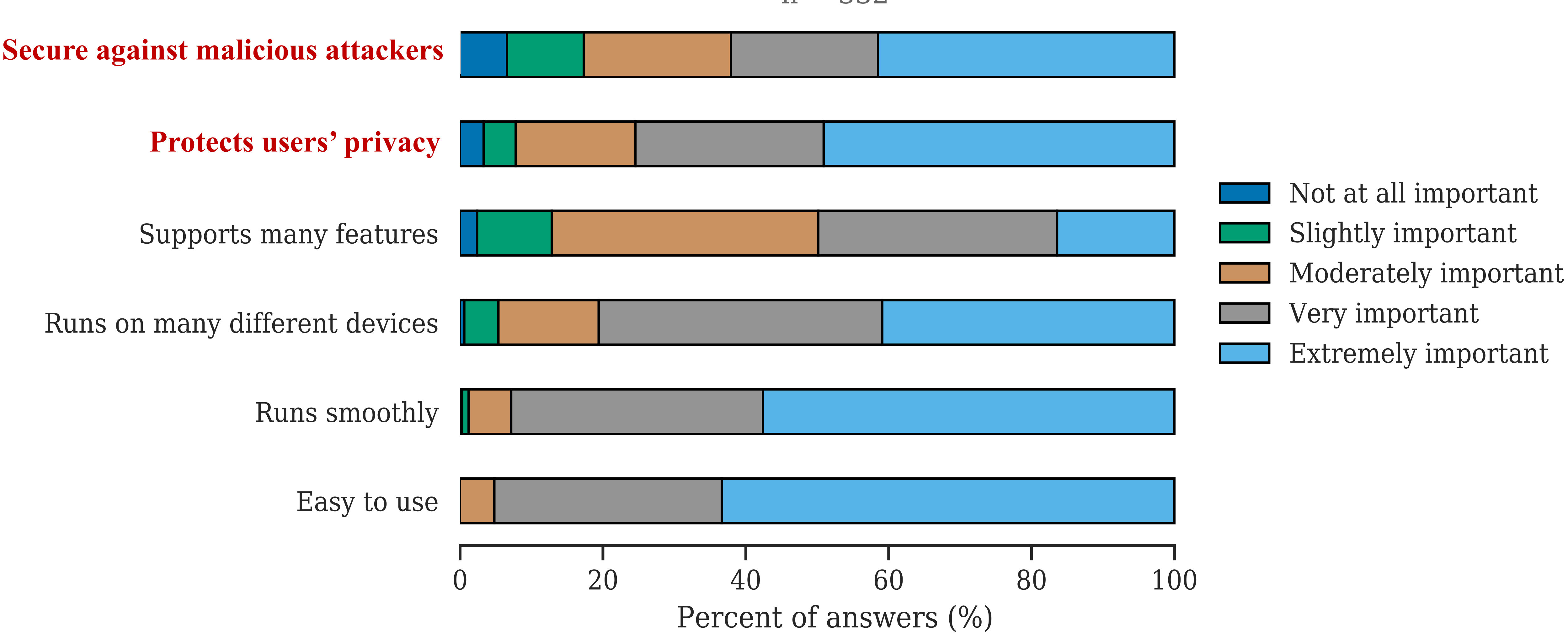
APK Analysis

Started=454
Cognicrypt failed=0
FlowDroid failed=18
MalloDroid failed=82
Full results=358

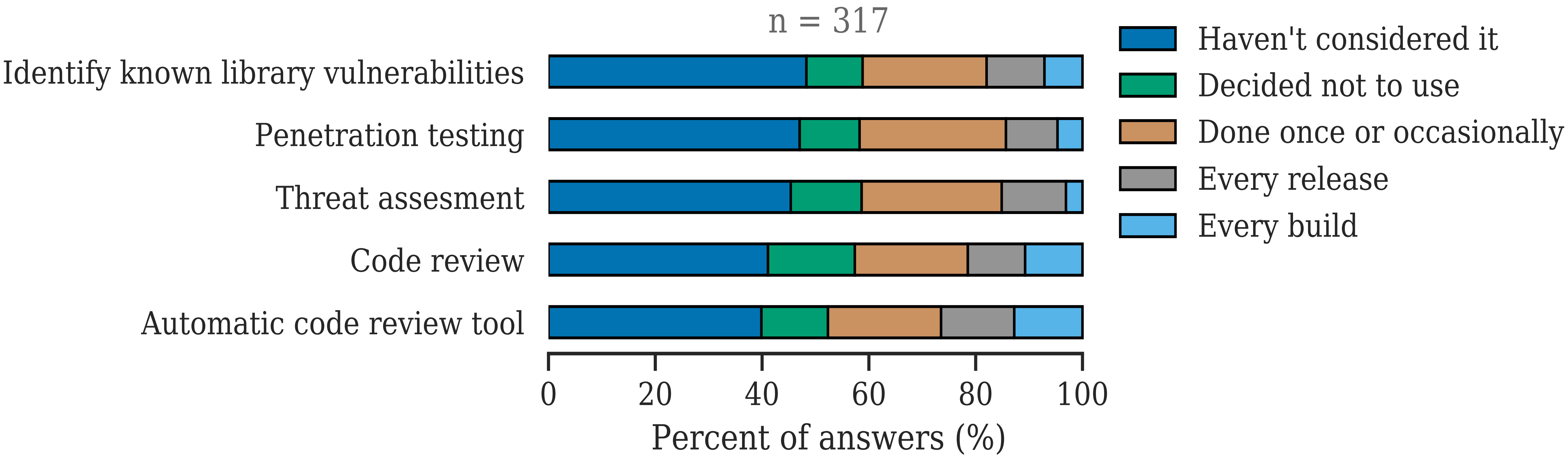


Discussing the Results

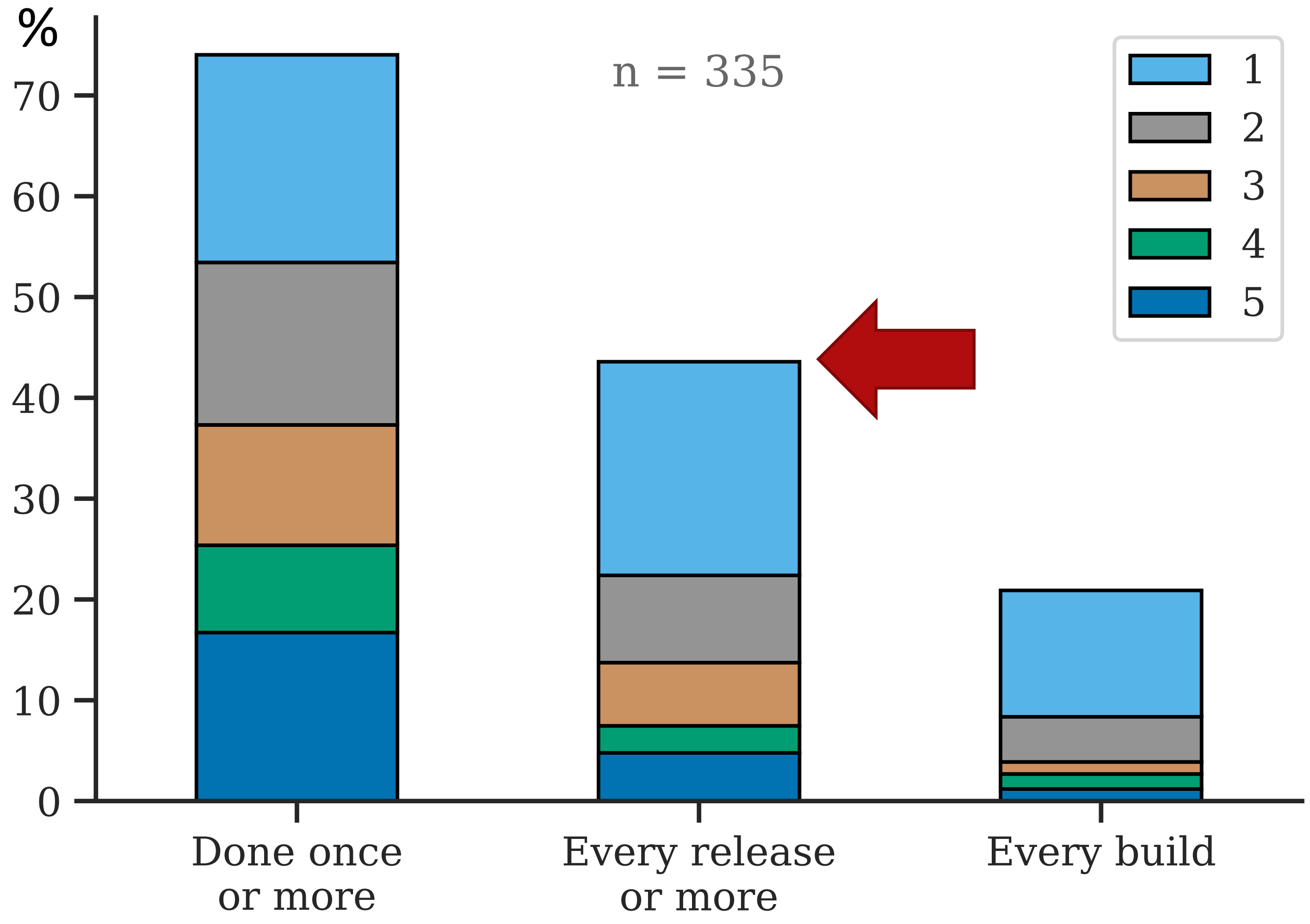
- Description of the Survey Data
- Relationships in the Survey Data
- Adding the Binary App Analysis



