GPS Study

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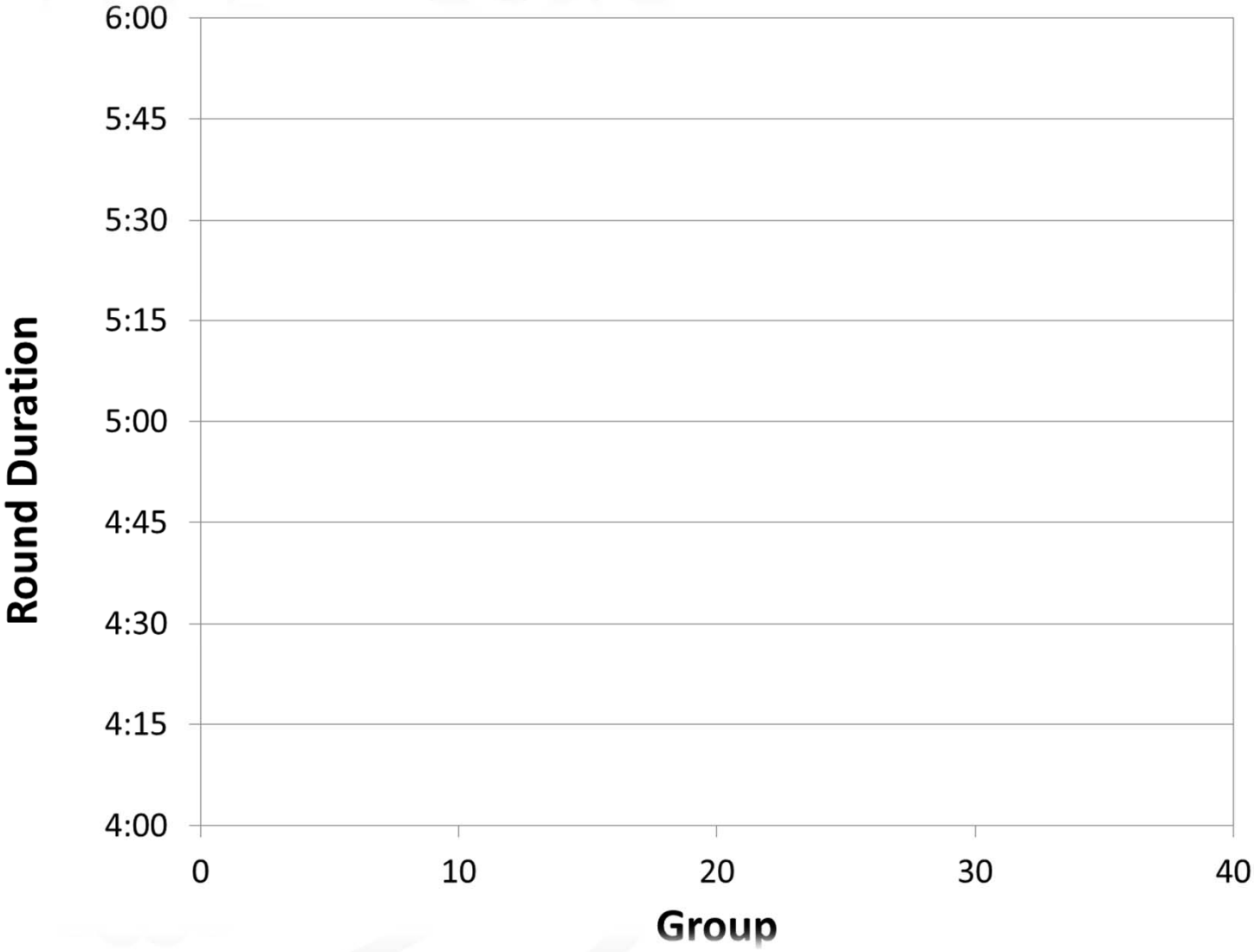

