An Introduction to Ranking Data and a Case Study of a National Survey of First Responders

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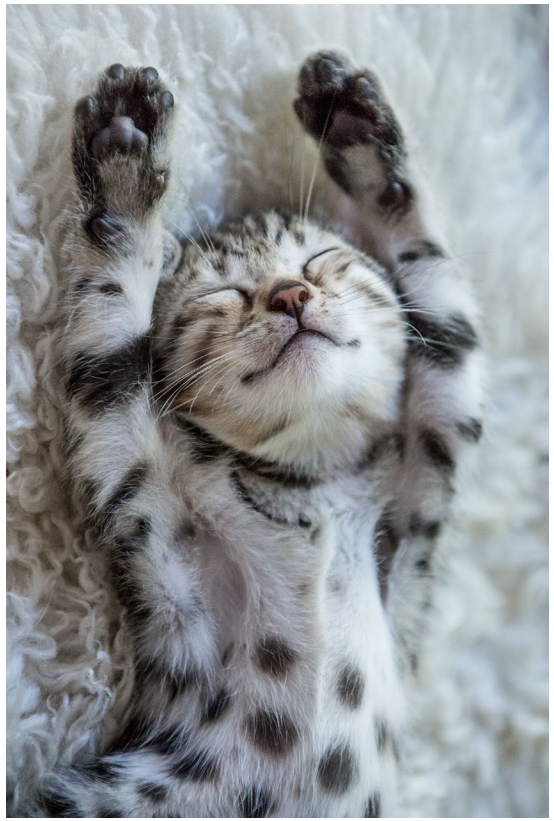
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Outline

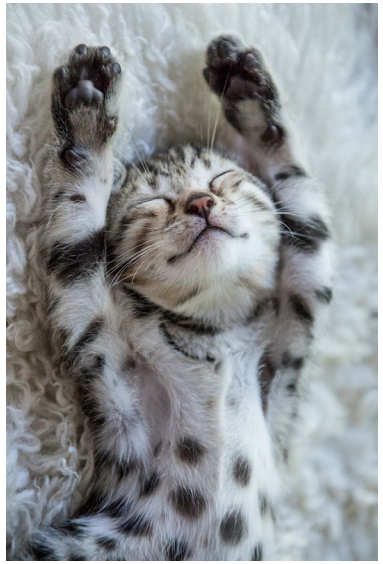
- Choices and ranking data
- First responders ranking data
- Plackett-Luce model
- First responders results
- Software

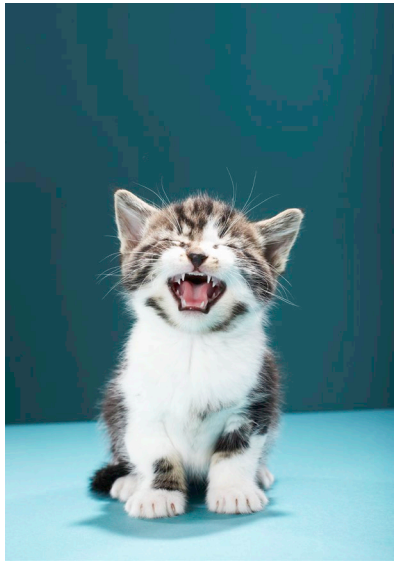
Choice Data: Two Alternatives



Choose the cutest kitten

Choice Data: More than two Alternatives

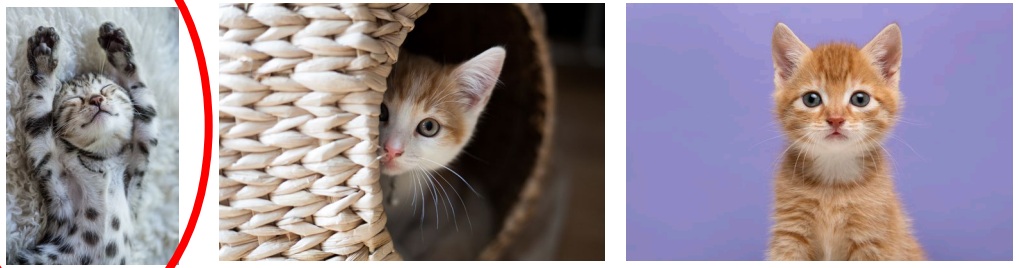




Same question: which is the cutest?

Ranking Data: Sequence of Choices

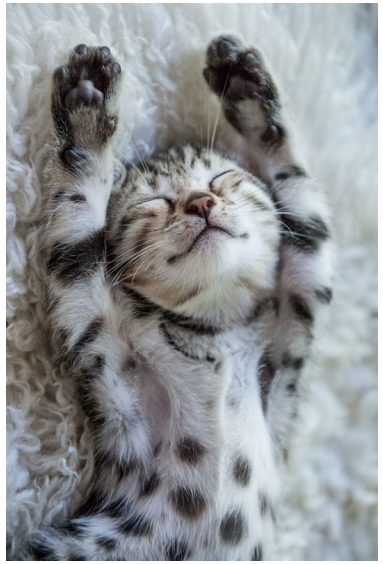
First Choice



Second Choice

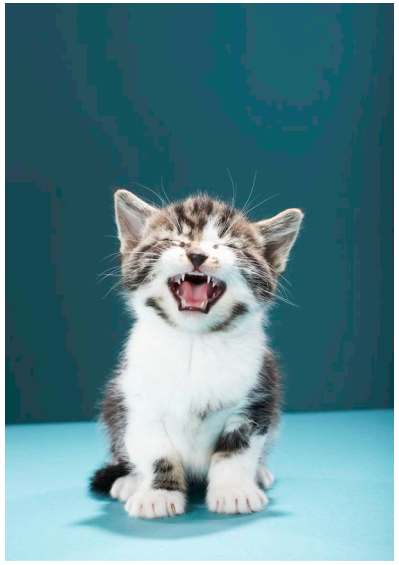
Third Choice

Final Ranking



(2,

3,



1,

4)