Importance of Different Requirements



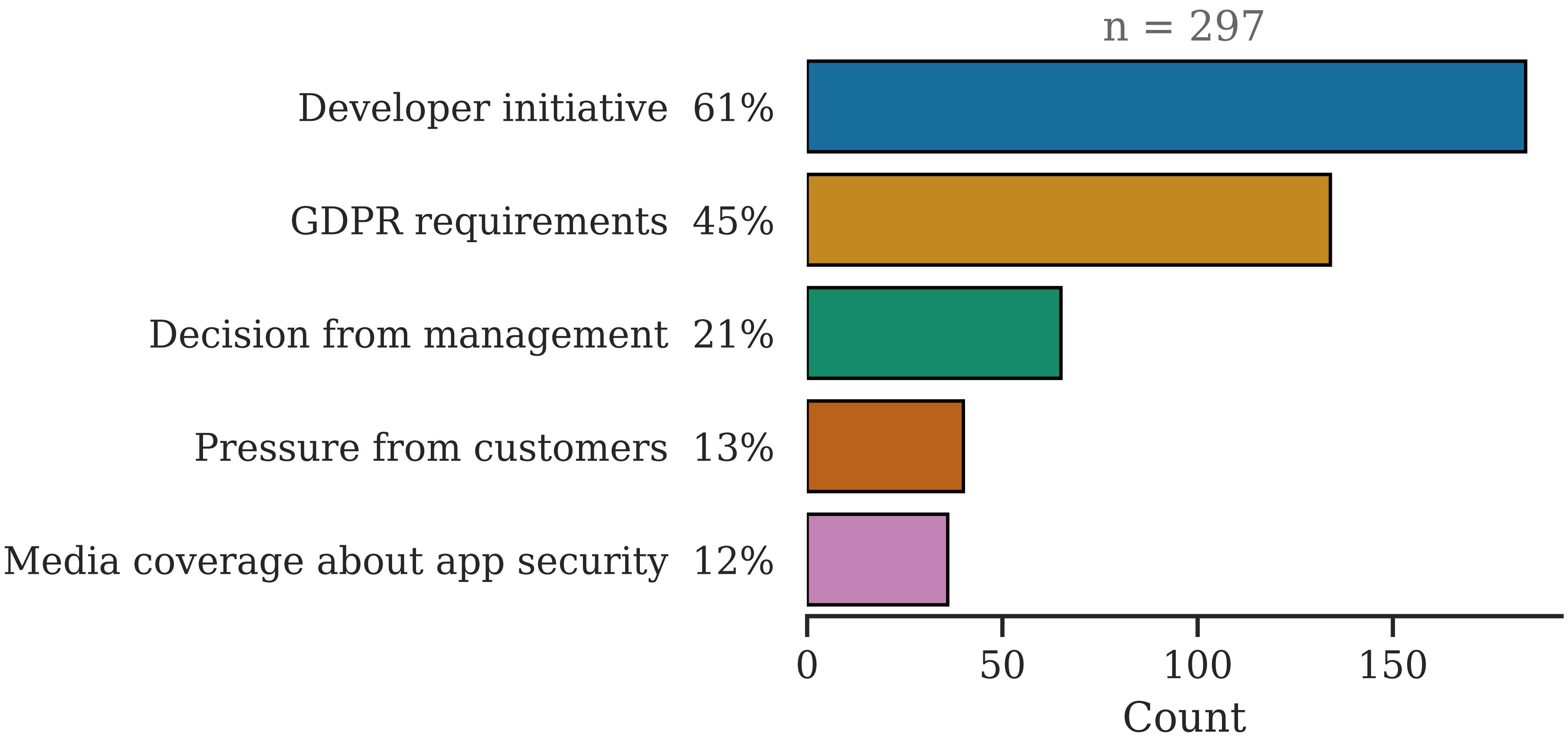
Use of Assurance Techniques



# Assurance Techniques Used

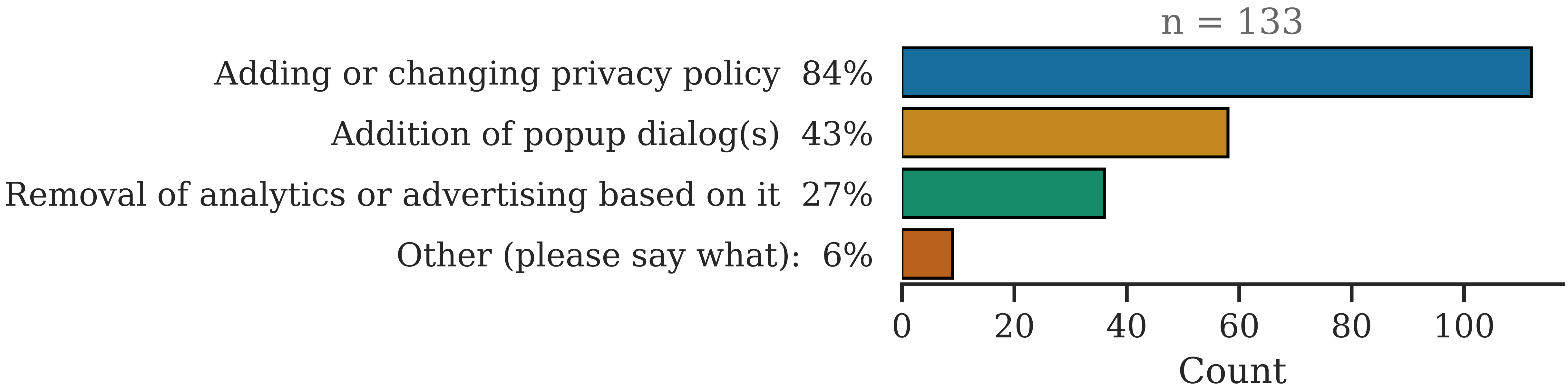
Adoption of Assurance Techniques

First Technique	Second Technique	Proportion
Automatic Code Review	Automatic Library Vulnerabilities	38%
Automatic Code Review	Code Review	32%
Code Review	Automatic Library Vulnerabilities	22%
Threat Assessment	Code Review	16%

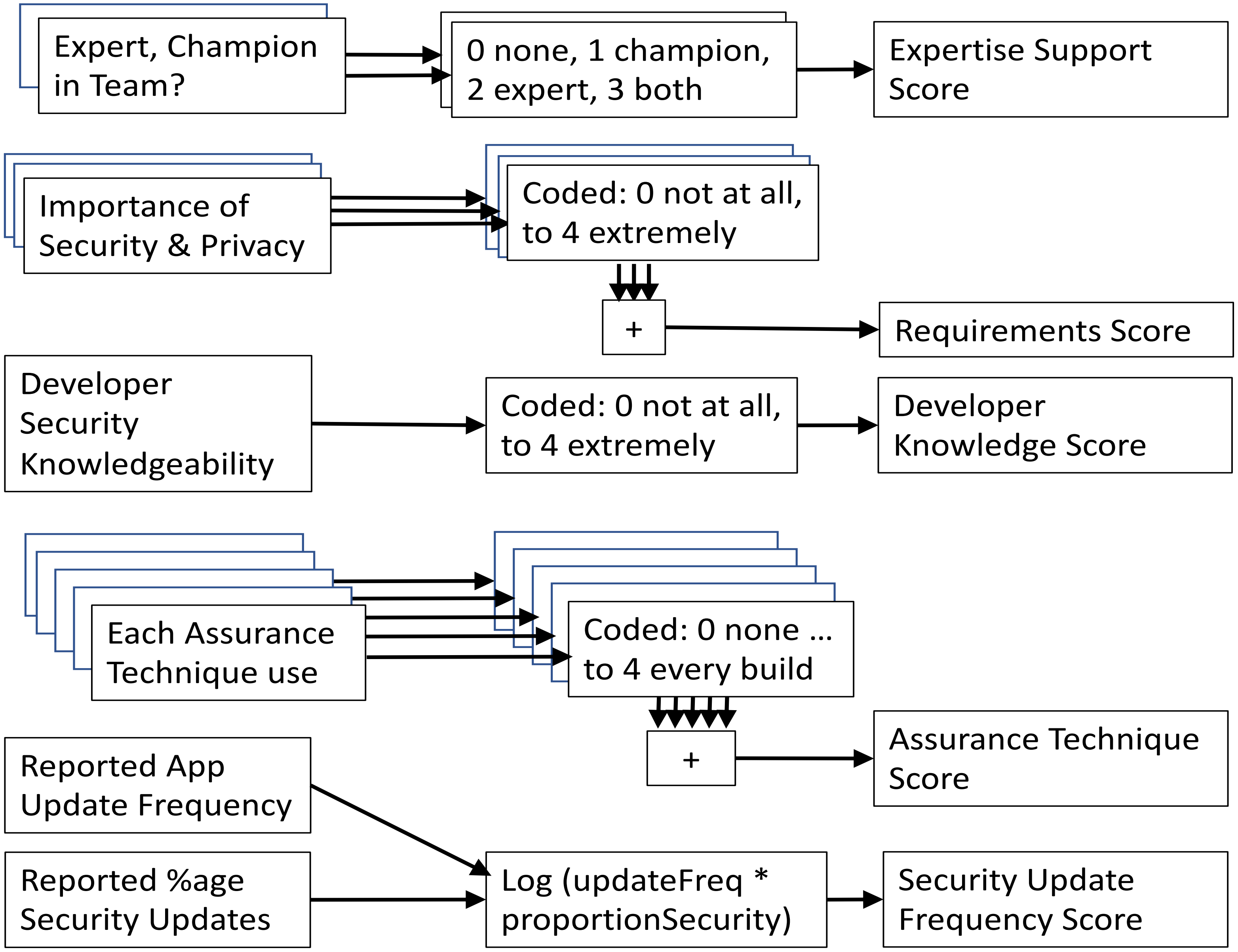


Reasons for Security Changes

GDPR Changes



Relationships in the Survey Data


Expert, Champion in Team?