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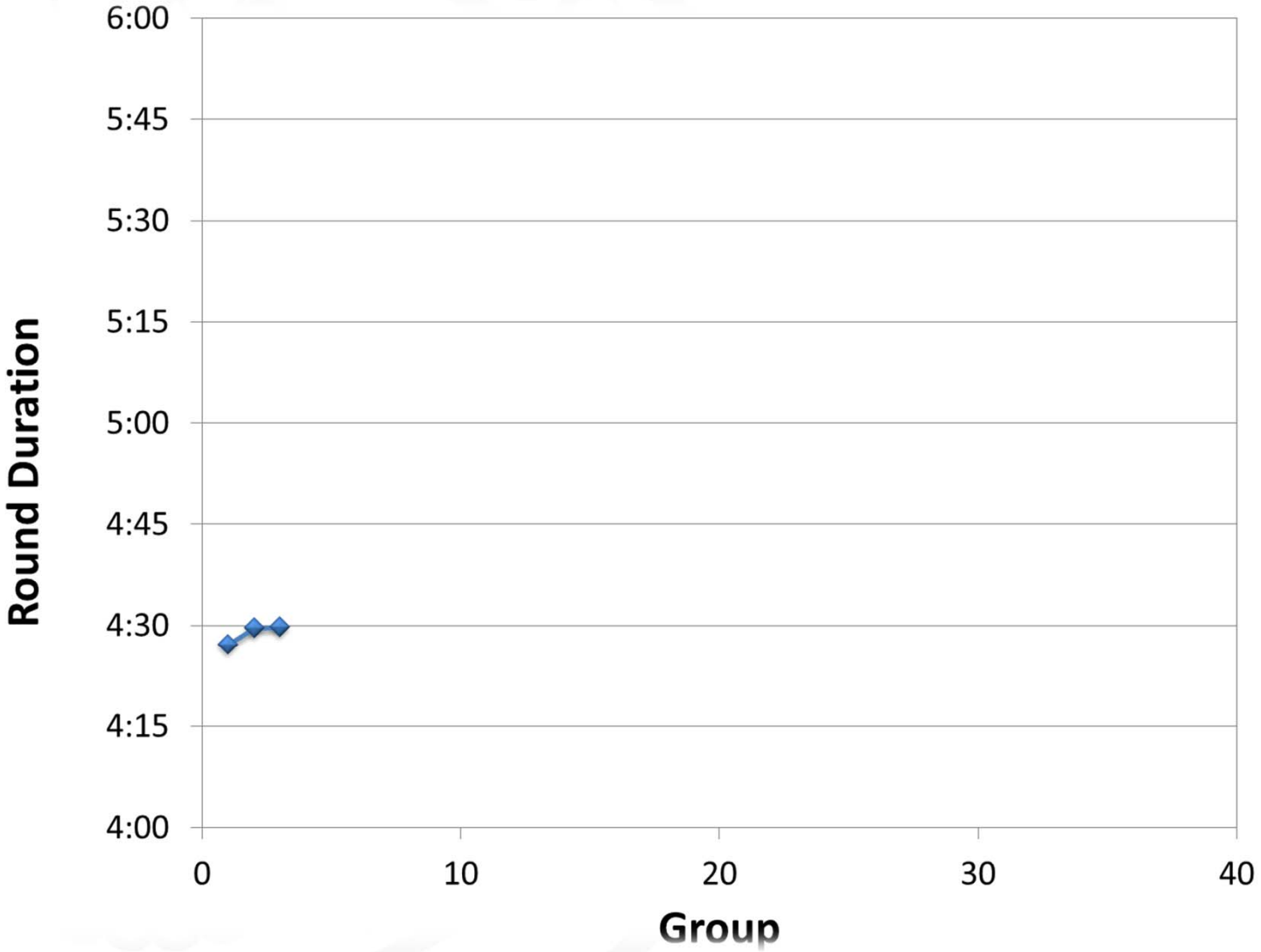

