QUANTUM IMPROVEMENTS CONSULTING

CTTSO *Combating Terrorism Technical Support Office*

Modeling Performance for Marksmanship Training Tools

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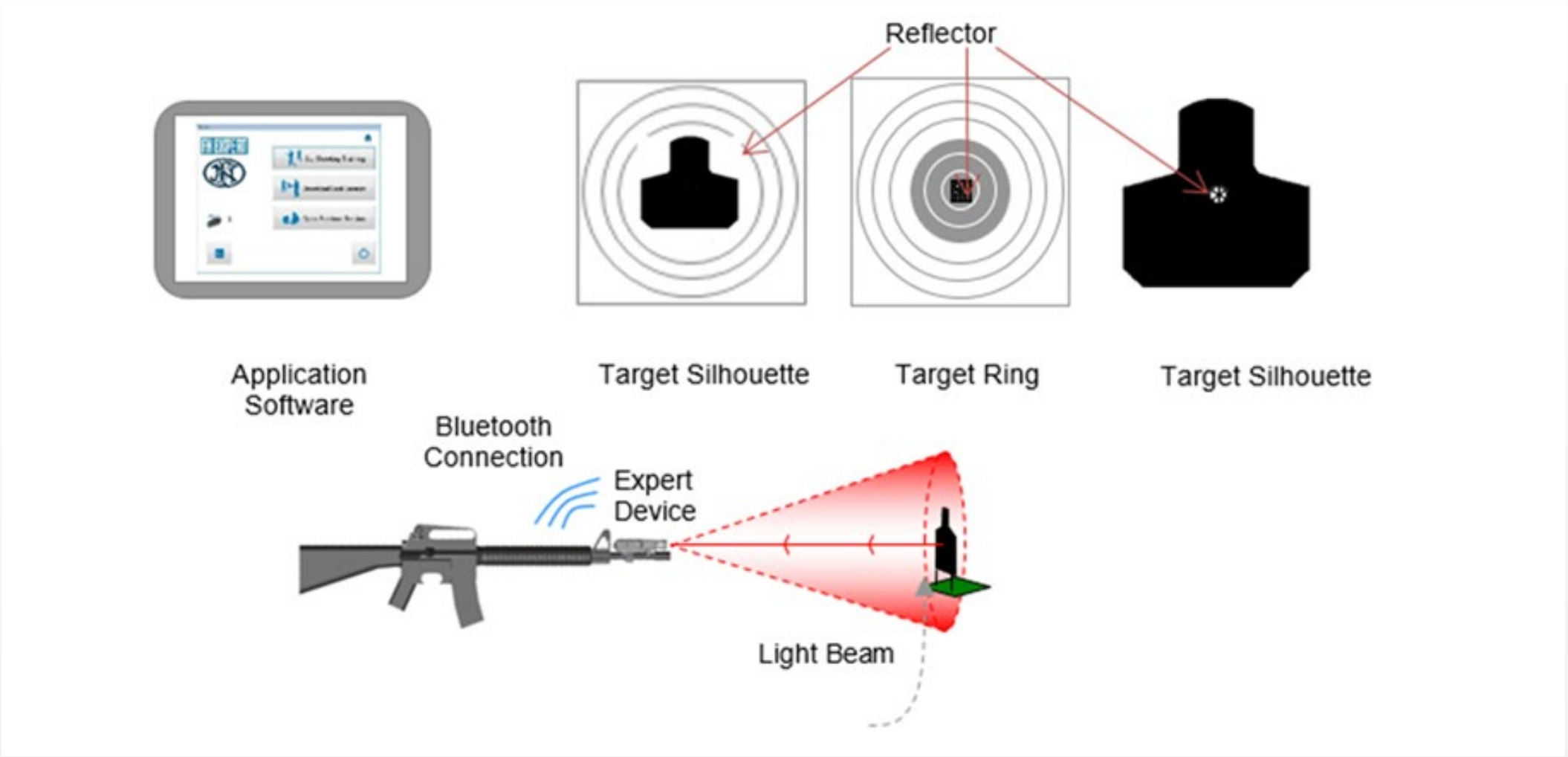
Purpose

- Marksmanship skills are critical for the U.S. Marine Corps but are expensive, time-consuming and labor-intensive to develop
- Shooters with skill deficiencies cause bottlenecks in the training process, as instructors must take additional time to remediate
- Skill deficiencies can be difficult to diagnose and multiple instructors may be required to provide remediation

Purpose

- Provide an automatic evaluation of fundamental marksmanship skills to support instructors
- Data Source: Rifle-mounted aim-trace sensor