0 none, 1 champion, 2 expert, 3 both

Expertise Support Score

Importance of Security & Privacy

Coded: 0 not at all, to 4 extremely

+

Requirements Score

Developer Security Knowledgeability

Coded: 0 not at all, to 4 extremely

Developer Knowledge Score

Each Assurance Technique use

Coded: 0 none … to 4 every build

+

Assurance Technique Score

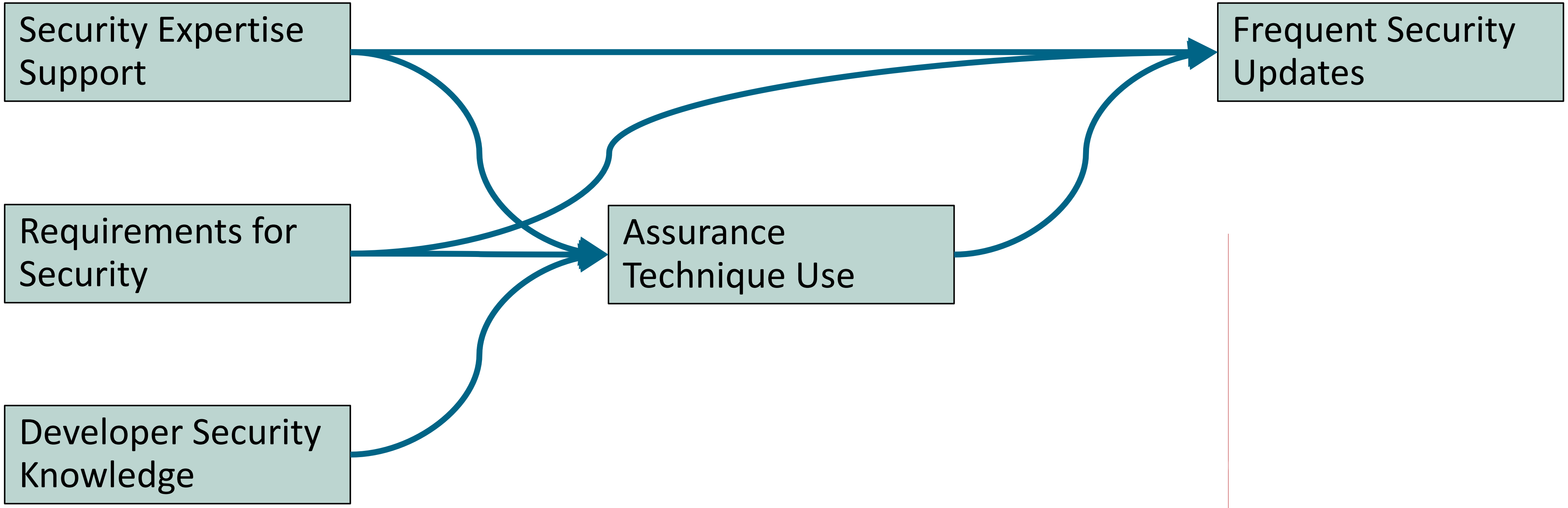
Reported App Update Frequency

Reported %age Security Updates

Log (updateFreq * proportionSecurity)