Ordering Versus Ranking

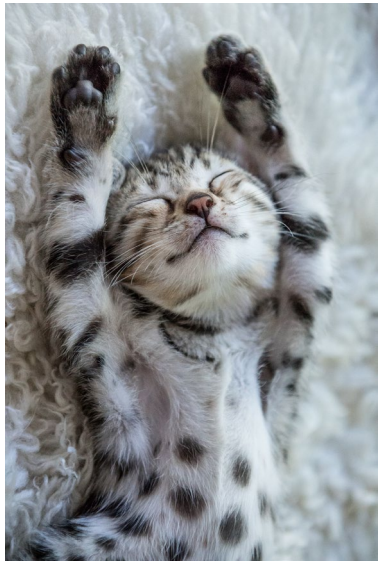
Original sequence

Ordering

(2, 3, 1, 4)

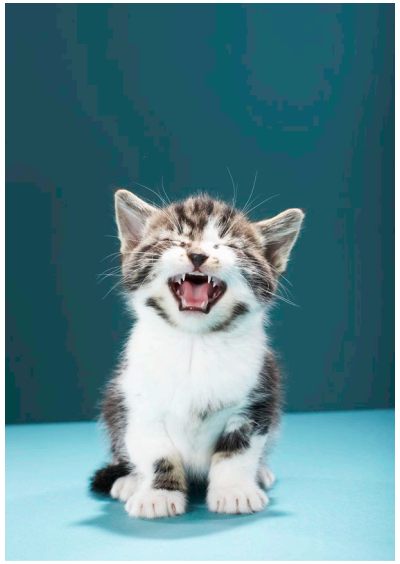
Ranking

Partial Ranks



(2,

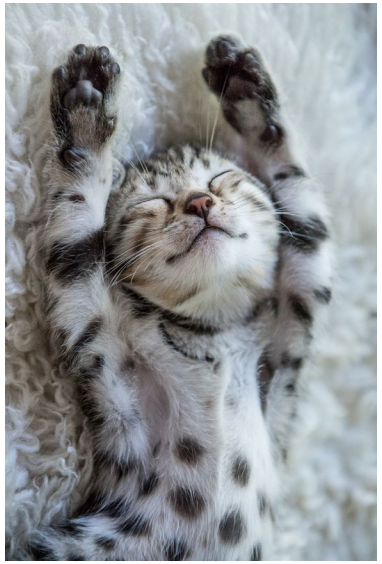
Not Ranked,



1,

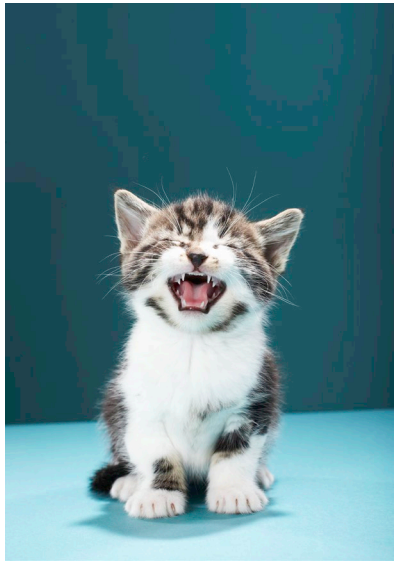
Not Ranked)

Ties



(1,

3,



1,

3)

First Responders Ranking Data

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PSCR Usability Team (2017-2022)

Kerrianne Buchanan
Social Scientist

Yee-Yin Choong
Human Factors Scientist

Shanée Dawkins
Computer Scientist

Susanne Furman
Cognitive Scientist

Kristen Greene
Cognitive Scientist

Kurtis Goad
Social Scientist

Kevin Mangold
Computer Scientist

Adam Pintar
Mathematical Statistician

Brian Stanton
Cognitive Scientist

Mary Theofanos
Computer Scientist

Michelle Steves
Computer Scientist
(retired)

Sandra Prettyman
Social Scientist
(NIST Associate)