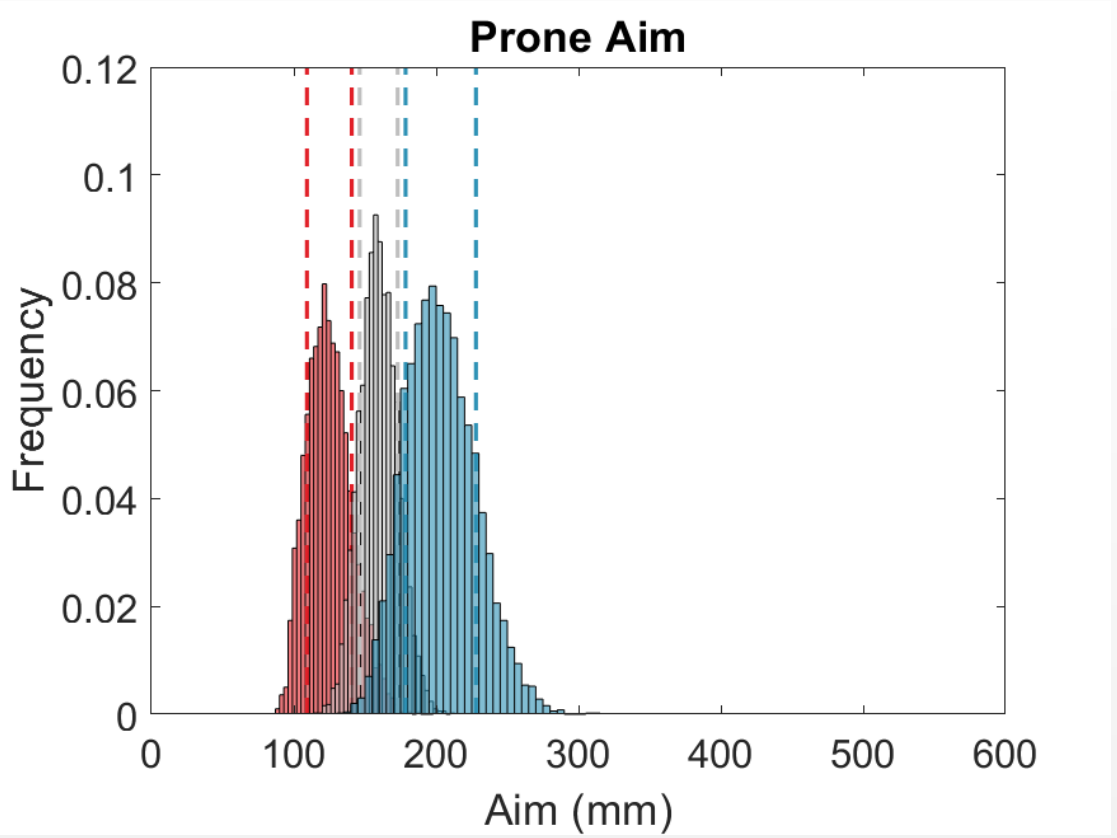
Data Collection System



Project Goals

Improved Instructor Experience

Algorithm Development and Validation



Needs Analysis

- US Marine Corps Weapons Training Battalion Instructors were interviewed about information and features that would assist in training.
- As a result of these interviews, several features were incorporated into software development:
  - Commenting function so instructors can add comments to shots
  - Video playback of shots were included
  - Timeline of shot was color-coded
  - Legends of markers were added
  - Icons were updated to be more intuitive

Software Development & Testing

- Data Collection and Data Management software designed to display the same visualization (good, moderate, poor), use the same cutoff scores, and maintain same ‘look and feel’
- Systems both tested for usability throughout the development process
  - Usability conducted with Weapons Training Battalion instructors at Quantico, VA and Weapons and Field Training Battalion instructors at Camp Pendleton, CA
  - Systems updates include: new icons, new timeline colors, shot grouping visualization