Security Update Frequency Score

Correlations Found



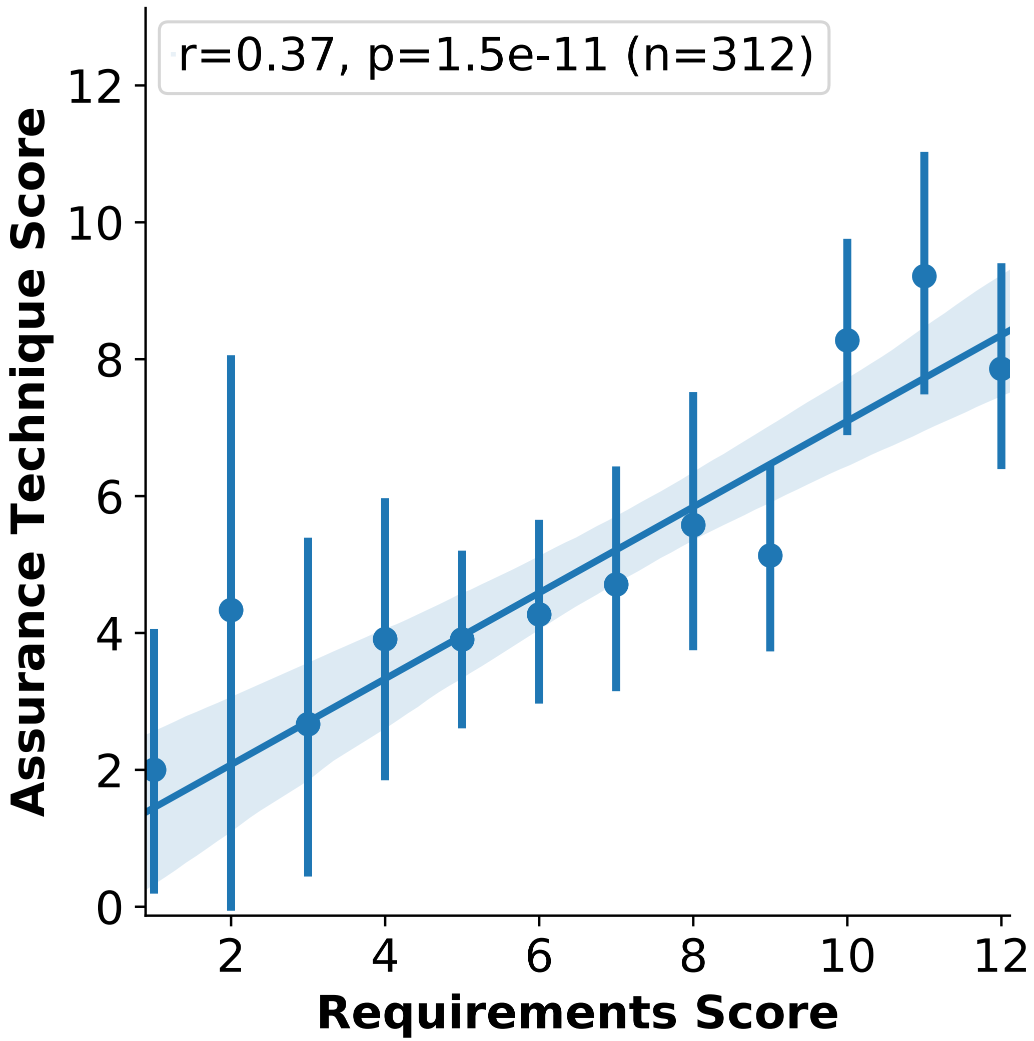
Security Expertise Support

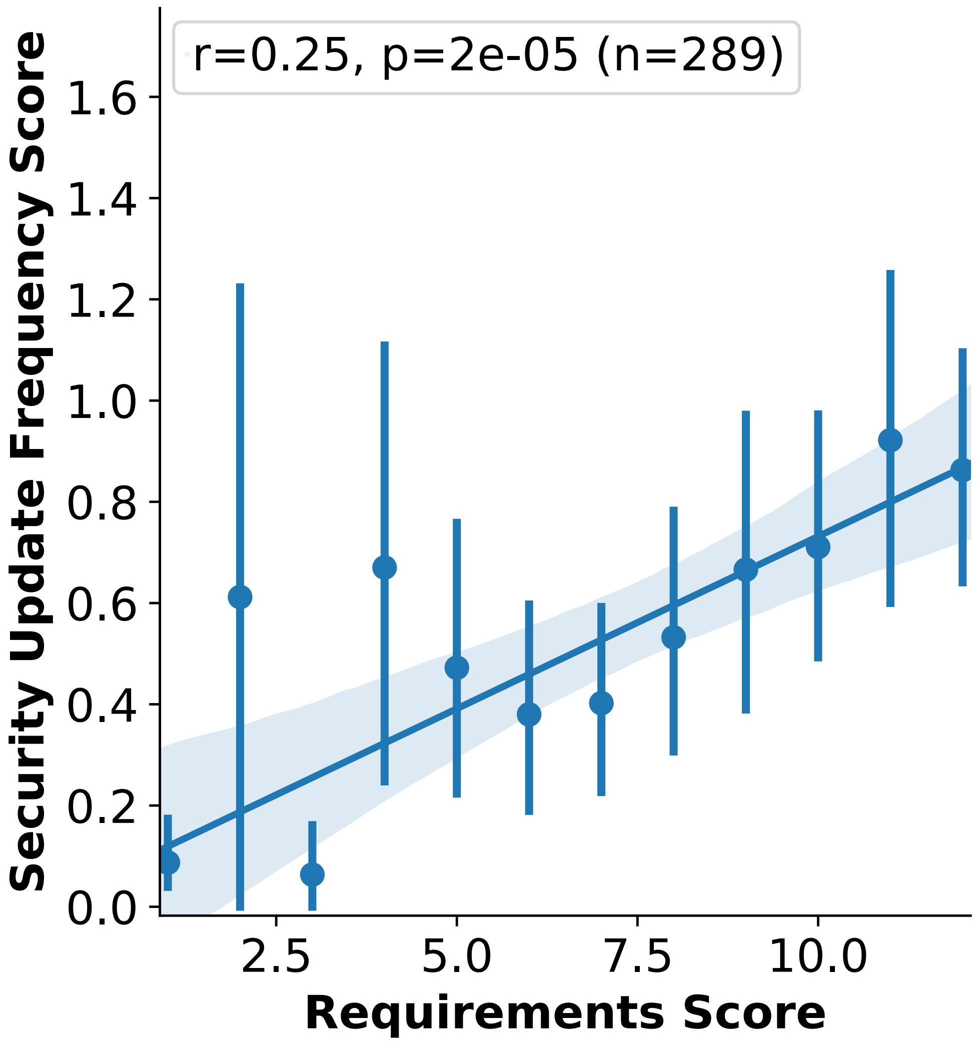
Requirements for Security

Developer Security Knowledge

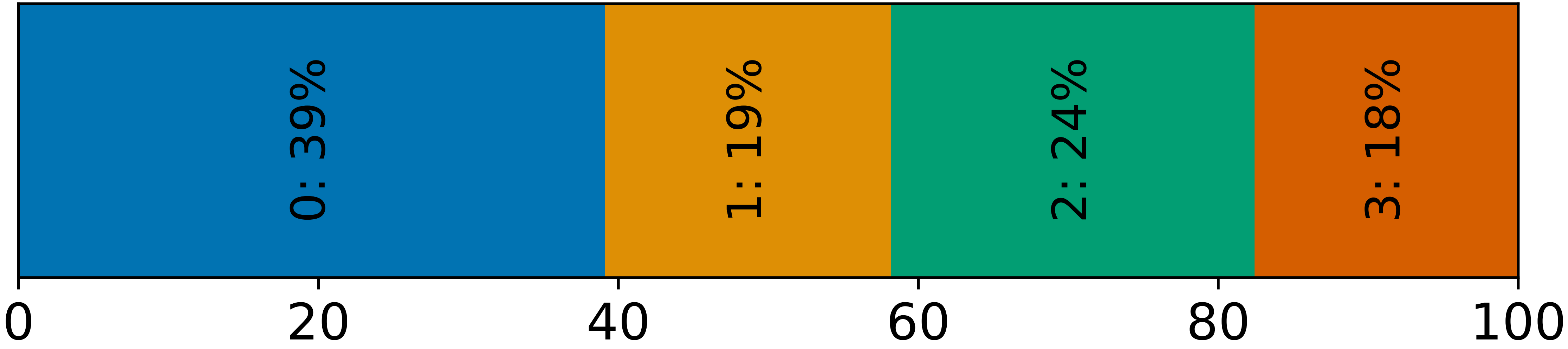
Assurance Technique Use

Frequent Security Updates


r=0.37, p=1.5e-11 (n=312)
Assurance Technique Score
0
2
4
6
8
10
12
Requirements Score
2
4
6
8
10
12

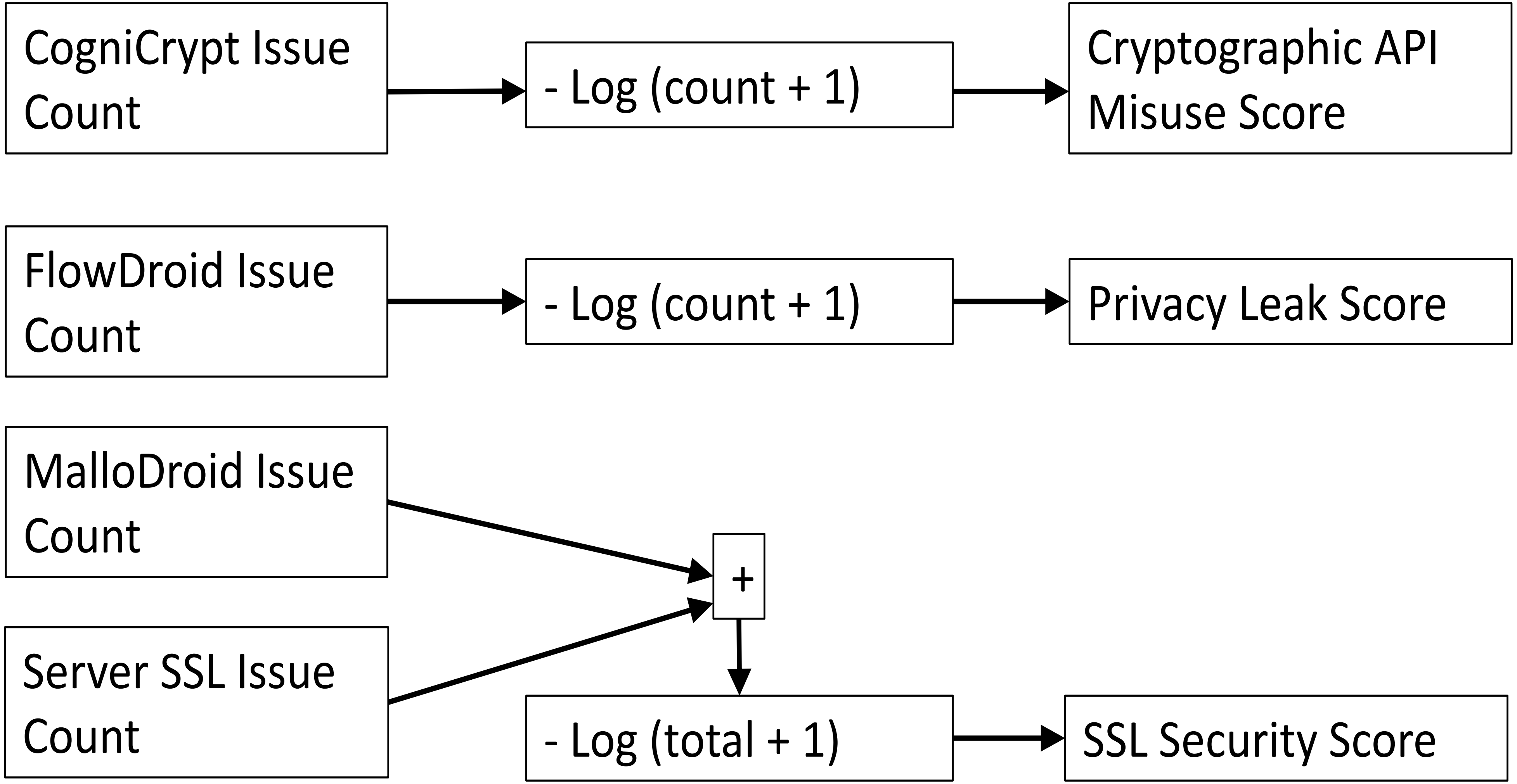

r=0.25, p=2e-05 (n=289)
Security Update Frequency Score
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Requirements Score
2.5
5.0
7.5
10.0

Adding the App Analysis Data



Binary Analysis ‘Failures’

FlowDroid
CogniCrypt
MalloDroid, plus OPAL framework, curl & openSSL



CogniCrypt Issue Count

- Log (count + 1)

Cryptographic API Misuse Score

FlowDroid Issue Count

- Log (count + 1)