Gavriel Salvendy
Distinguished Professor, University of Central Florida

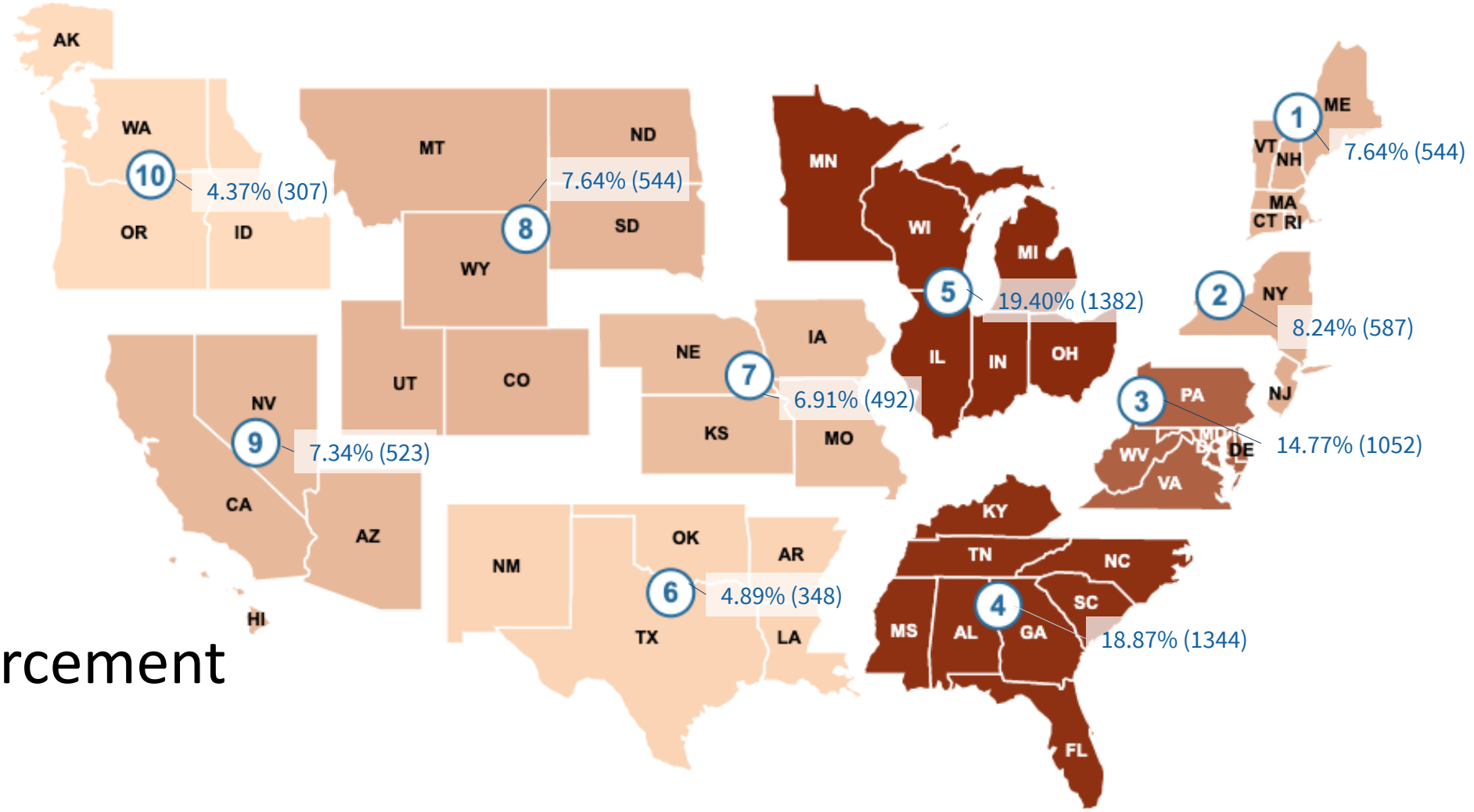
Survey Respondents by FEMA Region

911

EMS

Fire

Law Enforcement



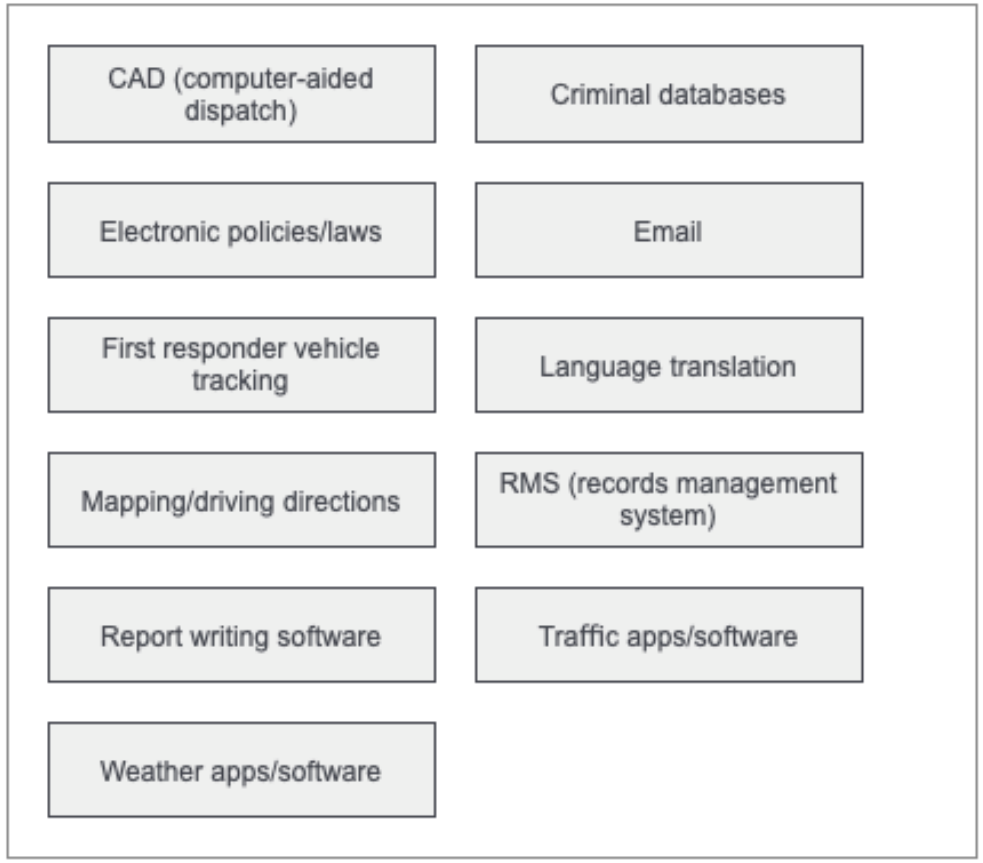
PSCR Usability Results Tool: Voices of First Responders (https://publicsafety.nist.gov/)

Ranking Survey Question

Use of technology in your DAY-TO-DAY work

Of the following applications/software, rank up to 5 that **are most useful** in your **DAY-TO-DAY** work, with 1 being the most useful.

Click or drag each item into a rank position.



Auxiliary Information (Area)