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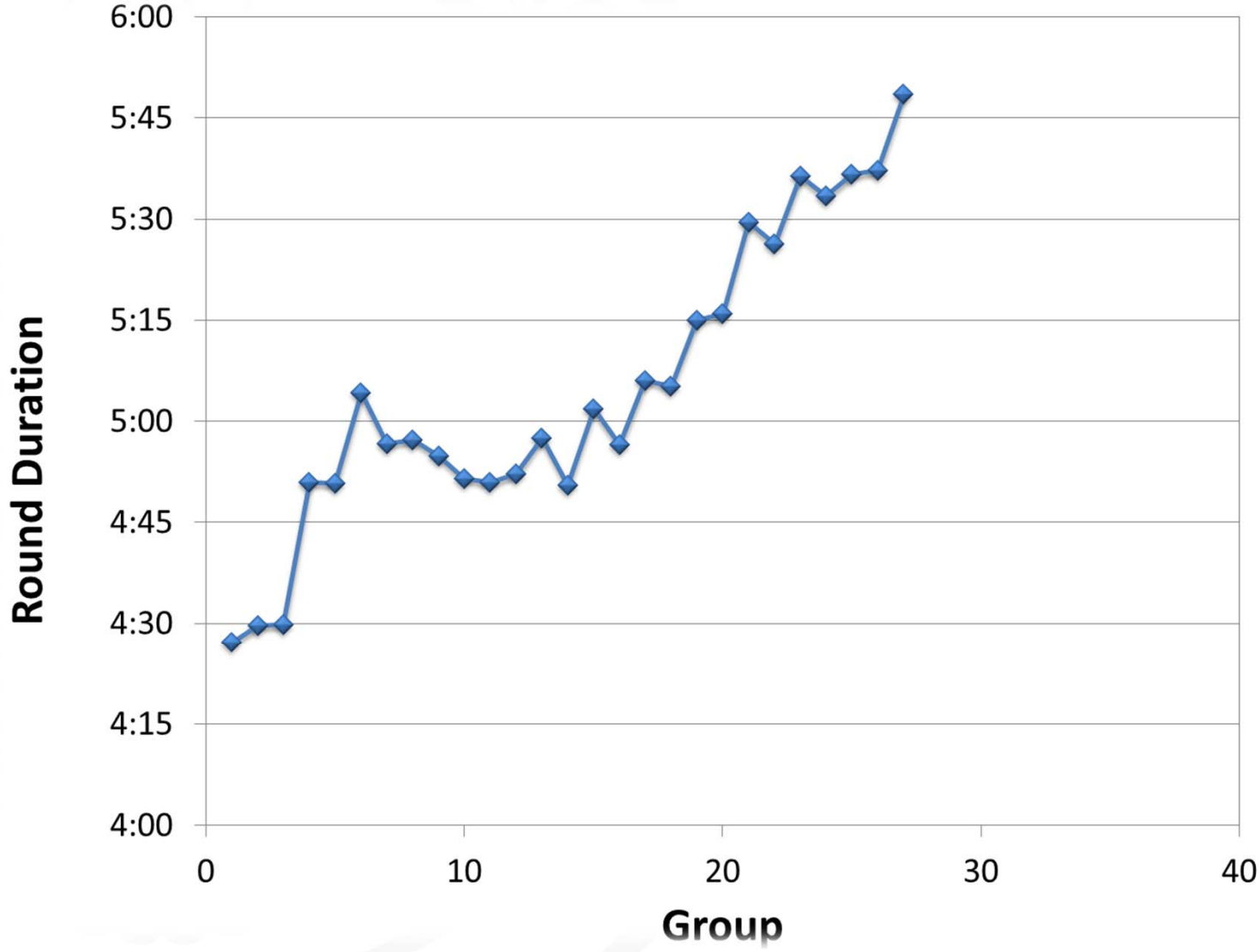