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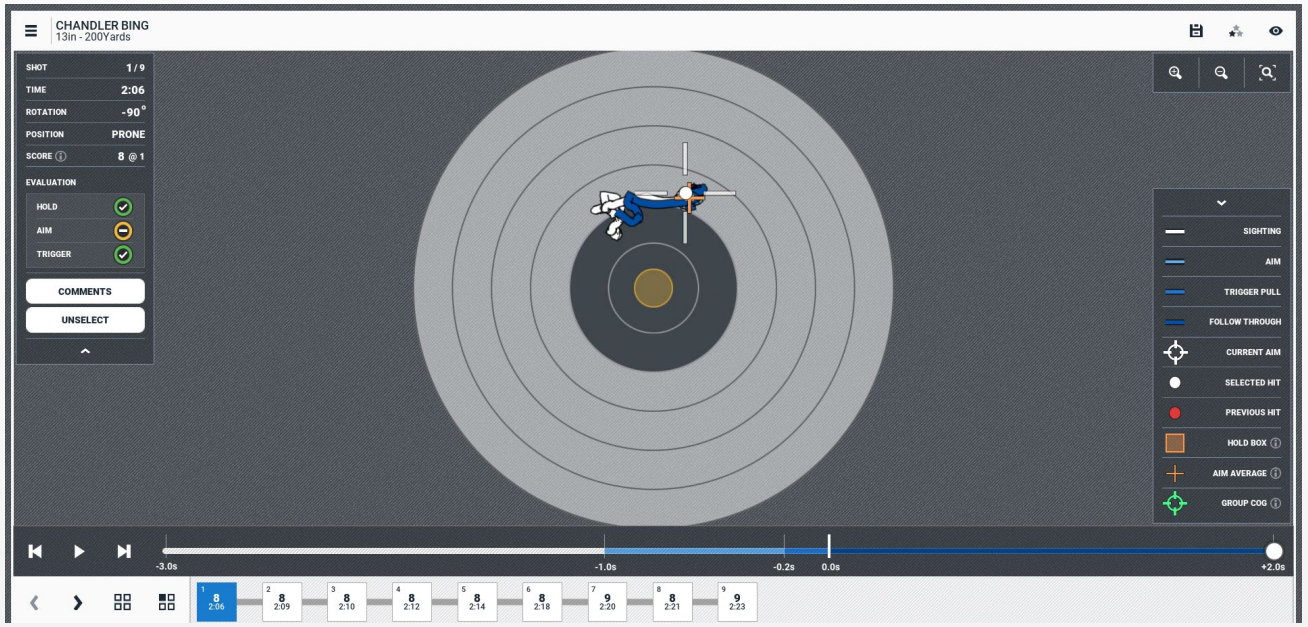
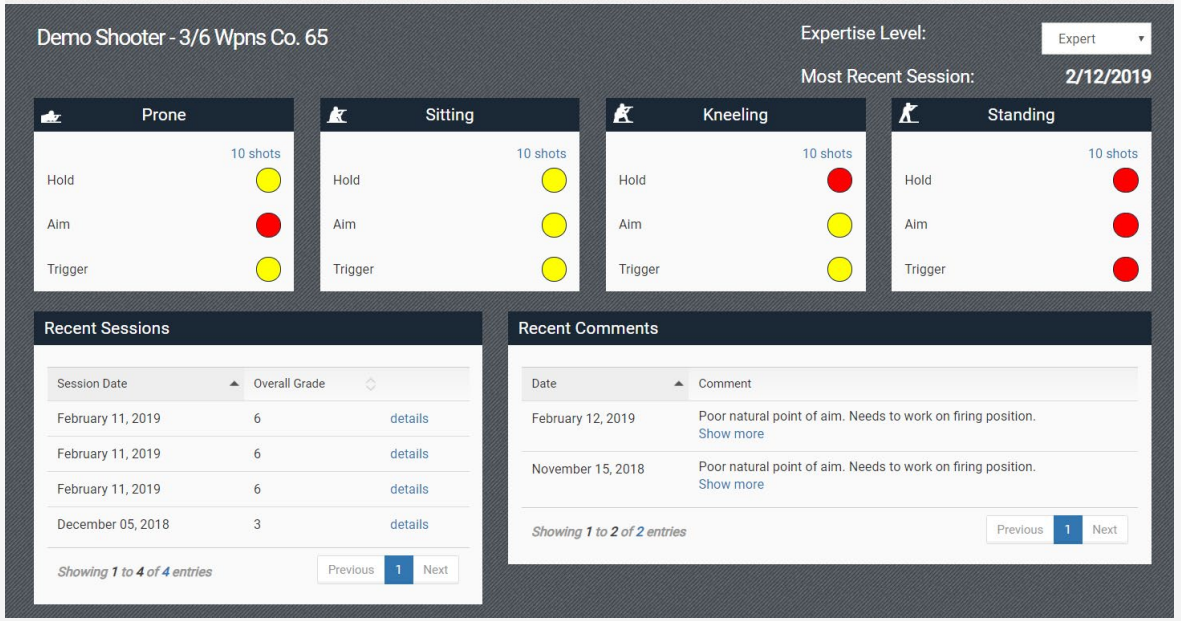
Software Development

Data Collection Software



Data Management Software



Data Collection & Model Development

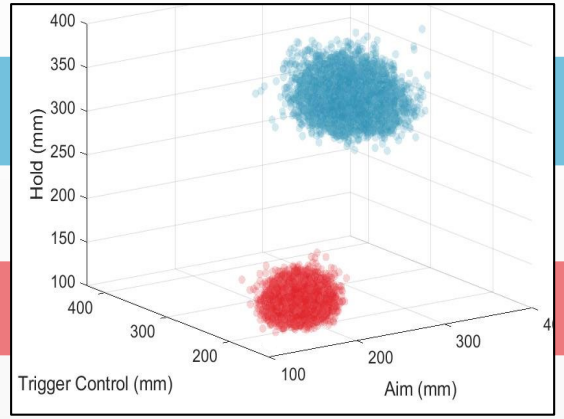
- 3 Data Collection Events
  - Quantico, VA
  - Camp Pendleton, VA
  - Quantico, VA
- Experts and novices took 10 shots in each shooting position at dry fire simulated distance 200 yards
- Performance was used to determine whether the system can discriminate between experts and novices and to create evaluation criteria

Shooter Performance Data Collection 1

- US Marine Corps Shooters at Quantico, VA
- Expert Shooters (n = 7)
- Novice Shooters (n=8)
- 10 shots in each position (prone, sitting, kneeling, standing)