Rural

Urban/Suburban

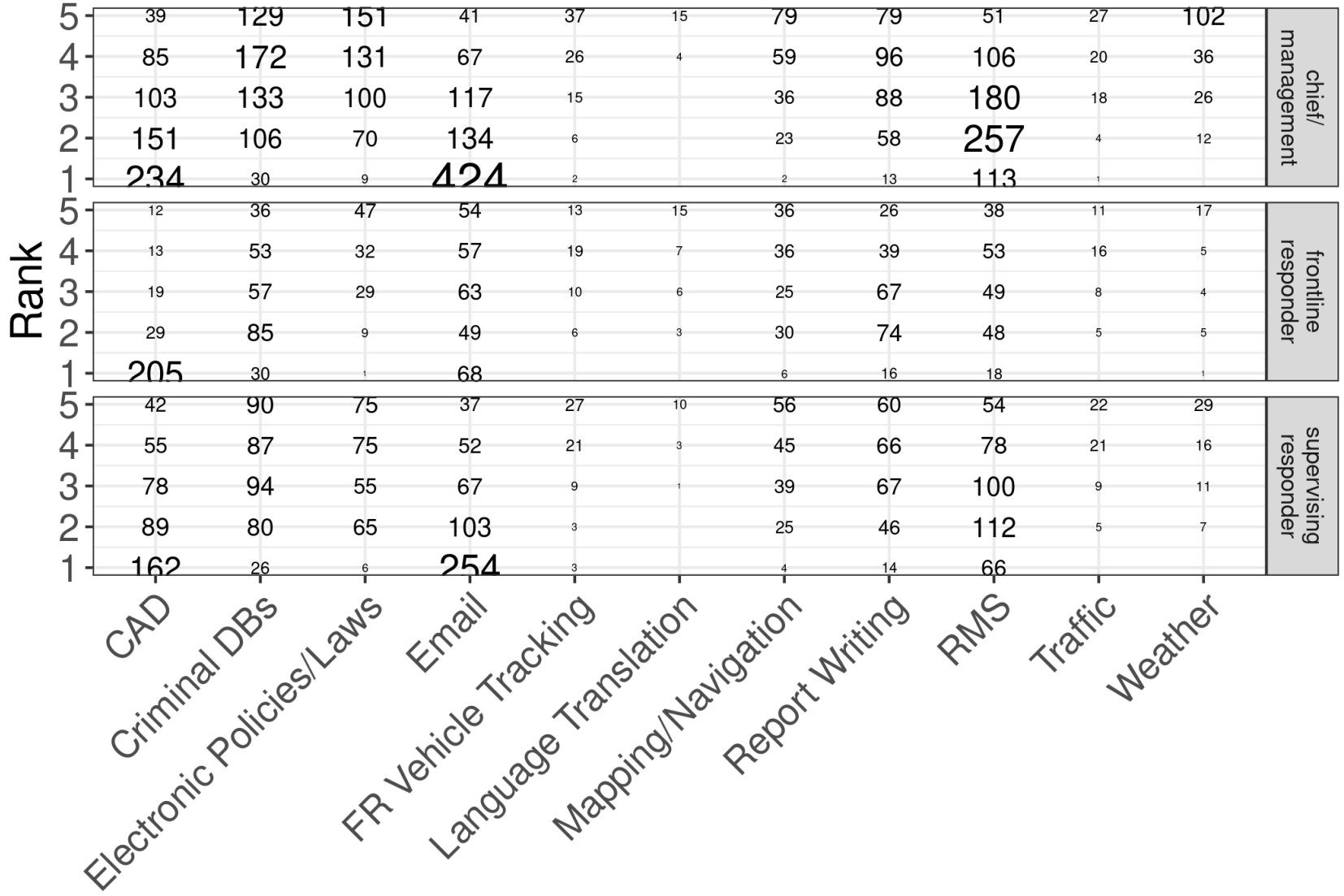
Auxiliary Information (Responder Roles)

Chief/Management

Supervising Responder

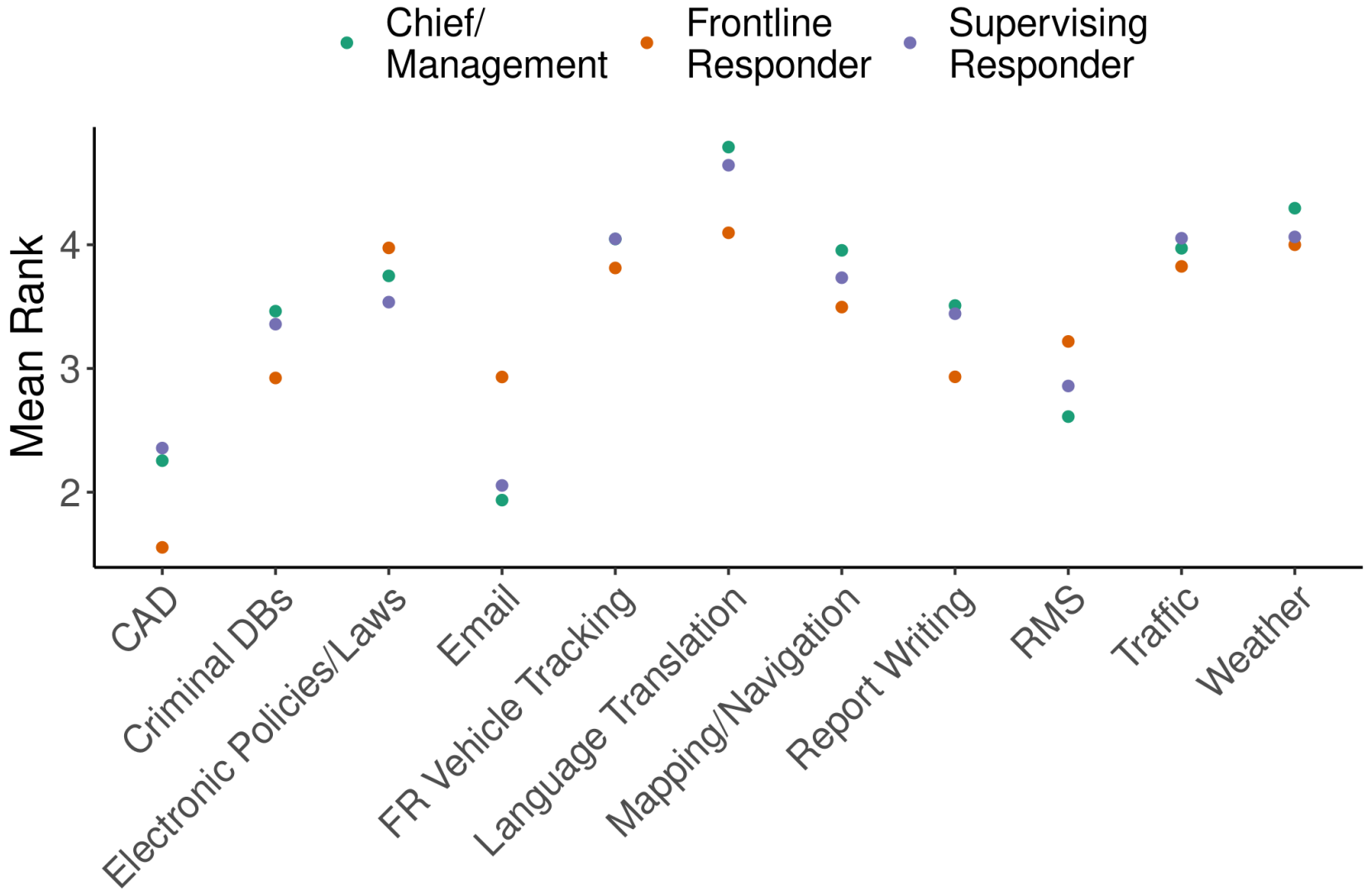
Frontline Responder

Marginals by Responder Role



CAD – computer aided dispatch; DBs – databases; FR – first responder; RMS – records management system

Mean Rank by Responder Role



CAD – computer aided dispatch; DBs – databases; FR – first responder; RMS – records management system