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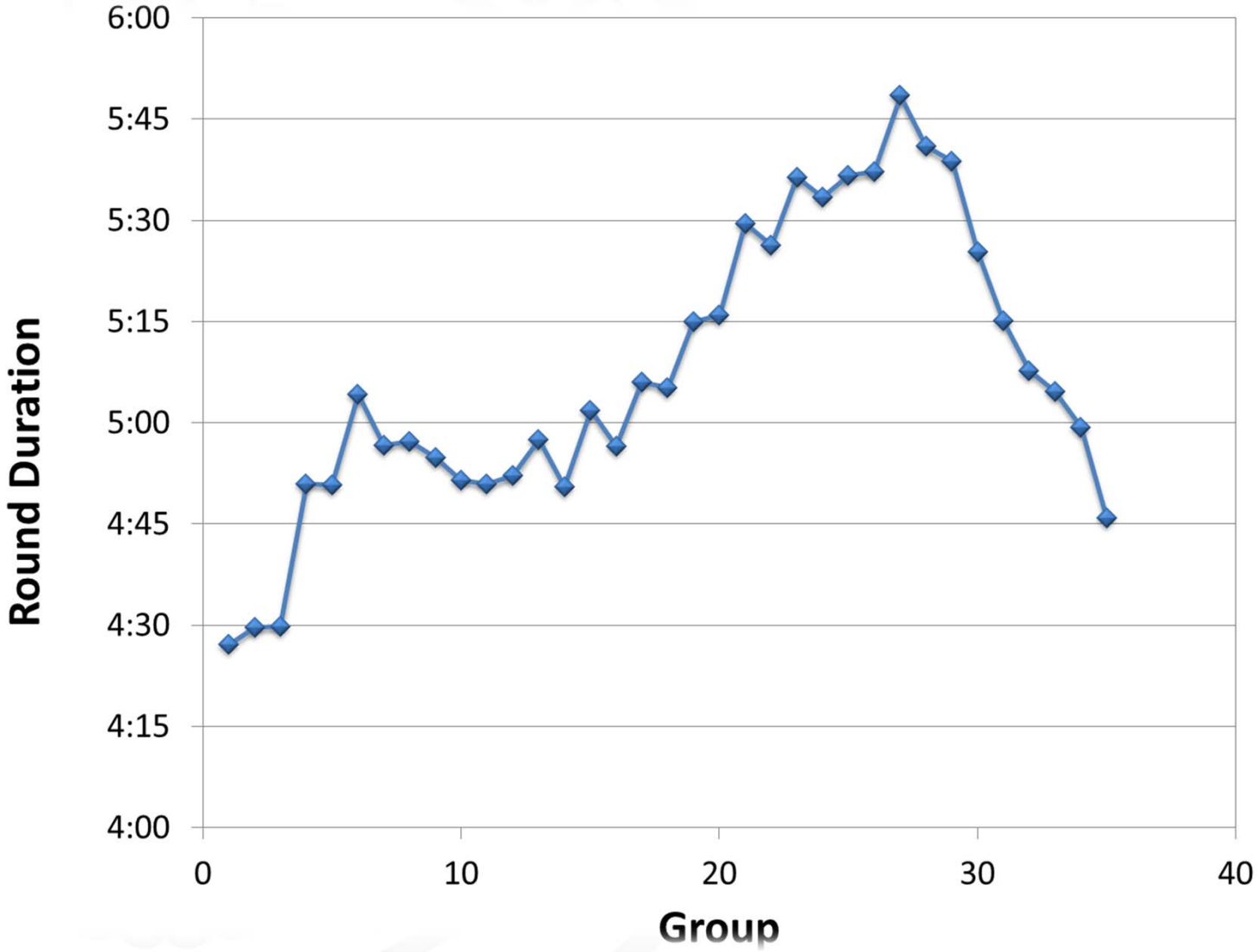