Prediction of Competency Level

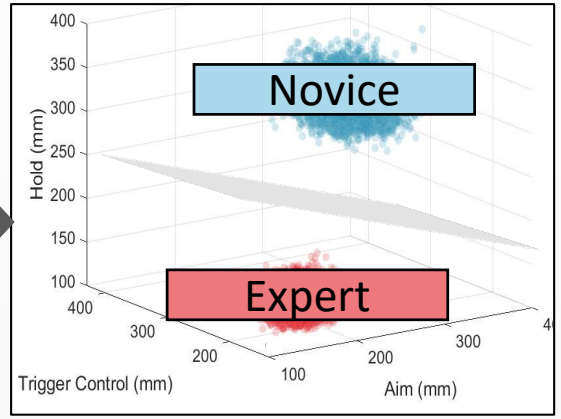
Step 1: Build Model



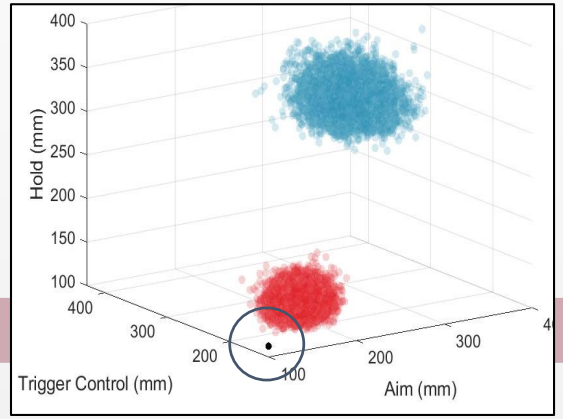
Novice Data

Expert Data

Train model (Linear Discriminant Analysis)

