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U.S. Army Research, Development and Engineering Command

# Soldier Decision-Making for Allocation of Intelligence, Surveillance, and Reconnaissance Assets

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**Jonathan Bakdash**
**Human Research and Engineering Directorate, U.S. Army Research Laboratory**

**Diego Pizzocaro & Alun Precee**
**School of Computer Science and Informatics, Cardiff University, UK**

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# Background



- Intelligence, Surveillance, and Reconnaissance is the “hub” of 21st century military operations

  (Lt General Deptula, US Airforce, AAAI Keynote, 2010)

- Hard information sources: Physical sensors
- Objective Soldier decision-making ISR allocation

# Example of Sensor Capabilities



Allocation decisions and

sensor platform capabilities

- Identify the license plate
- Detect a vehicle
- Identify the vehicle as a four door sedan

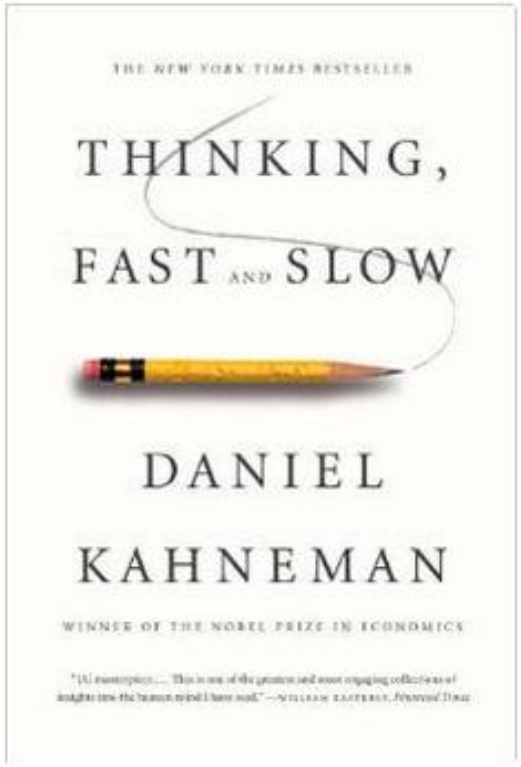
*High*

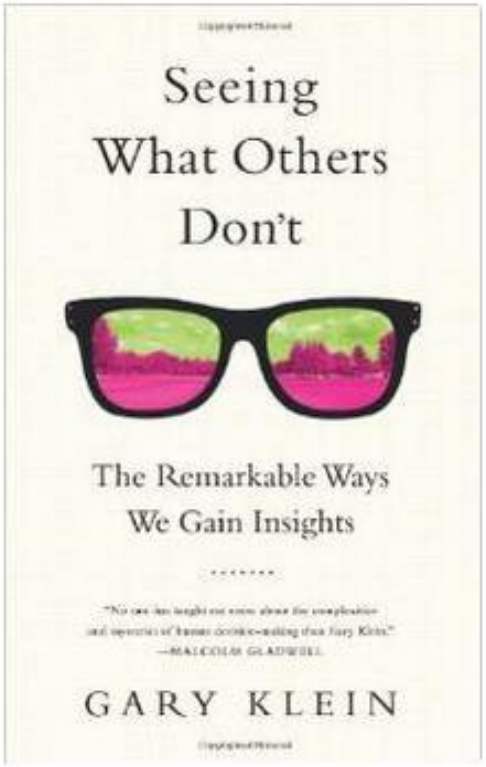
**Sensor Capabilities**

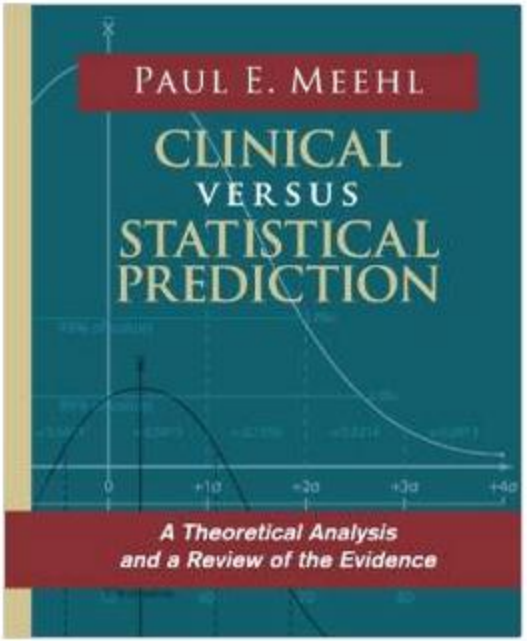
*Low*

# Decision-Making Theories






- Heuristics and biases (Kahneman and Tversky)
- Naturalistic decision-making (Klein)
- Statistical (actuarial) judgments (Meehl)