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12
1
2
3
4
5
6
7
8
9
10
11
12
1
2
3
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7
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9
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11

$$T_{round} = 4:00 hours$$

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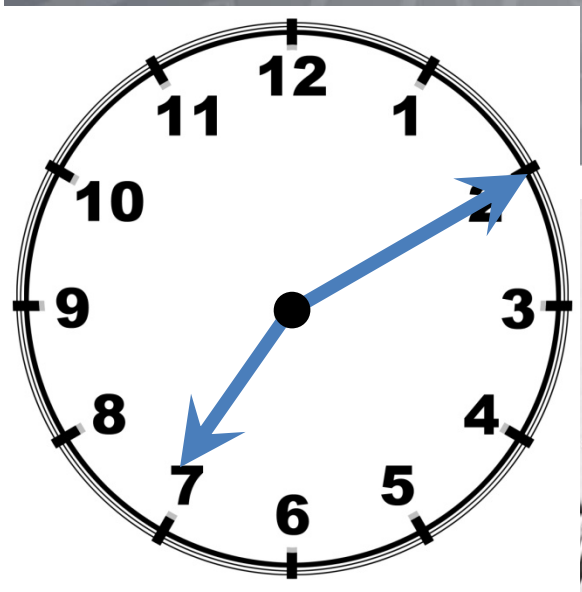
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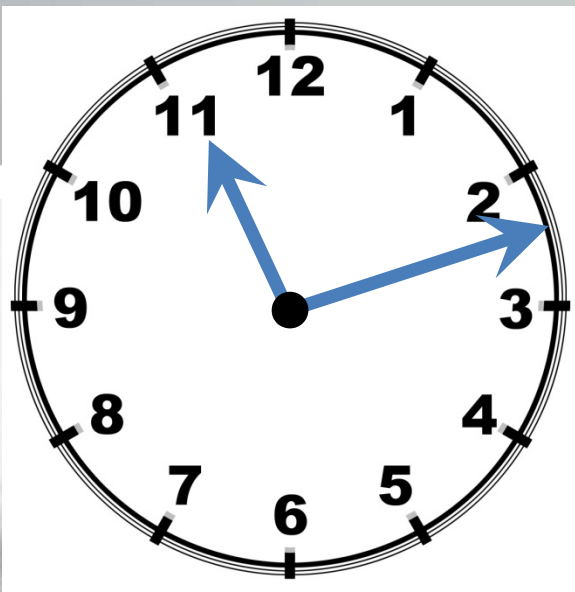
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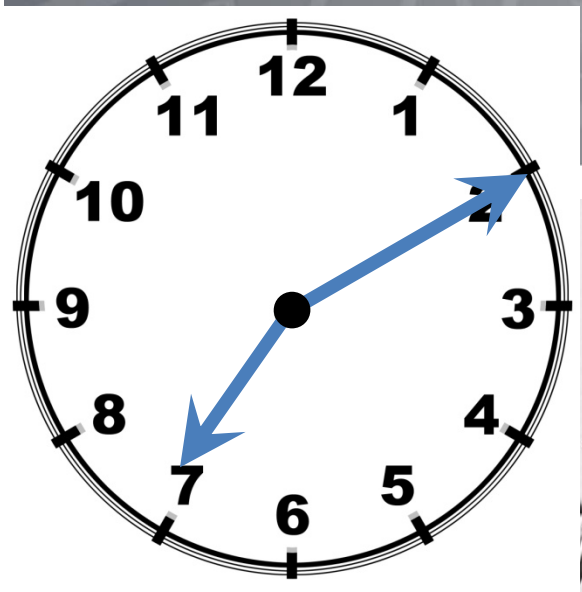
$$T_{round} = 14:22 - 7:10$$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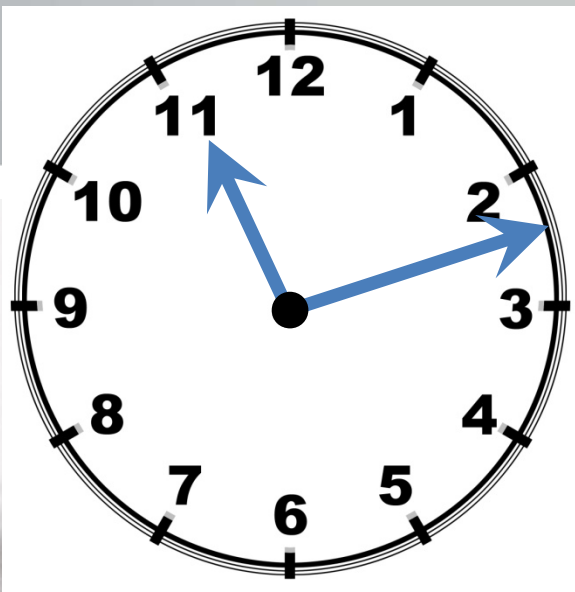