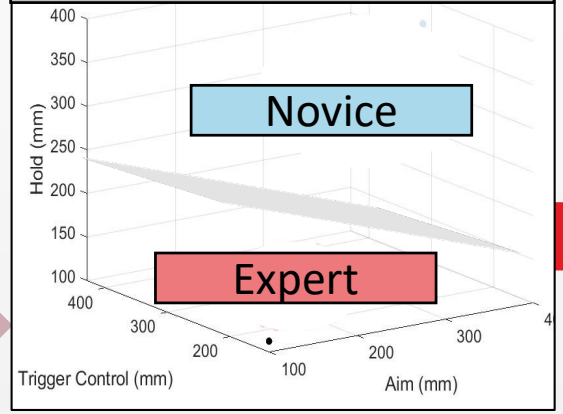


Step 2: Classify Shooter



Data

Trained model



Classify Shooter: Novice or **Expert**

Lower scores indicate better performance

Predict Competency Level

Prone Prediction Accuracy:
87%

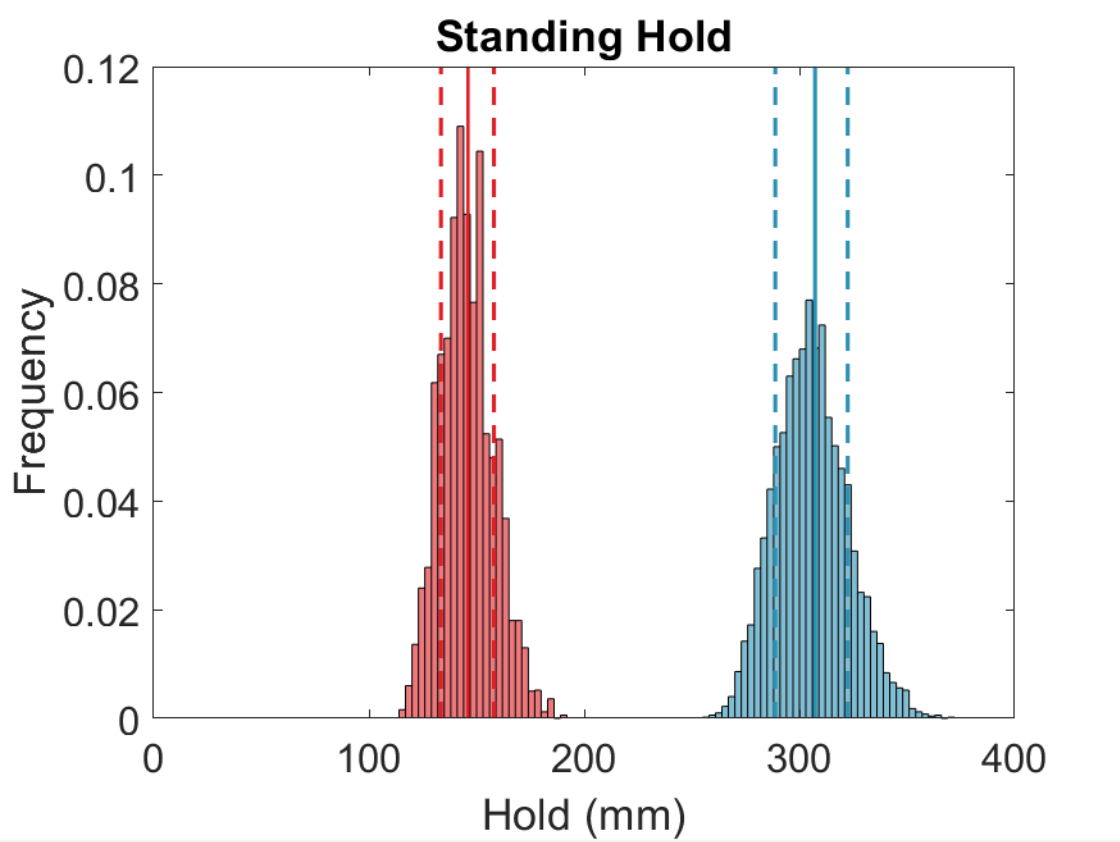
Sitting Prediction Accuracy:
80%

Kneeling Prediction Accuracy:
87%

Standing Prediction Accuracy:
100%

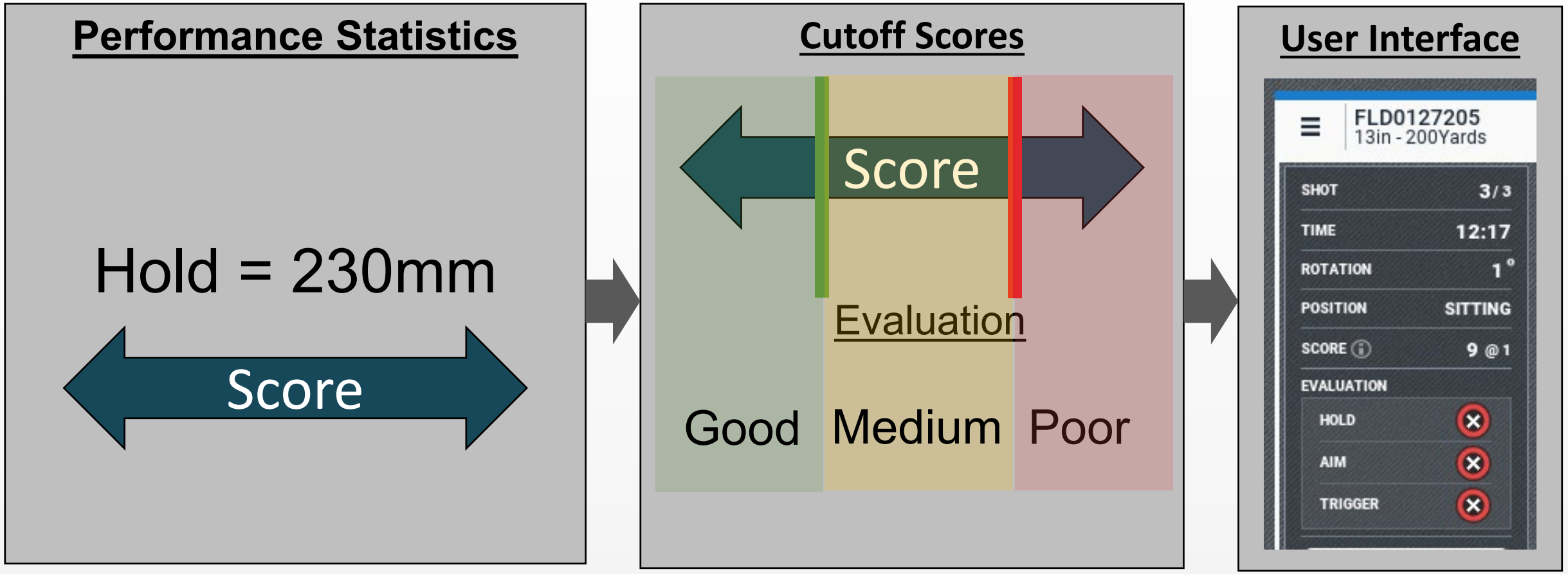
- Shooters can be accurately be classified as novices or experts, on average, 89% of the time *based on data from other shooters*.

Modeling Individual Skills



- Skills: Aim, Trigger Control, Hold
- Firing Positions: Prone, Kneeling, Sitting, Standing
- Scores were bootstrapped 5000 times to generate means and 95% confidence intervals

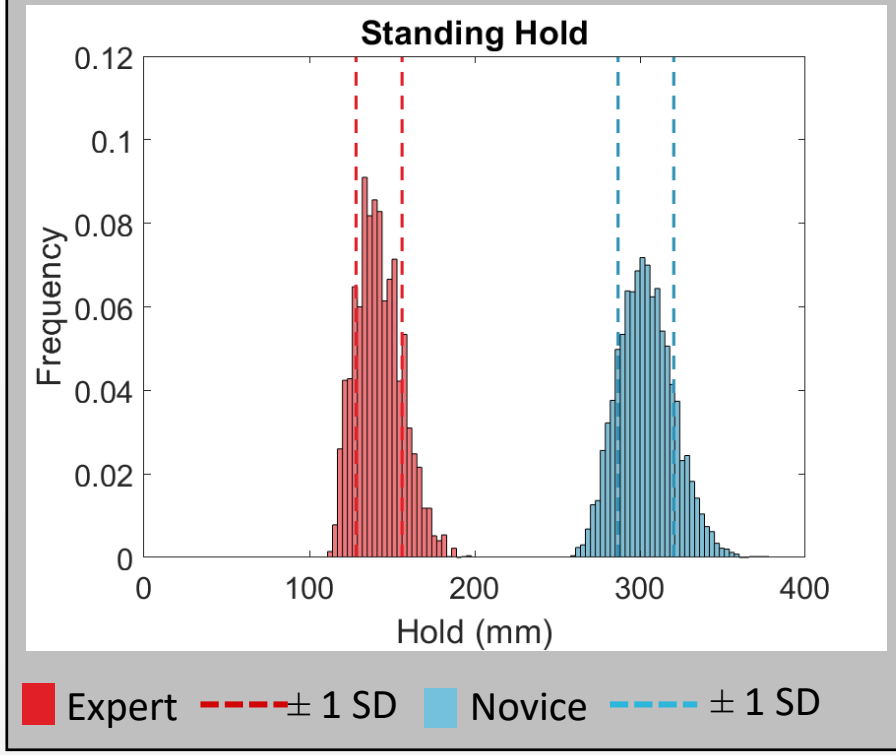
Expert ----- 95% CI Novice ---- 95 % CI



- Cutoff scores need to be created to **evaluate** performance as good, medium, or poor