# Hypotheses

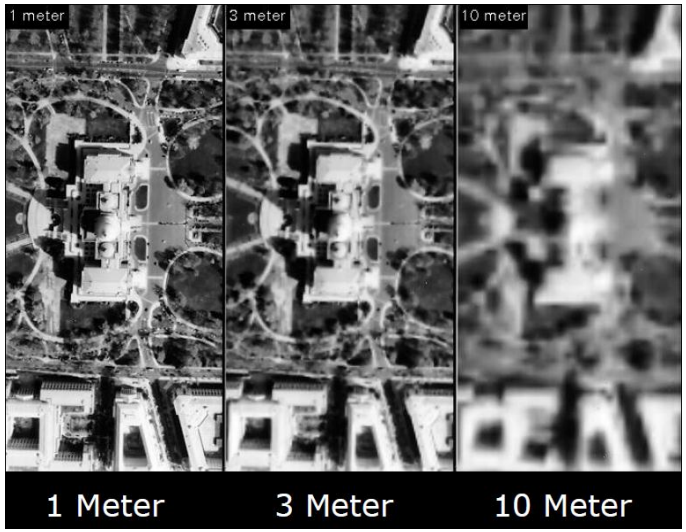


1) Complete information on sensor capabilities will result in greater allocation decision accuracy
2) Even with complete information, decision accuracy will be less than 100%

# Decision-Making Task

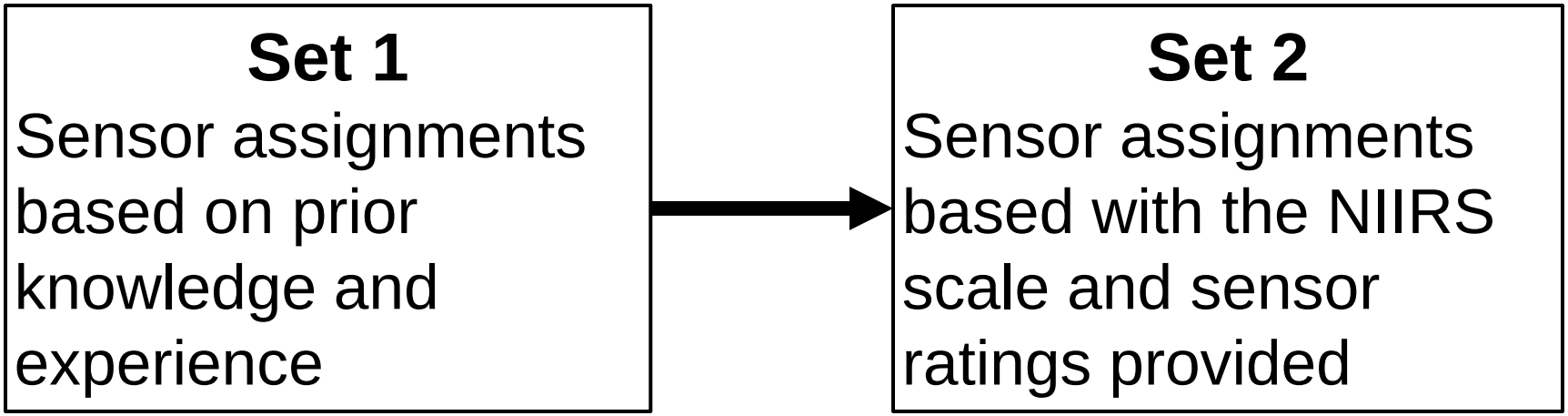


- Objective decision-making tasks
  - Identify a license plate
  - Moving car, jeep, or Humvee
- Ground truth: National Imagery Interpretability Reconnaissance Scale (NIIRS)
- Unclassified/open-source sensor ratings