12
1
2
3
4
5
6
7
8
9
10
11

$$T_{round} = 4{:}00 + 0{:}12 - 0{:}10$$

Flow Out

$$T_{round}^{i} = T_{round}^{i-1} + \Delta T_{finish}^{i} - \Delta T_{tee}^{i}$$

Flow In

Cycle Time

$$T_{round}^{i} = T_{round}^{i-1} + \Delta T_{finish}^{i} - \Delta T_{tee}^{i}$$

Tee Interval

$$T_{round}^{6} = T_{round}^{1} + \Delta T_{finish}^{6} - 5\Delta T_{tee}$$

Cycle Time

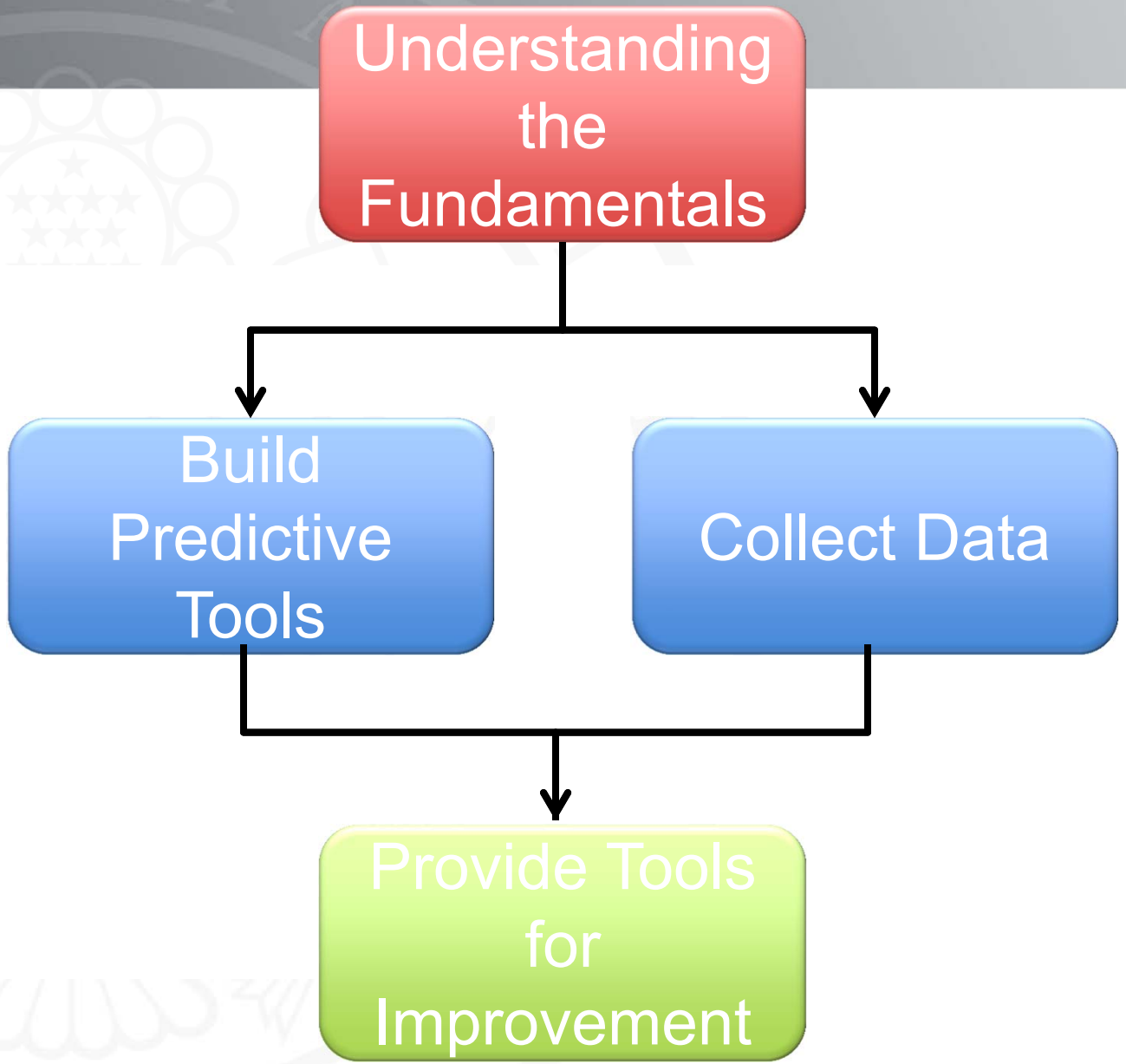