System Updates

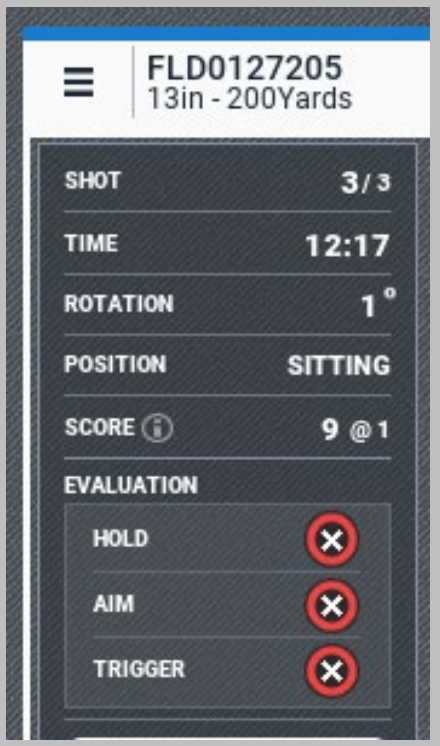
Performance Statistics



Cutoff Scores

		Hold		
		Good	Neutral	Bad
		≤	≤	>
Standing	Expert	133.42	158.00	158.00
	Marks	212.75	258.54	258.54
	Unq	289.09	322.12	322.12

User Interface



- Performance statistics (mean, 95% CI) were used to create cutoff scores.
- These cutoff scores were incorporated into software and visualized in the user interface to provide diagnostic information about shooter performance.

Shooter Performance Data Collection 2 & 3

Data Collection 2

12 Experts, 10 Novices at Camp Pendleton, CA

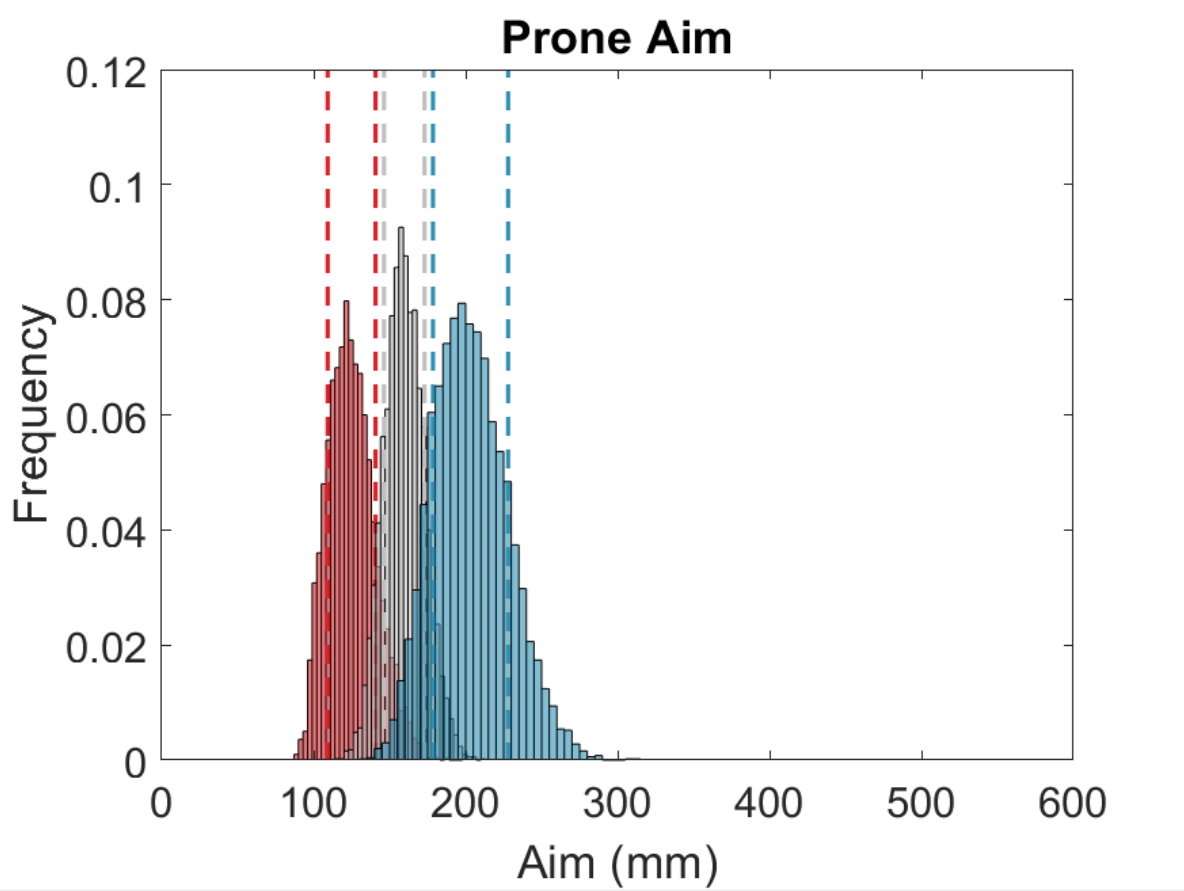
- 10 shots in each position (prone, sitting, kneeling, standing) at simulated distance 200 yards