Privacy Leak Score

MalloDroid Issue Count

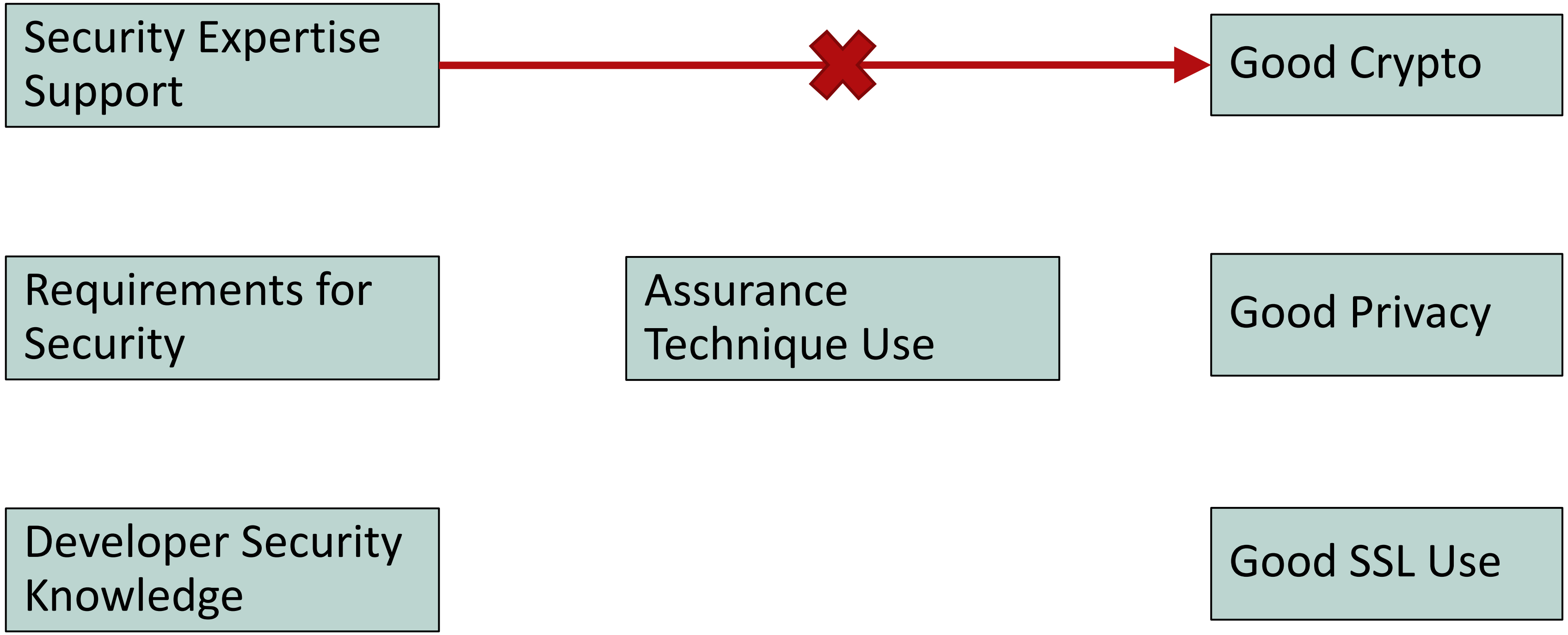
Server SSL Issue Count

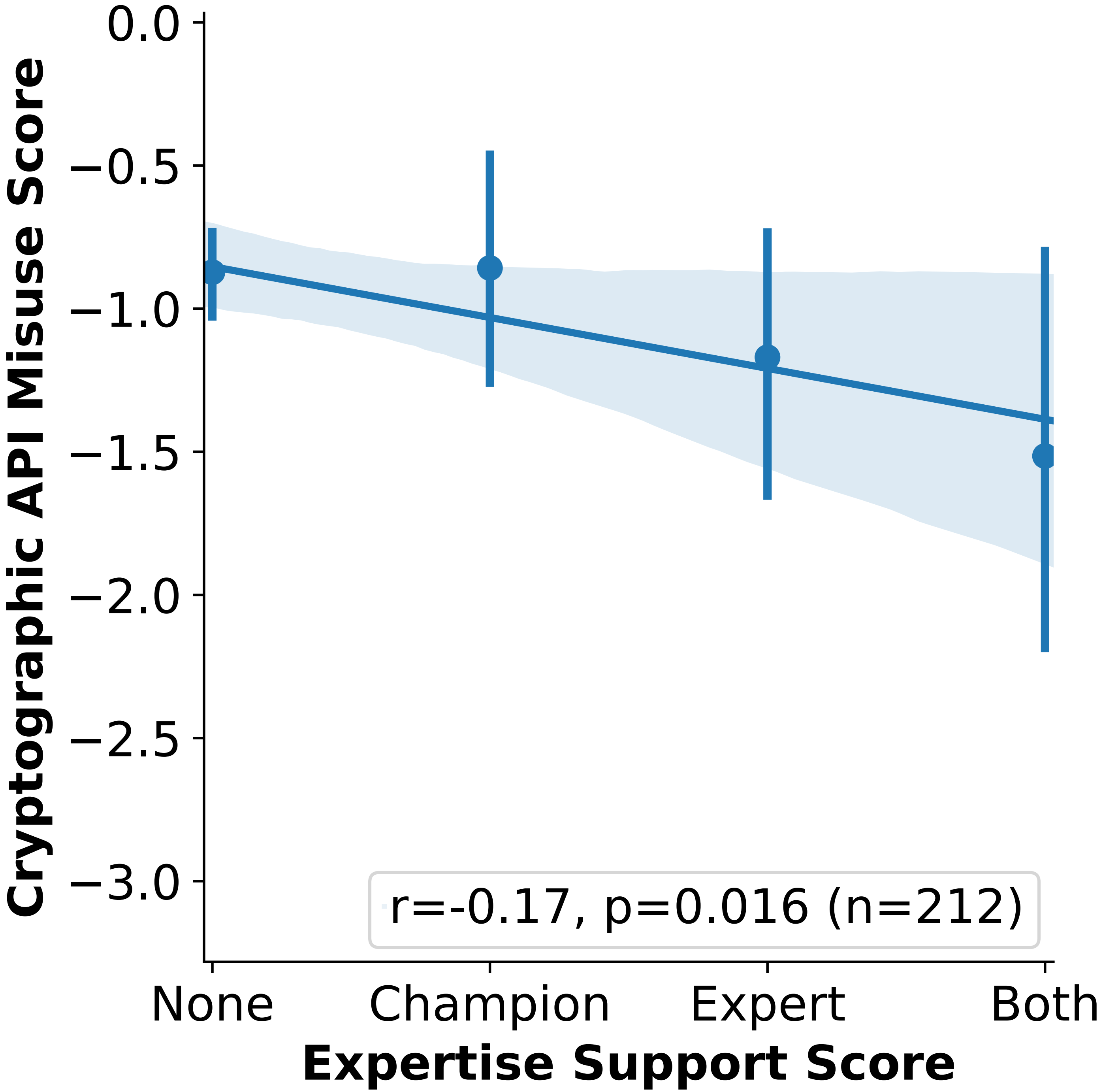
+

- Log (total + 1)

SSL Security Score

Correlations Found


Security Expertise Support
Good Crypto
Requirements for Security
Assurance Technique Use
Good Privacy
Developer Security Knowledge
Good SSL Use


Cryptographic API Misuse Score
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
r=-0.17, p=0.016 (n=212)
None
Champion
Expert
Both
Expertise Support Score

Summary: Android Developers and their Apps

- Less than a quarter of developers have access to security experts
- Less than half use assurance techniques regularly
- GDPR has had little impact
- Assurance technique use, and app security updates, both relate to security need
- Security expert involvement is linked to more crypto issues
- Binary analysis tools are not yet adequate for measurement

Thank you

Credit to:

Christian Stransky, Dominik Wermke

Tamara Lopez, Yasemin Acar, Thomas Gross, Ian White

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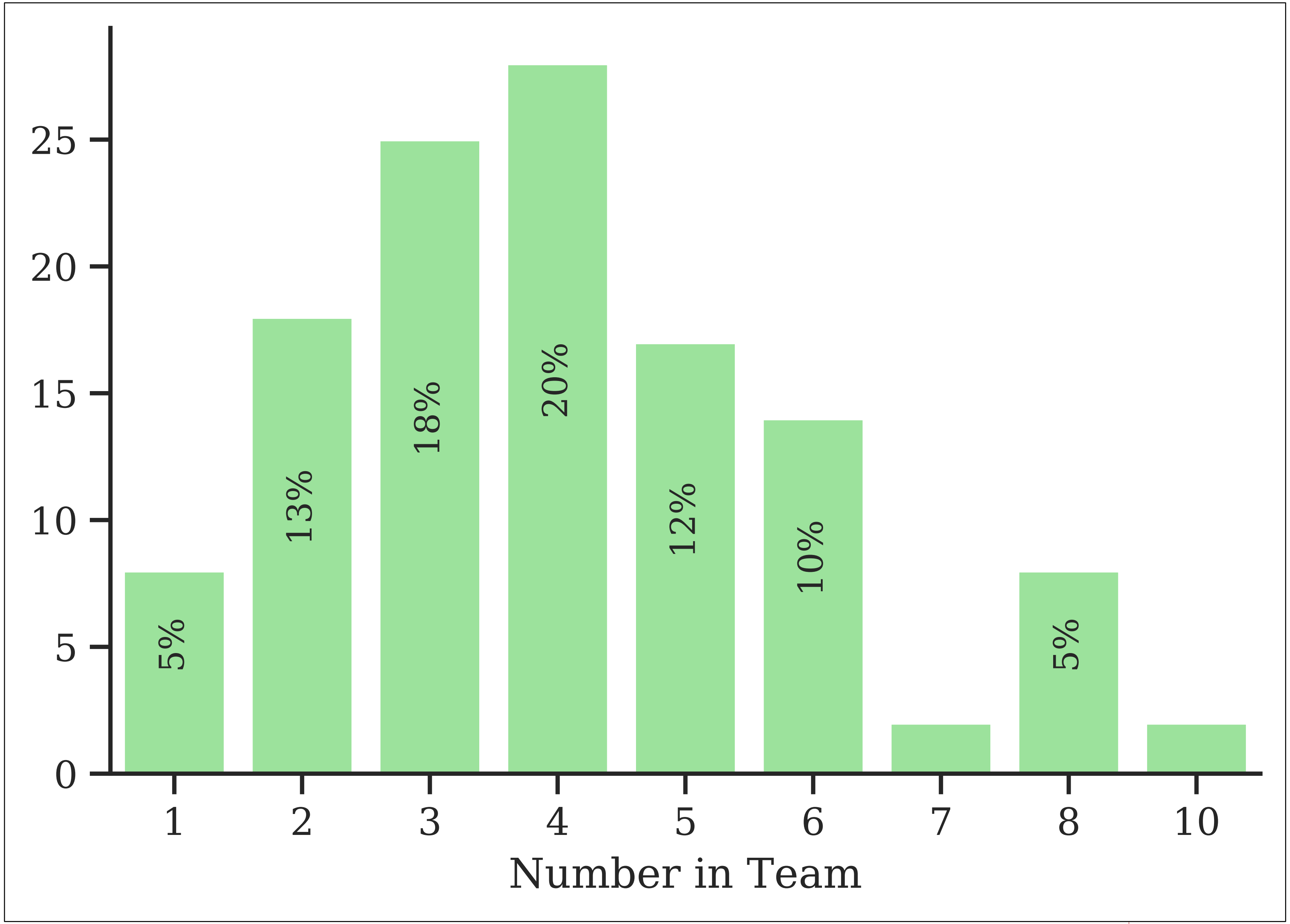
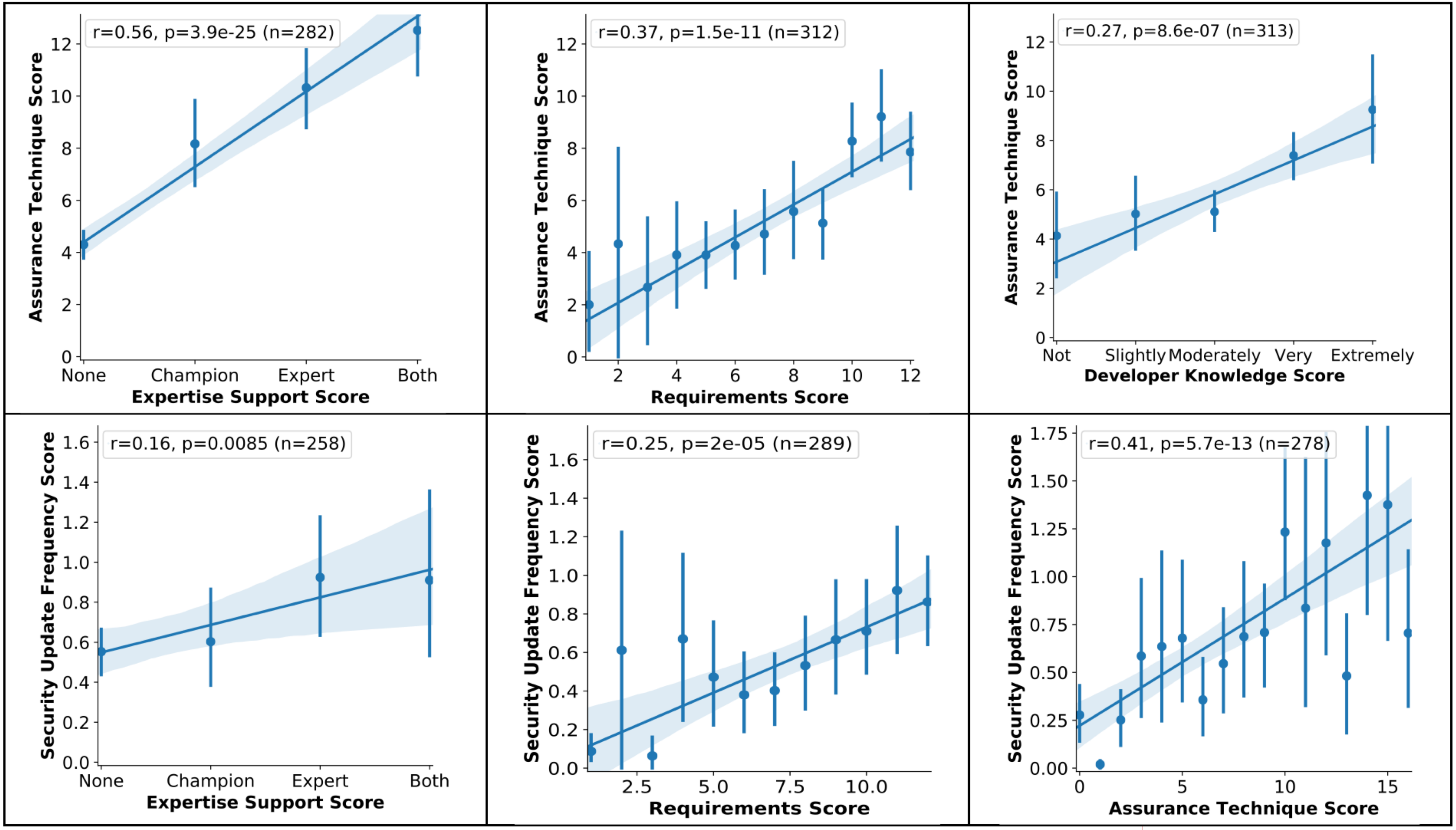

0
5
10
15
20
25
5%
13%
18%
20%
12%
10%
5%
1
2
3
4
5
6
7
8
10
Number in Team


r=0.56, p=3.9e-25 (n=282)
Assurance Technique Score
0
2
4
6
8
10
12
None
Champion
Expert
Both
Expertise Support Score
r=0.37, p=1.5e-11 (n=312)
Assurance Technique Score
0
2
4
6
8
10
12
2
4
6
8
10
12
Requirements Score
r=0.27, p=8.6e-07 (n=313)
Assurance Technique Score
0
2
4
6
8
10
12
Not
Slightly
Moderately
Very
Extremely
Developer Knowledge Score
r=0.16, p=0.0085 (n=258)
Security Update Frequency Score
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
None
Champion
Expert
Both
Expertise Support Score
r=0.25, p=2e-05 (n=289)
Security Update Frequency Score
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
2.5
5.0
7.5
10.0
Requirements Score
r=0.41, p=5.7e-13 (n=278)
Security Update Frequency Score
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
0
5
10
15
Assurance Technique Score

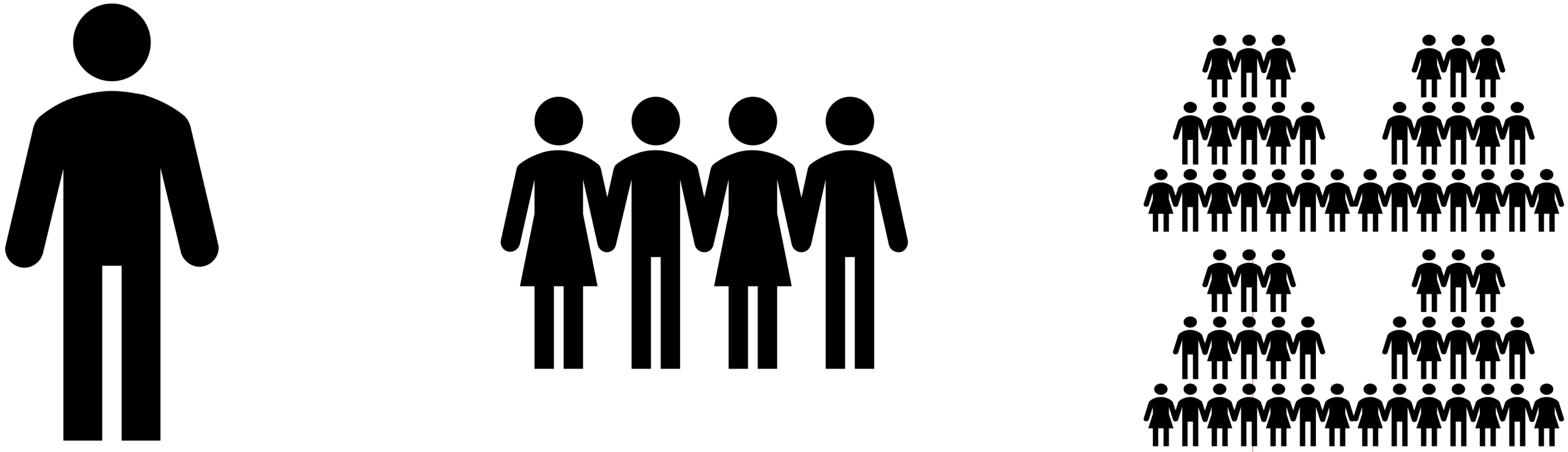
Integrity?