Plackett-Luce Model

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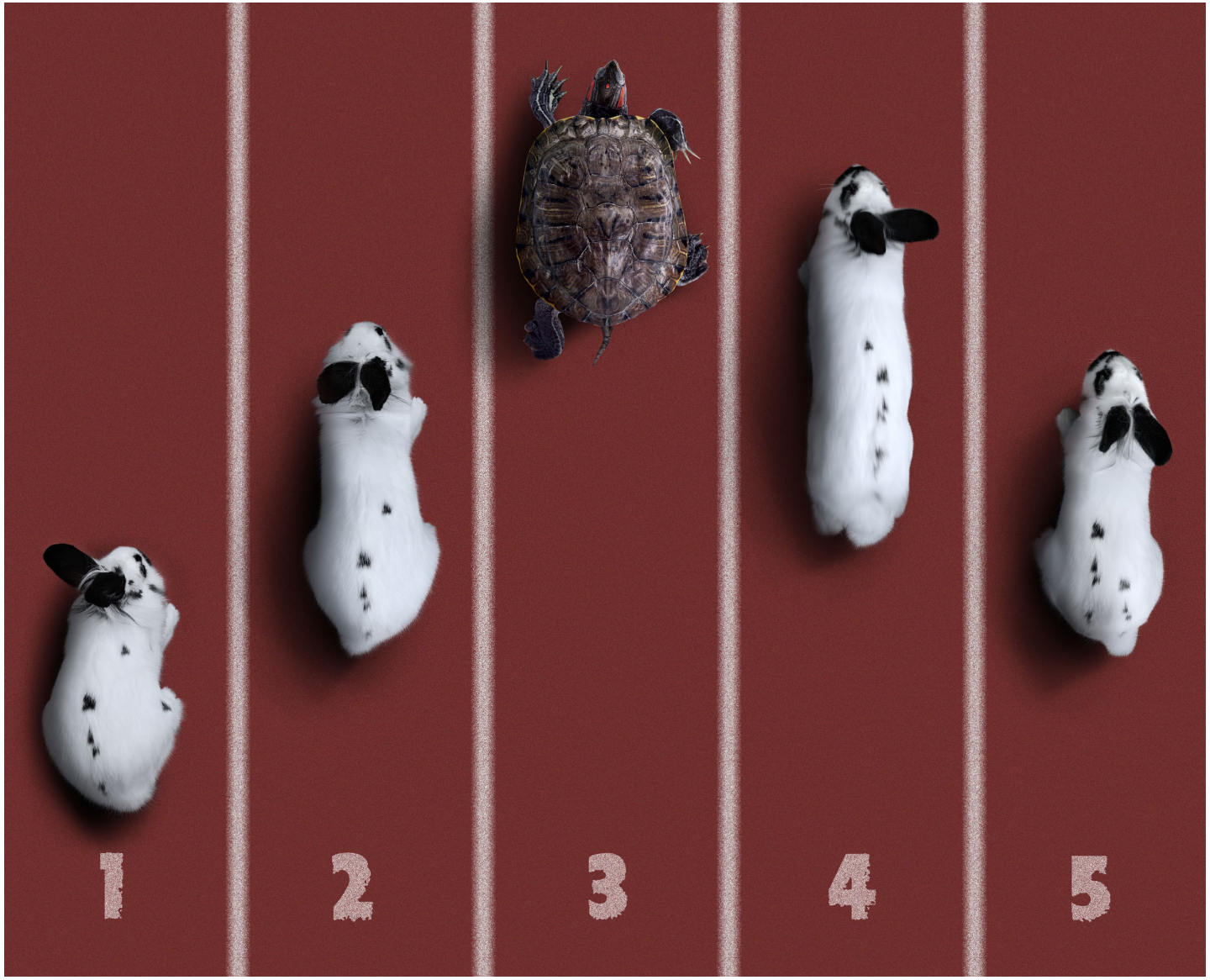
Track Racing Analogy



Translation to First Responder Ranks

Track Racing Analogy	First Responder Survey
Athletes →	Communication devices and applications
Track races →	Survey respondents

First Responder Results

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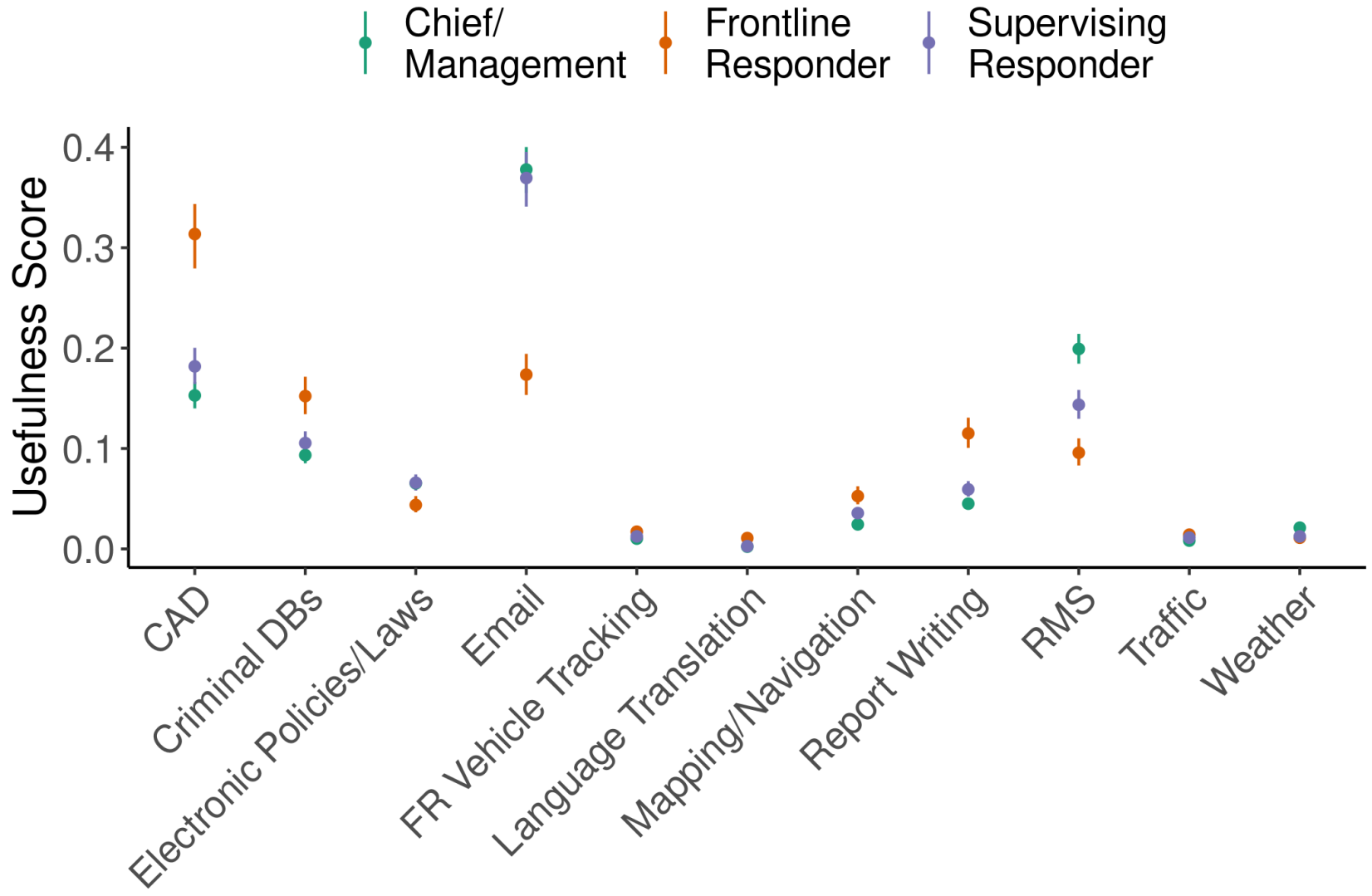
Law Enforcement – Software – Roles