Data Collection 3

13 Experts, 13 Novices at Quantico, VA

10 shots in each position (prone, sitting, kneeling, standing) at simulated distance 200 yards

Updates



- Data from all data collection sites were collapsed, expert and novice scores were bootstrapped to generate new performance distributions.
- Moderate distribution was created by combining novice and expert scores
- Criterion Scores were updated to reflect combined data

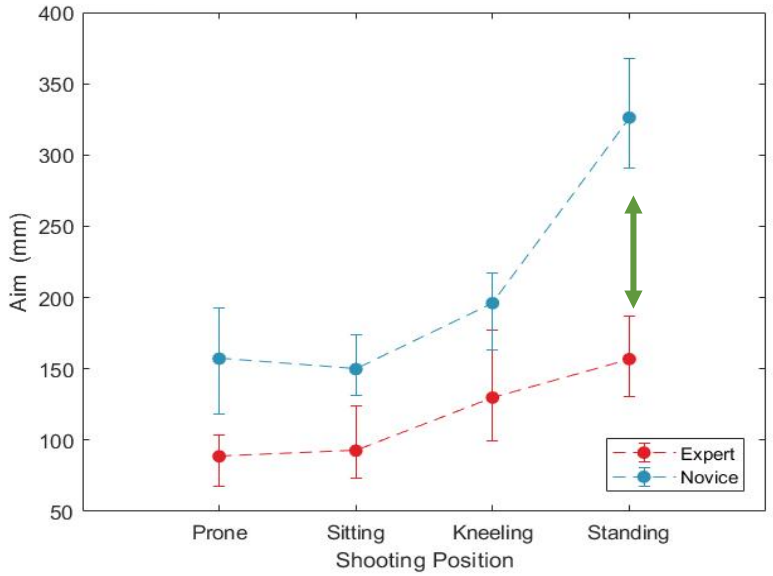
Questions?

Backup

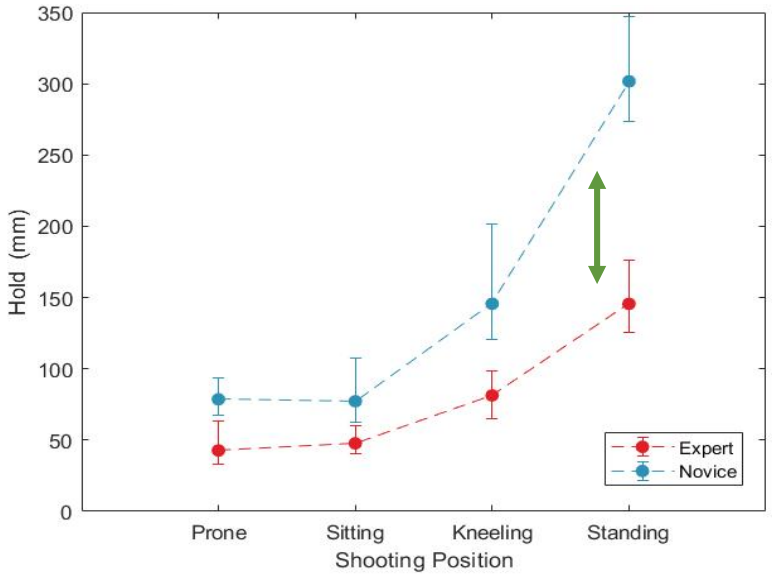
2. Individual Skills

- Experts perform better than novices across all skills
- These differences are greatest in the standing position