# Study Design



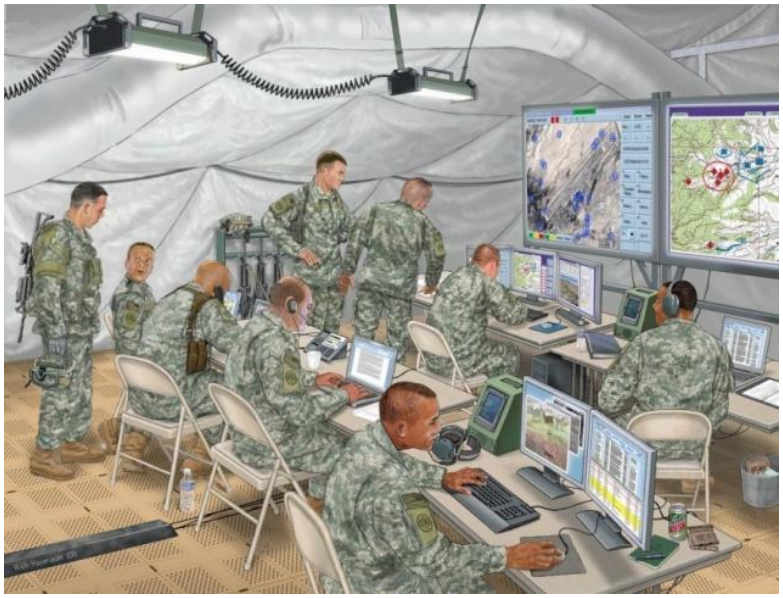



- 5 ISR platforms with visible, infrared, and/or radar sensors
- 8 detection/identification tasks
- 208 allocation decisions (104 for each set) per Soldier