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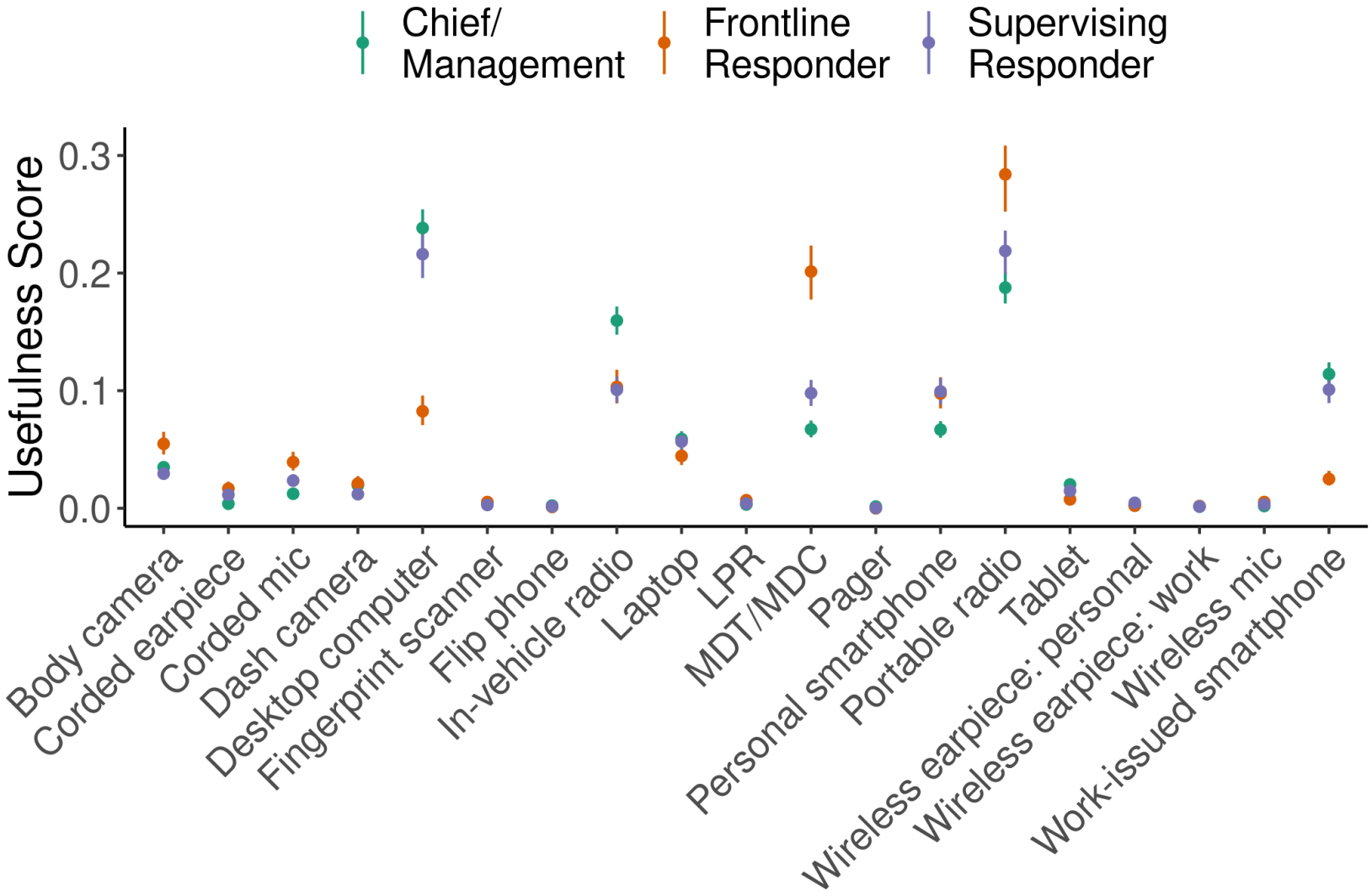
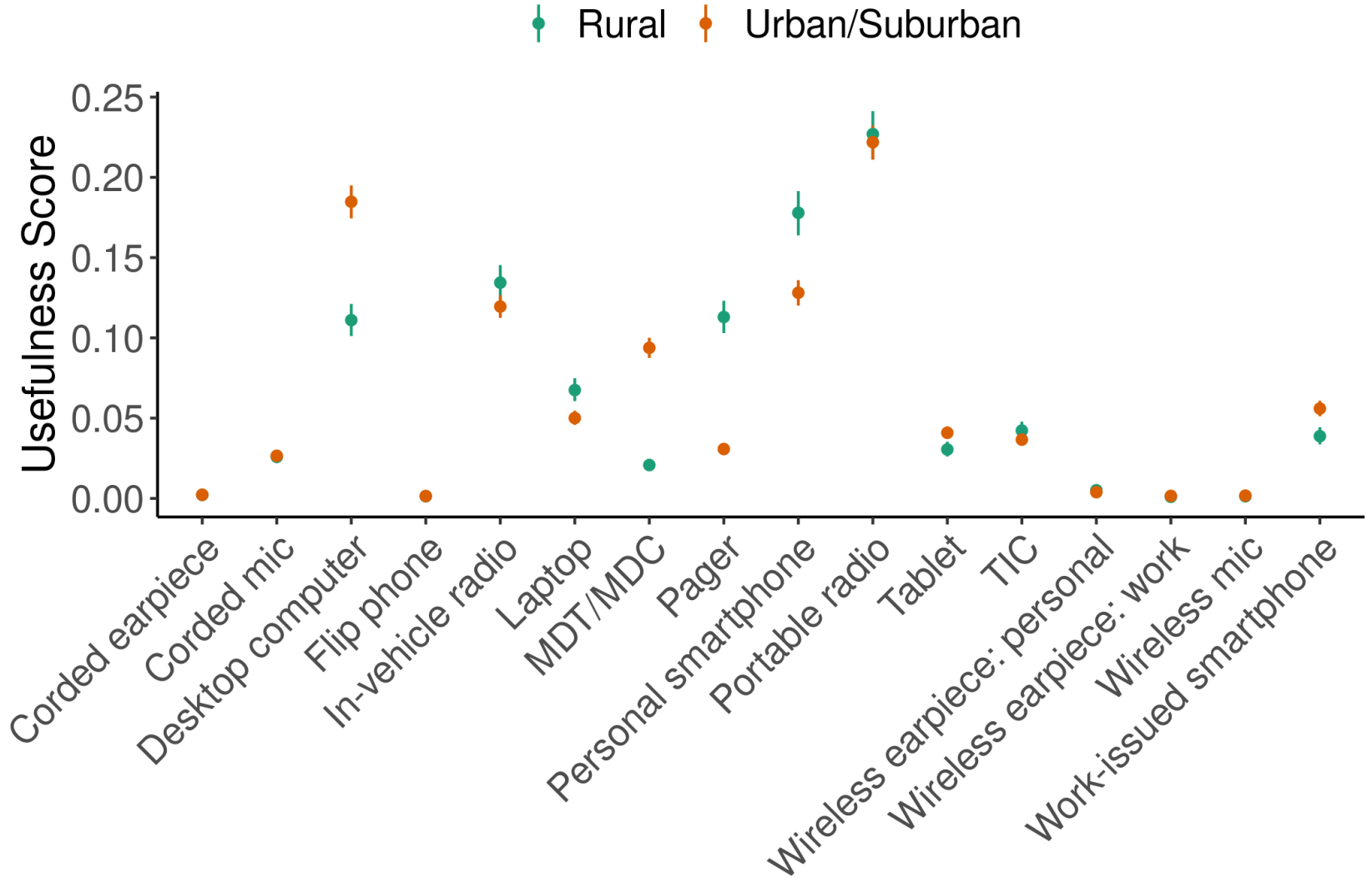
Law Enforcement – Devices – Roles