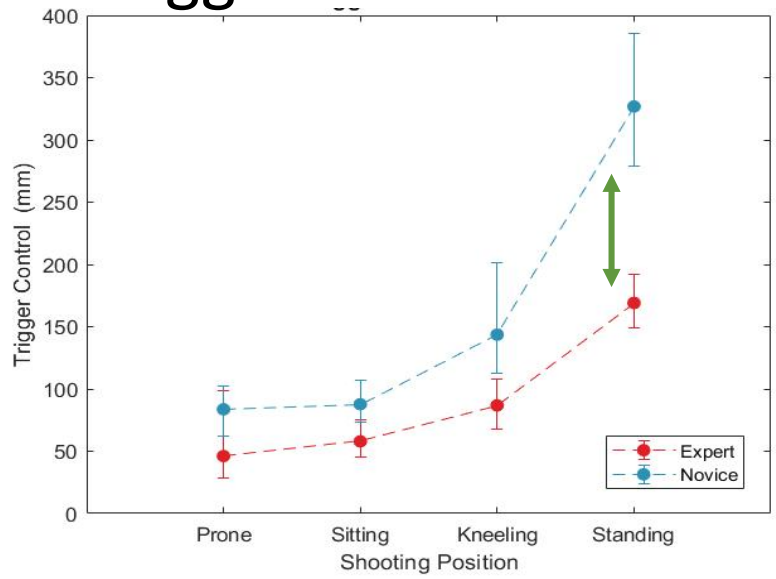
Aim Scores



Hold Scores



Trigger Control Scores



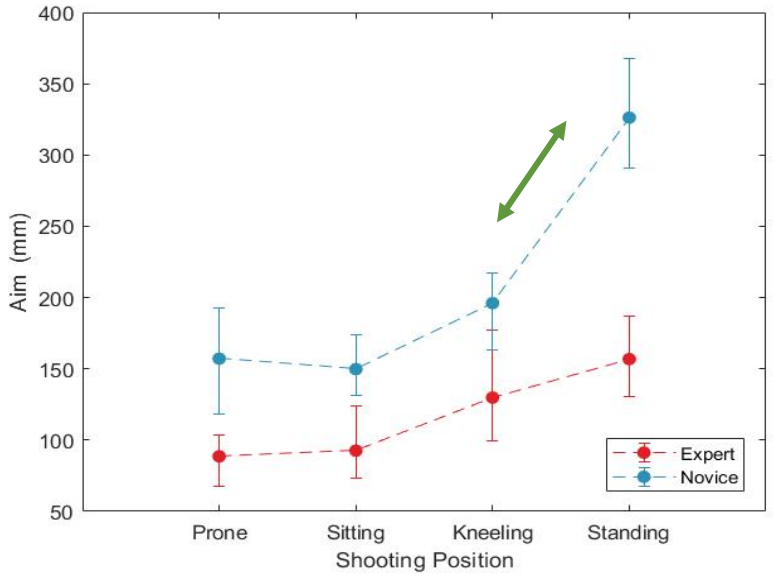
Lower scores indicate better performance

Error Bars Represent 95% Confidence Intervals

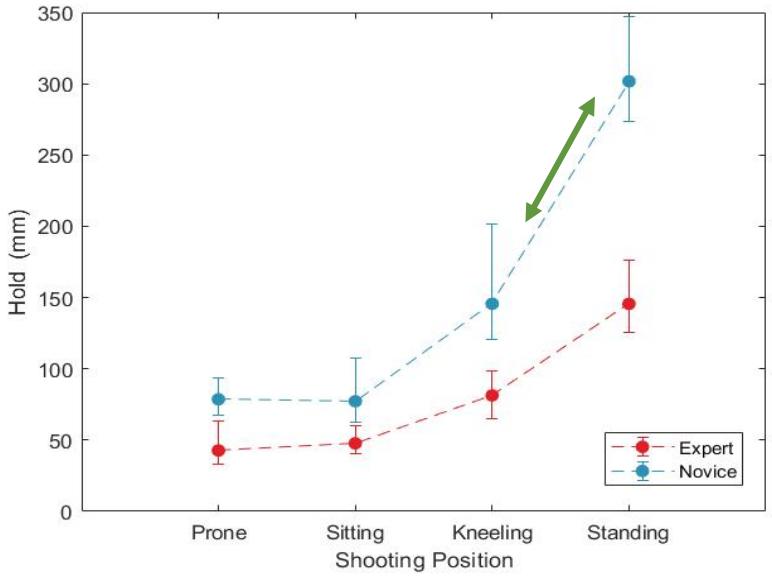
Individual Skills

- Performance is dramatically worse as shooters move into standing position

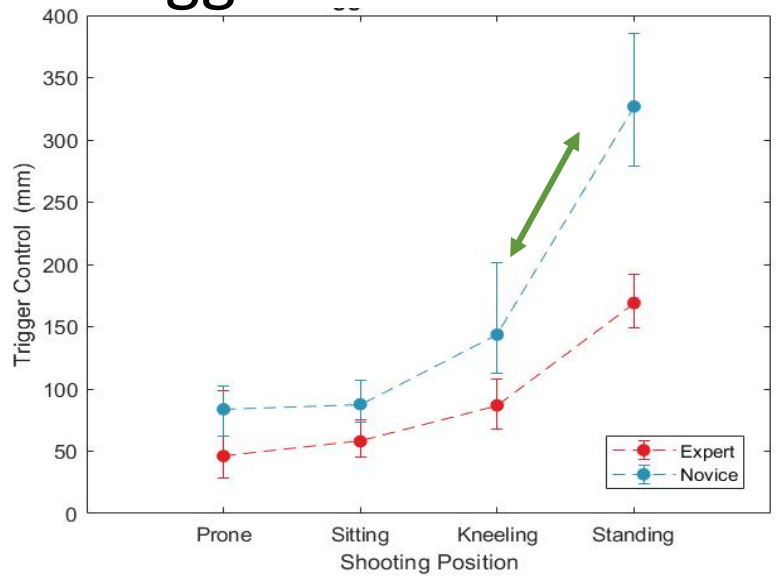
Aim Scores



Hold Scores



Trigger Control Scores



Lower scores indicate better performance

System Updates

Result	Evaluation Effect	System Updates
Skill scores differ substantially based on shooting position.	The same skill score means different things depending on the position. For example, a ‘good’ score in standing is ‘poor’ in prone.	Updated the interface so that the user can select shooting position. The cutoff scores to evaluate performance differ depending on shooting position
Skill scores differ substantially based on relative expertise.	Novices judged by an ‘expert’ standard may appear worse than they really are.	Updated the interface so user can select relative expertise (novice, moderate, difficult) of the shooter. Cutoff scores differ based on expertise level.