# Soldiers

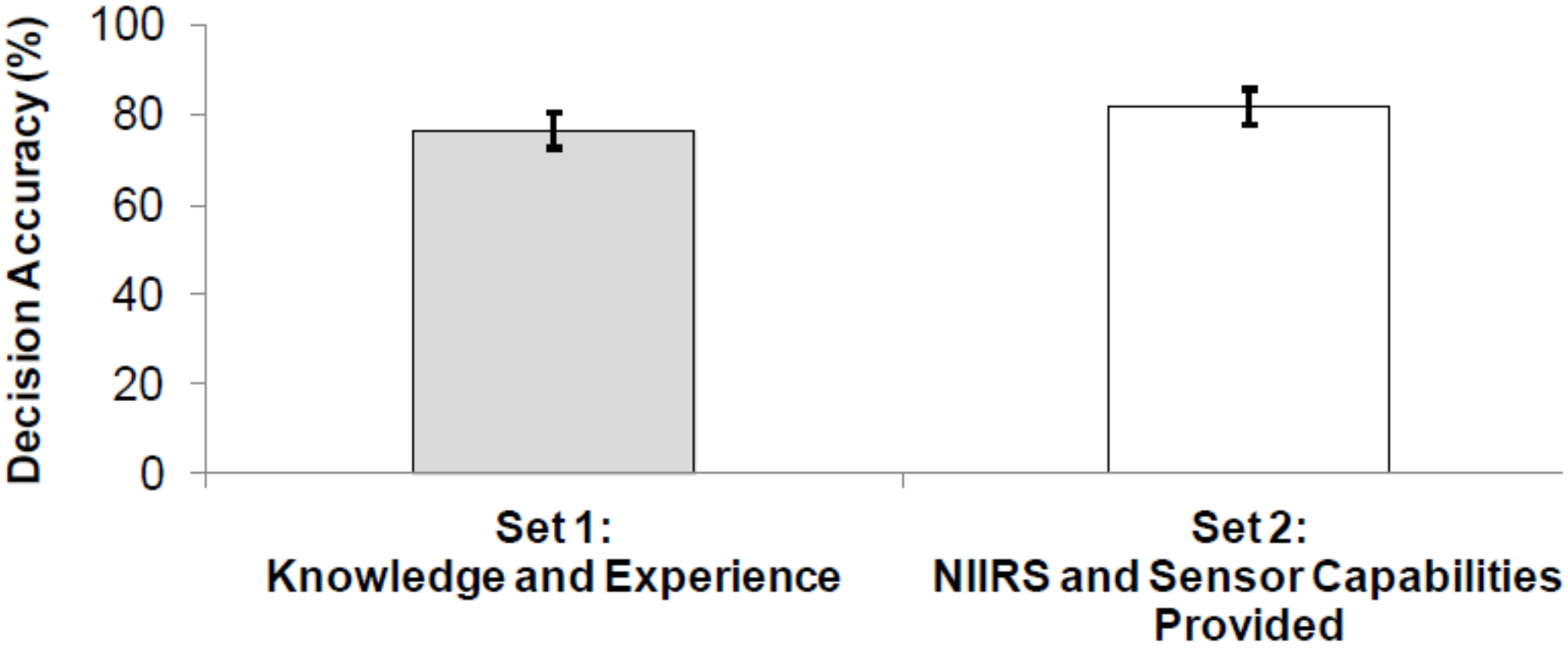


- **Recruitment**
  - Operational experience with ISR
  - Umbrella Week
  - 10 Soldiers
- **Background and Rank**
  - 7 out of 10 Intel Analysts
  - Rank: Sergeant to Captain
  - Echelon: Most Battalion to Brigade