Checked and double checked survey design

Meaningful citing of proportions

Prediction-first statistics

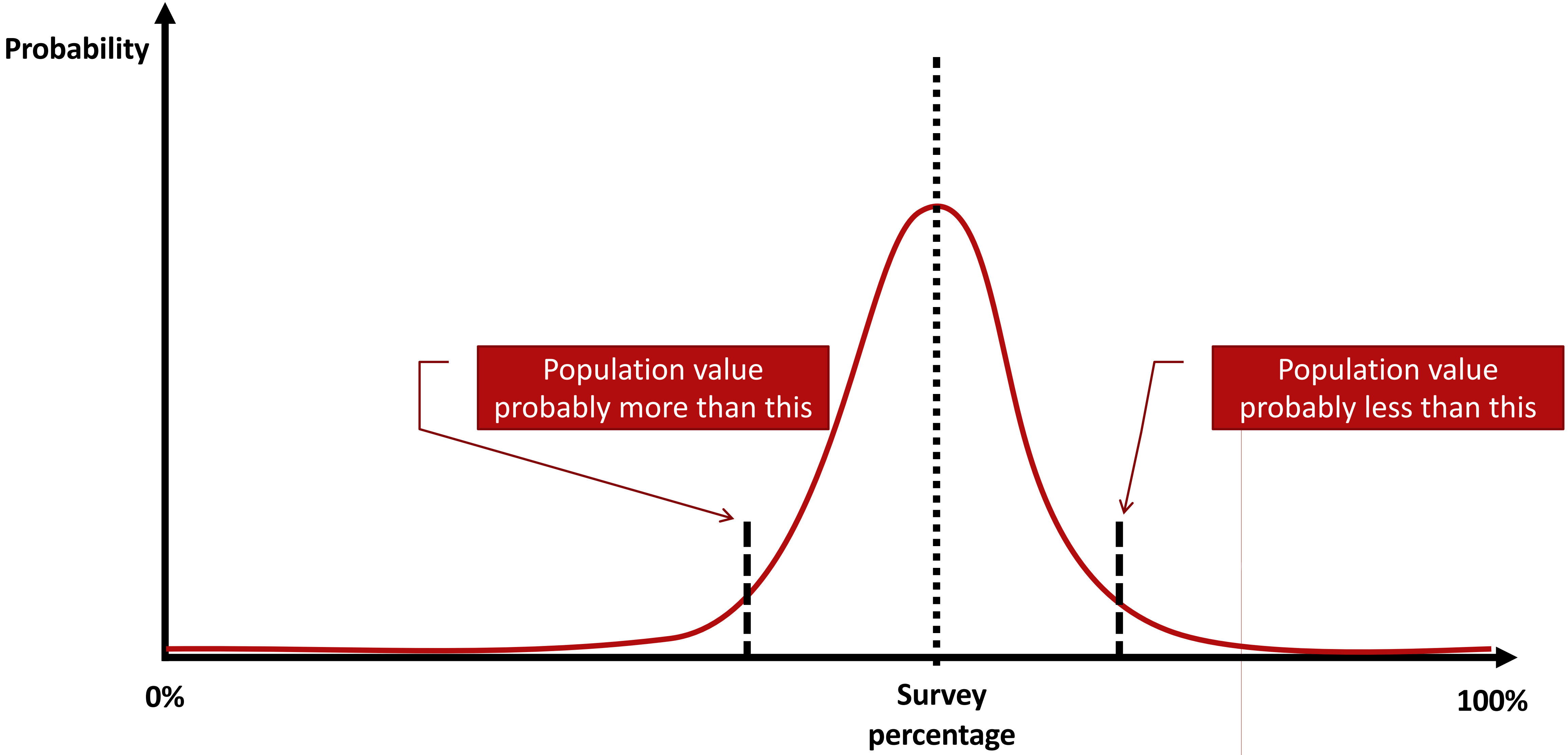
Checking…



And Double Checking…

- Sample size
- Filtering
- Statistical checks

Confidence Interval for a Population Proportion



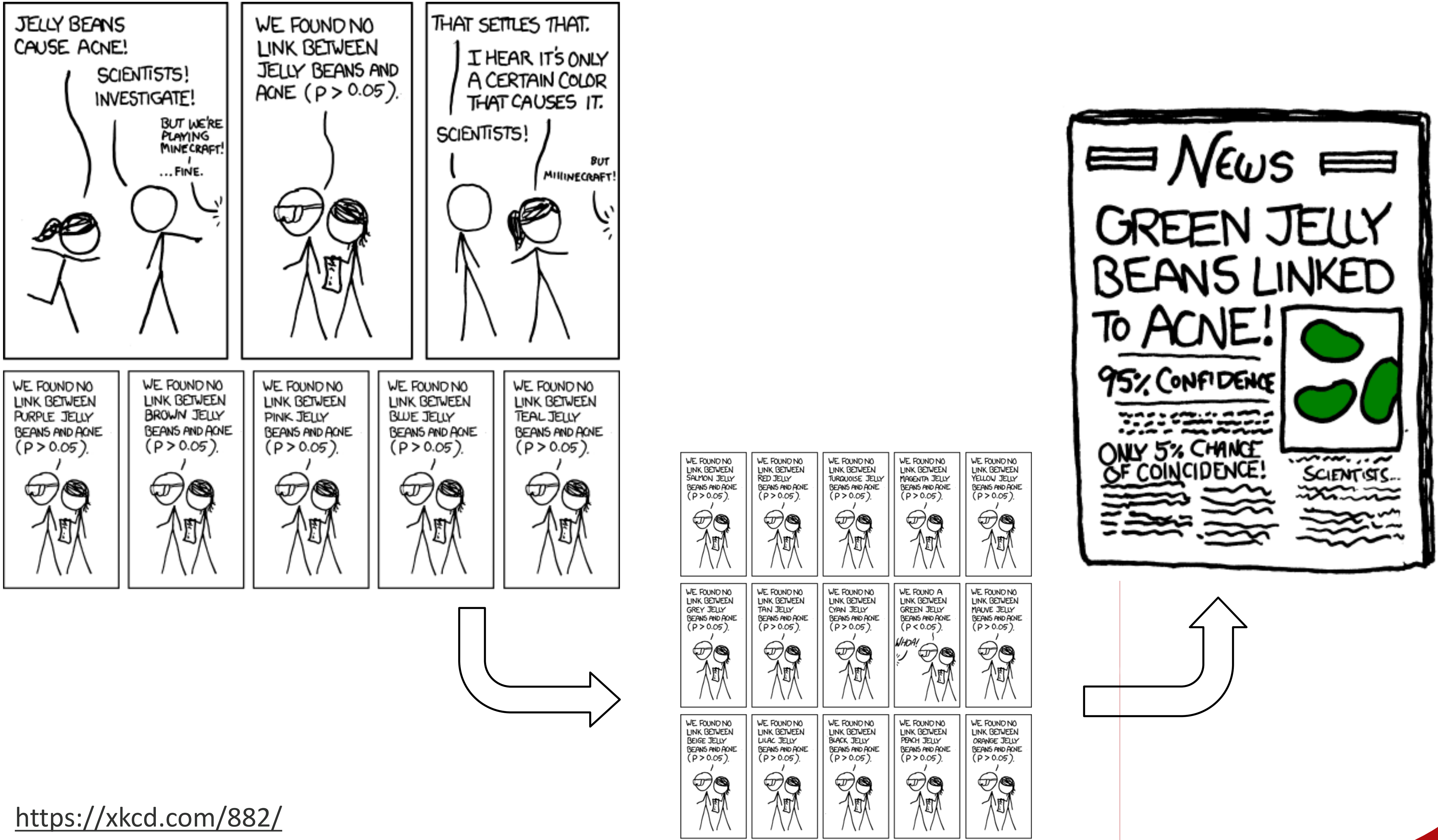
Probability
Population value probably more than this
Population value probably less than this
0%
Survey percentage
100%