$$+\Delta T_{finish}^{5}$$

$$+\Delta T_{finish}^{4}$$

$$+\Delta T_{finish}^{3}$$

$$+\Delta T_{finish}^{2}$$

Recommendation #1: In order to have control over pace of play, we must be measuring and controlling the relevant parameters



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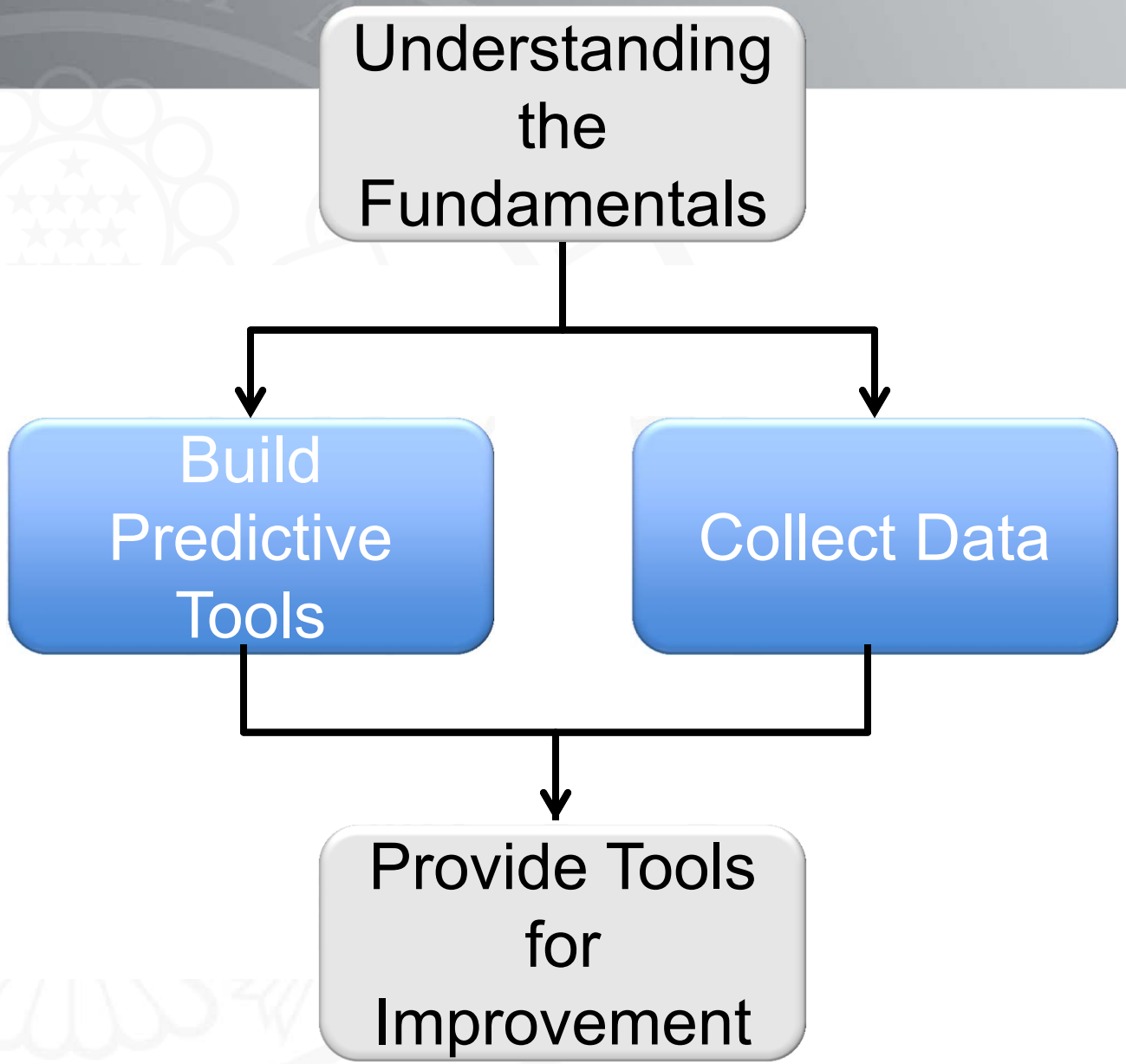
Understanding the Fundamentals
Build Predictive Tools
Collect Data
Provide Tools for Improvement