# Decision Accuracy





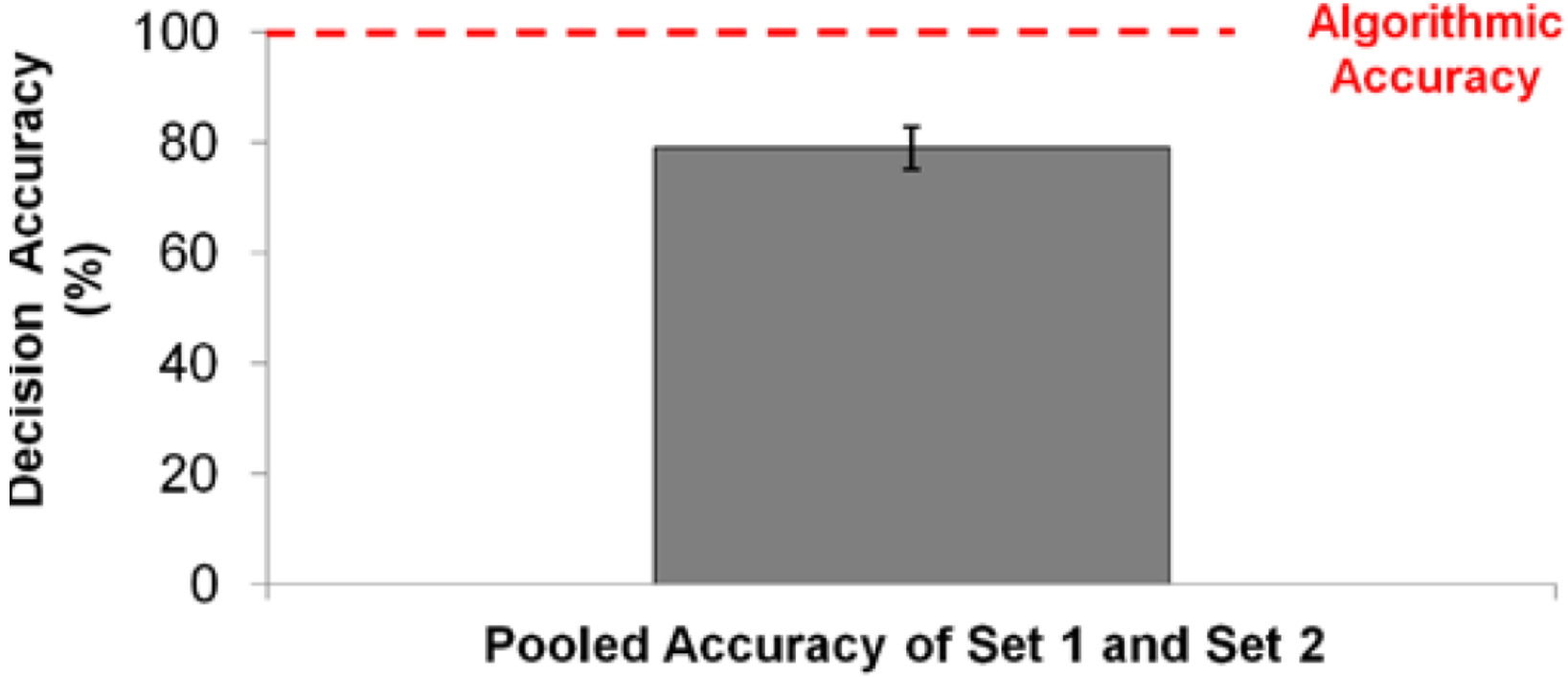

Error bars represent one bootstrapped standard error of the mean.

$p < 0.05$

$d = 0.59$ (95% CI: 0.04 - 2.84 percentile bootstrap)

# Decision vs. Algorithmic Accuracy






$p < 0.001$

$d = 1.77$ (95% CI: 1.42 - 4.23 percentile bootstrap)

# Summary of Results



- Decision-making accuracy for allocation of ISR under was 100%, despite complete information and no time pressure

- Exploratory results
  - Accuracy comparable across ISR assets
  - Moderate confidence in sensor assignments
  - Most relied on NIIRS information in Set 2

# Limitations



- Unclassified sensor capabilities
- No SIGINT
- Small sample size
- Simplified task: Only sensor assignments

# Discussion



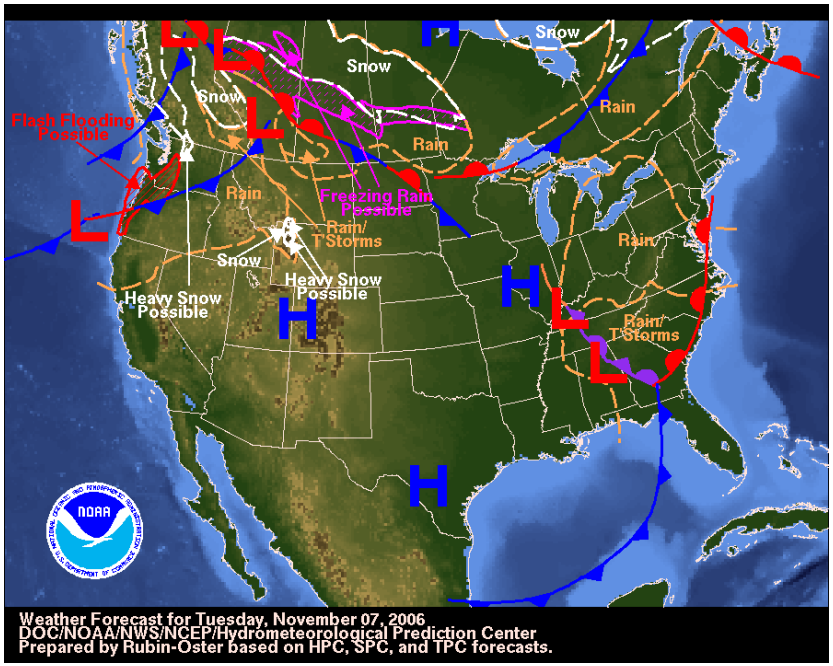
- **Automation**
  - Algorithm limitations
  - Complacency
  - Human supervisory control
  - Transparency

**Flying lawnmowers:**
Loud acoustic signature of some UAVs

# Human Computer Collaboration



Human and intelligent system work towards a common goal (Terveen, 1995)




Optimal weather forecasting accuracy: Human plus adjustable computer models (Silver, 2013)

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# Human Computer Collaboration for ISR