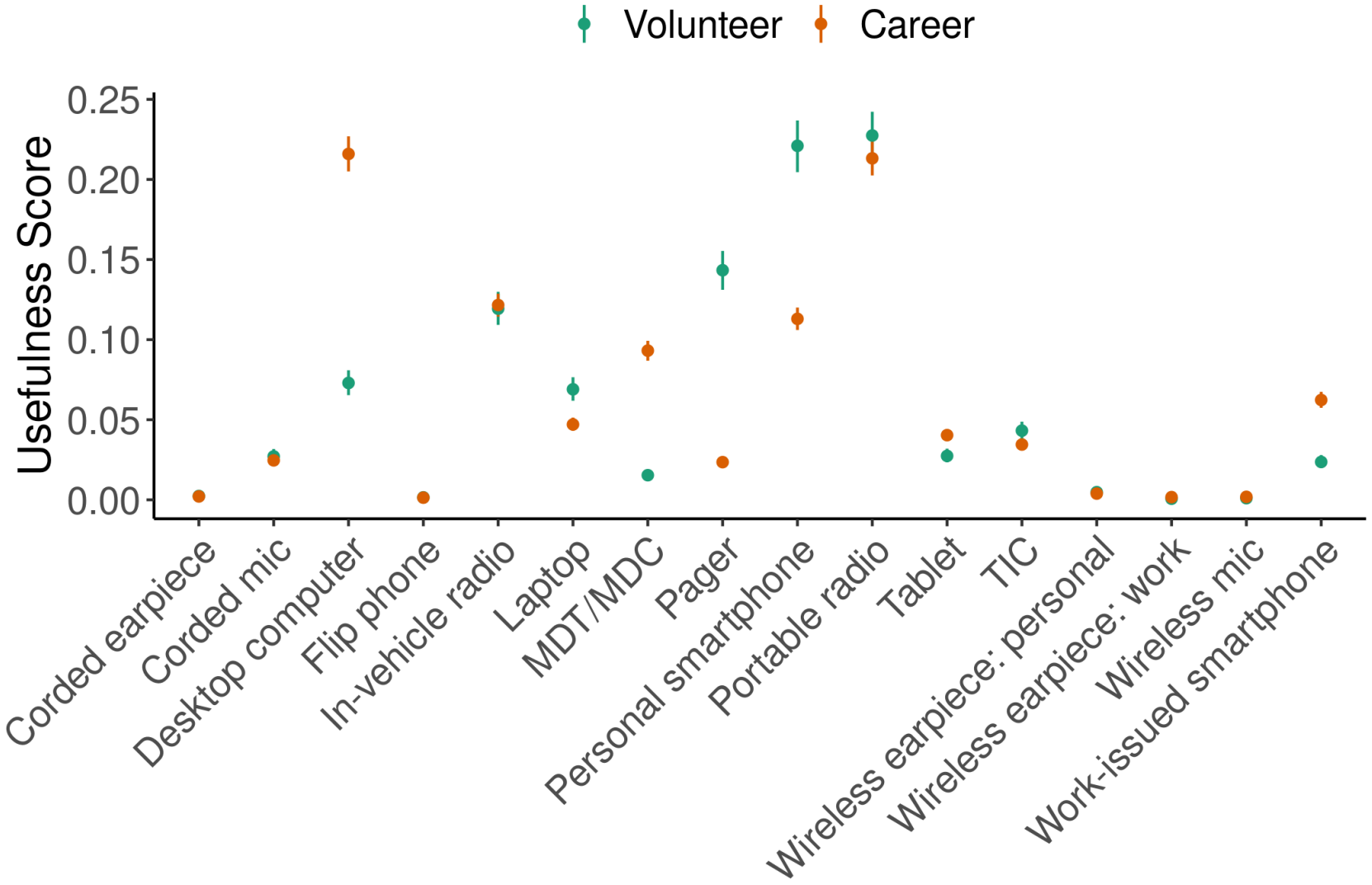
LPR – license plate reader; MDT/MDC – mobile data terminal/mobile data computer