Linear Correlation

Fundamental principal: prediction

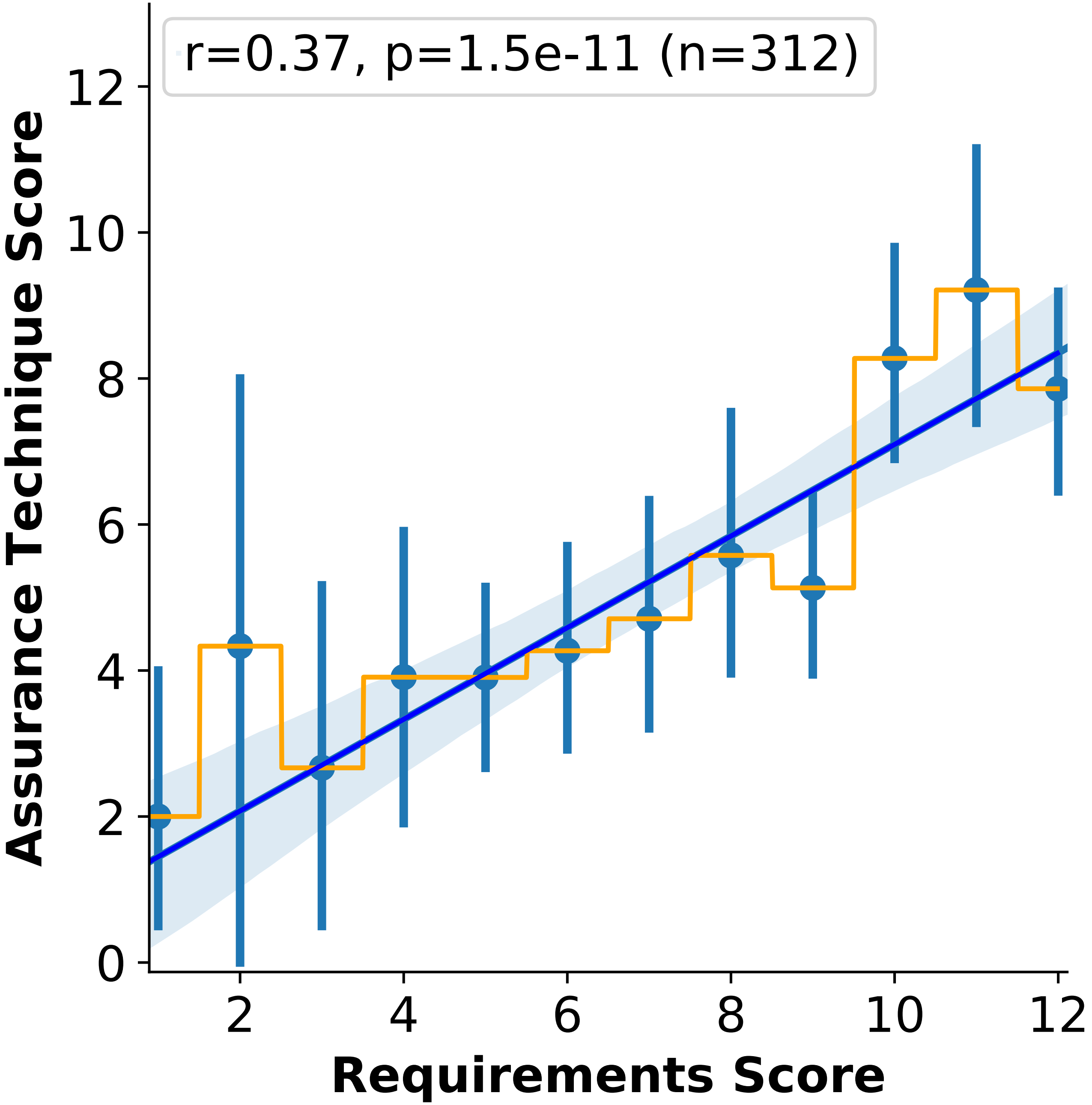
Combining and munging variables

Checking preconditions afterwards

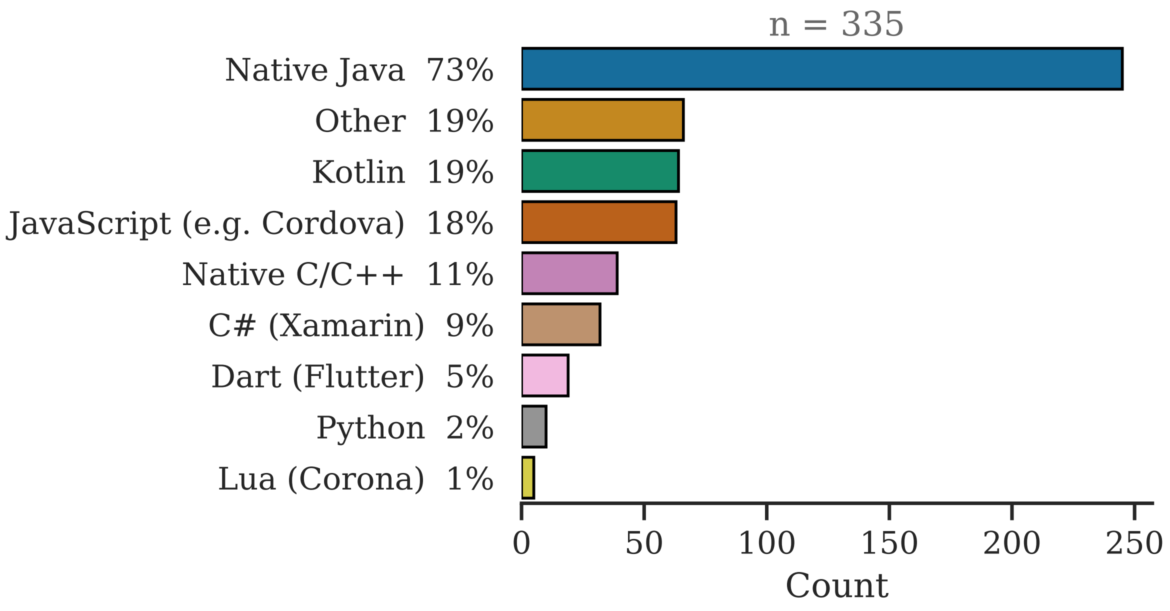


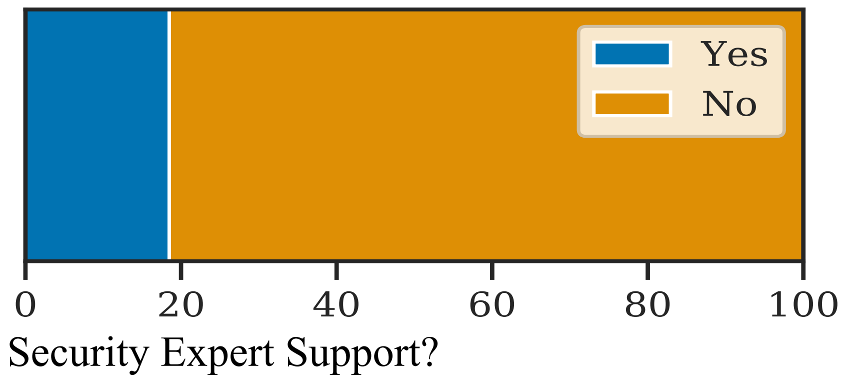
JELLY BEANS CAUSE ACNE!
SCIENTISTS! INVESTIGATE!
BUT WE'RE PLAYING MINECRAFT!
... FINE.
WE FOUND NO LINK BETWEEN JELLY BEANS AND ACNE (P > 0.05).
THAT SETTLES THAT.
I HEAR IT'S ONLY A CERTAIN COLOR THAT CAUSES IT.
SCIENTISTS!
BUT MIIIINECRAFT!
WE FOUND NO LINK BETWEEN PURPLE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN BROWN JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN PINK JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN BLUE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN TEAL JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN SALMON JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN RED JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN TURQUOISE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN MAGENTA JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN YELLOW JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN GREY JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN TAN JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN CYAN JELLY BEANS AND ACNE (P > 0.05).
WE FOUND A LINK BETWEEN GREEN JELLY BEANS AND ACNE (P < 0.05).
WHOA!
WE FOUND NO LINK BETWEEN MAUVE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN BEIGE JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN LILAC JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN BLACK JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN PEACH JELLY BEANS AND ACNE (P > 0.05).
WE FOUND NO LINK BETWEEN ORANGE JELLY BEANS AND ACNE (P > 0.05).
NEWS
GREEN JELLY BEANS LINKED TO ACNE!
95% CONFIDENCE
ONLY 5% CHANCE OF COINCIDENCE!
SCIENTISTS...

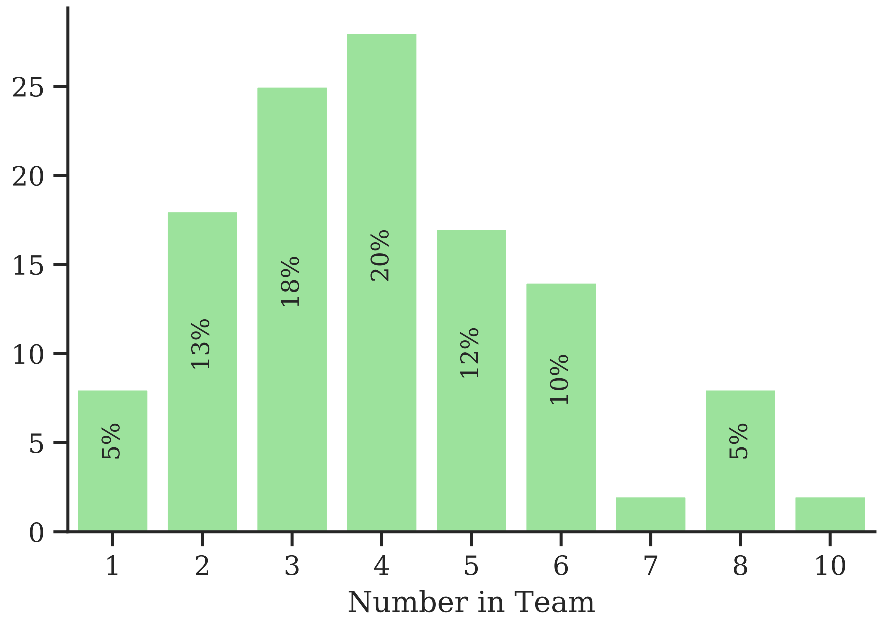
https://xkcd.com/882/



r=0.37, p=1.5e-11 (n=312)
Assurance Technique Score
0
2
4
6
8
10
12
Requirements Score
2
4
6
8
10
12


n = 335
Native Java 73%
Other 19%
Kotlin 19%
JavaScript (e.g. Cordova) 18%
Native C/C++ 11%
C# (Xamarin) 9%
Dart (Flutter) 5%
Python 2%
Lua (Corona) 1%
0
50
100
150
200
250
Count


Yes
No
0
20
40
60
80
100
Security Expert Support?


25
20
15
10
5
0
5%
13%
18%
20%
12%
10%
5%
1
2
3
4
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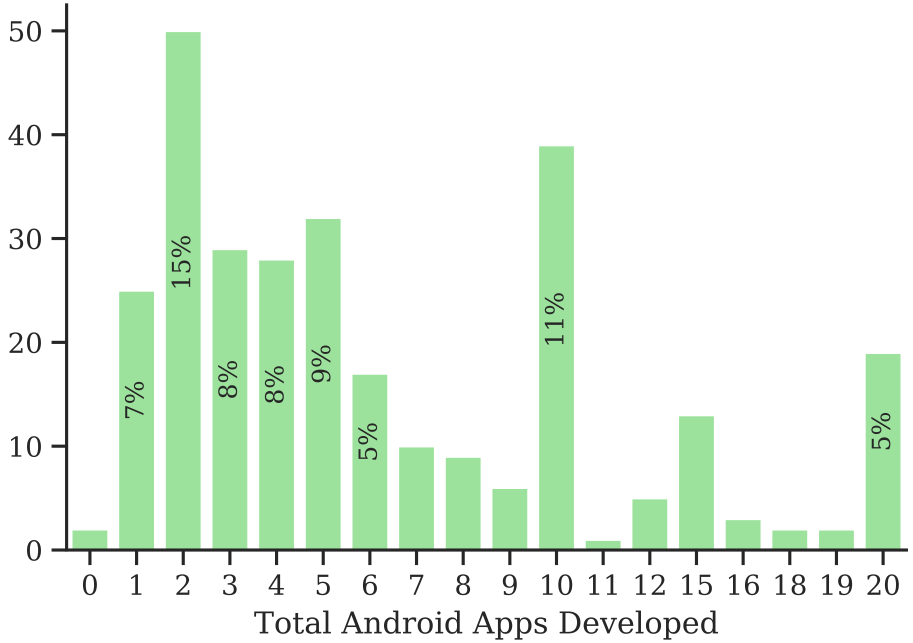
6
7
8
10
Number in Team


50
40
30
20
10
0
7%
15%
8%
8%
9%
5%
11%
5%
0
1
2
3
4
5
6
7
8
9
10
11
12
15
16
18
19
20
Total Android Apps Developed