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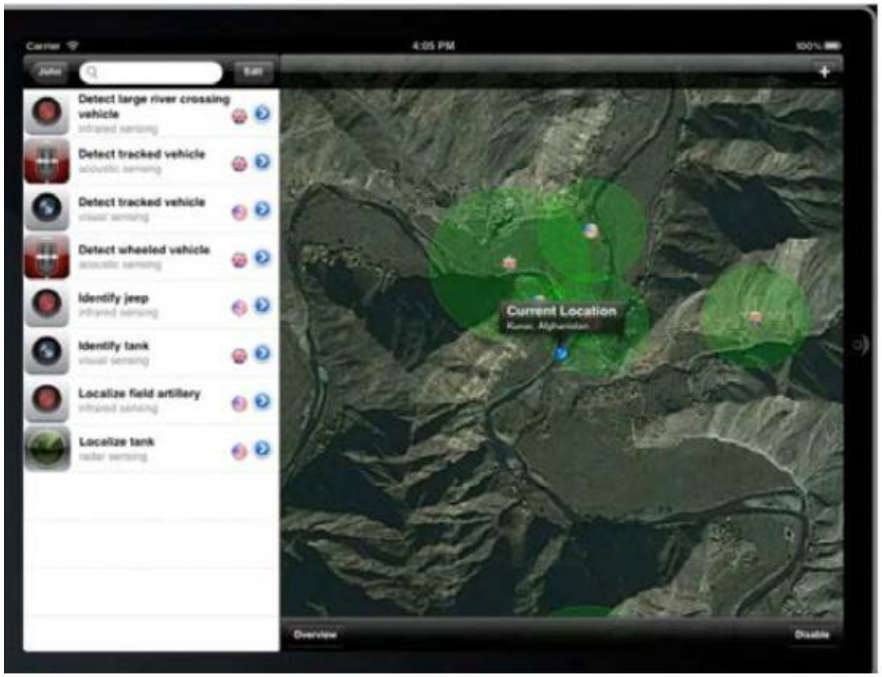
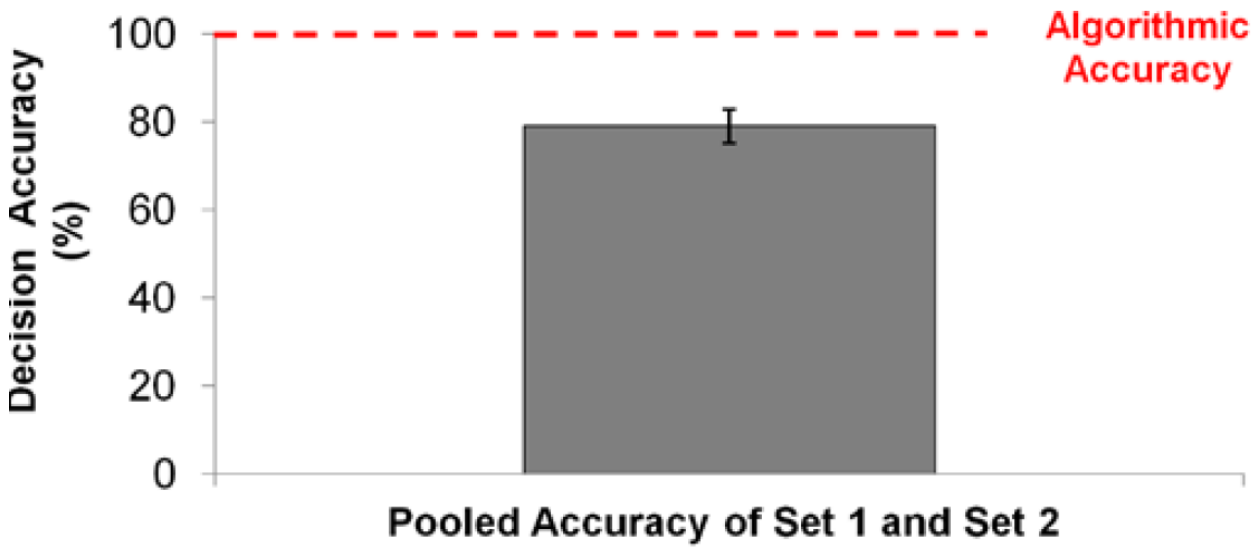



Research grade prototype technology for ISR

(Pizzocaro et al. 2011; Preece et al. 2013, 2014)

# Conclusion






- Empirical evidence for a technology gap
- Technology cannot completely replace human decision-making for ISR
- Need for technology?

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