Fire Service – Devices – Area



MDT/MDC – mobile data terminal/mobile data computer; TIC – thermal imaging camera

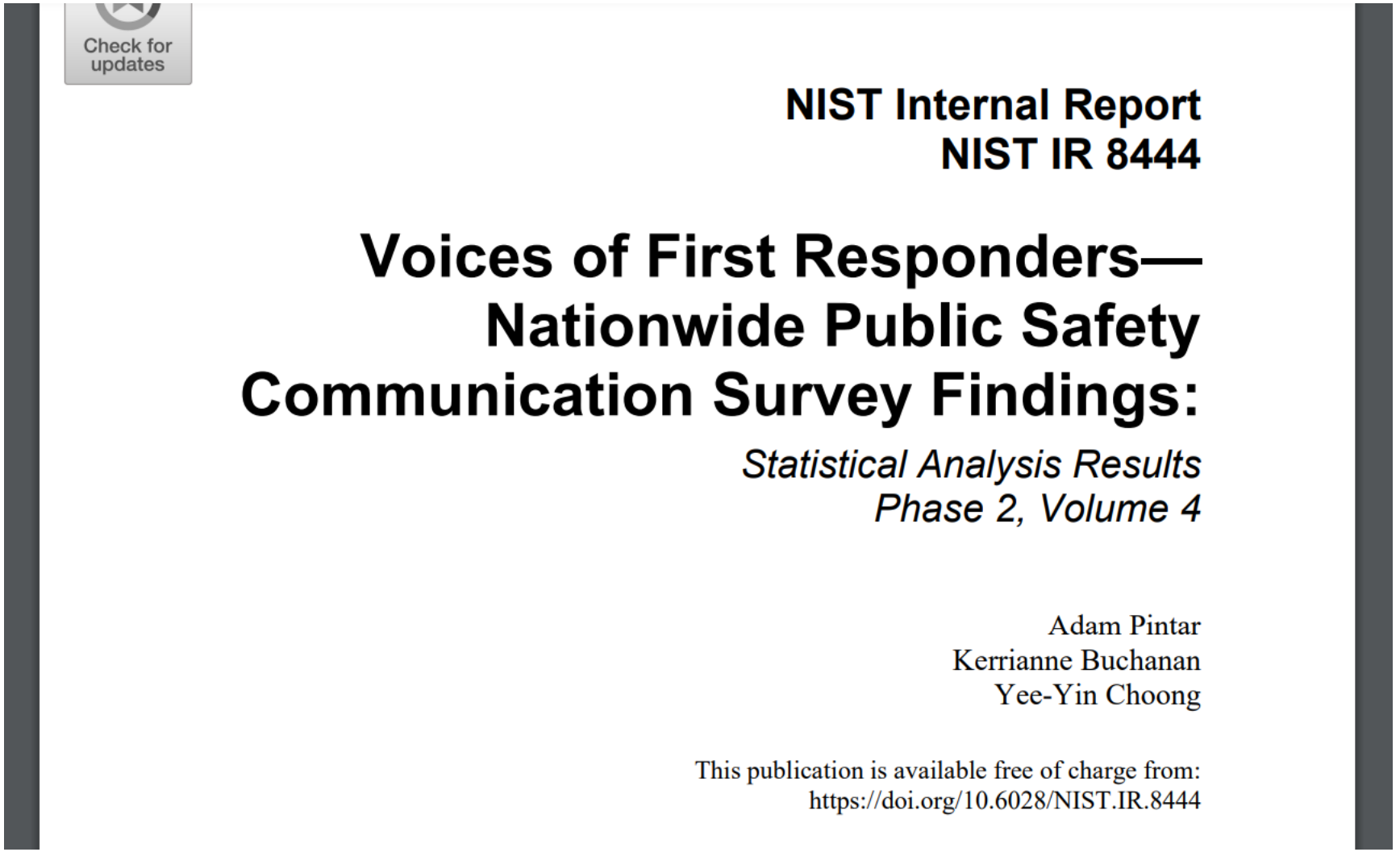
Fire Service – Devices – Career Status



MDT/MDC – mobile data terminal/mobile data computer; TIC – thermal imaging camera

All Results

https://nvlpubs.nist.gov/nistpubs/ir/2022/NIST.IR.8444.pdf



Check for updates

NIST Internal Report
NIST IR 8444

Voices of First Responders—Nationwide Public Safety Communication Survey Findings:

Statistical Analysis Results
Phase 2, Volume 4

Adam Pintar
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Yee-Yin Choong

This publication is available free of charge from:
https://doi.org/10.6028/NIST.IR.8444

R Software (Partial List)

R Package	Complete Rank	Partial Rank	Arbitrary Ties	Regression
PLMIX	✓	✓	✗	✗
mlogit	✓	✓	✓	✓
BayesMallows	✓	✓	✓	✗
PlackettLuce	✓	✓	✓	✗
StatRank	✓	✓	✓	✗
pmr	✓	✗	✗	✗
hyper2	✓	✓	✓	✗

Summary

- Ranking data can be thought of as a sequence of choices
  - The most basic choice is between two alternatives
- Survey of first responder communication preferences and needs
  - More than 7,000 respondents
  - Communication Center & 9-1-1 Services, Emergency Medical Services, Fire Service, Law Enforcement
- Analysis of ranking data
  - Plackett-Luce model
  - Elucidate preference differences between subgroups
- Software for calculations
  - Variety of open source options
  - Base decision on needs