Intro

- *About our GAME* Intern Program
- Data Collection Process
- Software Development
- Data Analysis
- Next Steps

Intern Program

- Summer intern program supported by Chevron STEM
- Had interns placed at 8 different regions around the United States
- Visited golf courses 2 – 3 times per week
- Each had 75 GPS loggers to record data
- They collected information about golfers (Handicap, Rounds Played, Drive Distance, etc…)

Intern Locations

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Notable Courses Visited

- Chambers Bay, University Place, Wash.
- Rustic Canyon Golf Club, Moorpark, Calif.
- Colonial Country Club, Ft. Worth, Texas
- CommonGround Golf Course, Aurora, Colo.
- The Glen Club, Glenview, Ill.
- The Pines Course, Joint Base Langley-Eustis, Va.
- Huntingdon Valley (Pa.) Country Club

Data Collection

- Each golfer is handed a small GPS device

- GPS records position and time every 5 seconds on course

- Use of data sheets to collect additional information on golfers

Data Collection

USGA Pace Data Research - Golf Course Data

Course Name:				
Address:				
Course Type:	◯ Public	◯ Private	◯ Resort	
	◯ Municipal	◯ Military		
Starter?:	◯ Yes	◯ No		
Pace Policy?:	◯ Yes	◯ No		

Scorecard Data

Hole	Tee:		Tee:		Tee:		Tee:	
	Rating	Slope	Rating	Slope	Rating	Slope	Rating	Slope
	Par	Yards	Par	Yards	Par	Yards	Par	Yards
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
Total								

USGA Pace Data Research - Event Data

Event Type:	◯ Regular Play	◯ Tournament		
Format:	◯ Stroke	◯ Match	◯ Stableford	
Tee Format:	◯ Straight	◯ Split	◯ Resort	
Starting Tees:				
Green Fee:				
Carts:	◯ Yes	◯ 90 Degree	◯ Cartpath	

Weather Info

	◯ Sunny	◯ Partly Sunny	◯ Cloudy	◯ Overcast
	◯ Drizzle	◯ Rain	◯ Heavy Rain	◯ Fog

Temperature:		°F	Humidity:		%
Windspeed:		mph	Direction:		

Course Setup

Green Speed:				
Firmness:	◯ Firm	◯ Medium	◯ Soft	
Cut Heights:	Fairway:	Rough:	Green:	in
Turfgrass:	Fairway:	Rough:	Green:	

Hole	Hole Location		Difficulty	Fairway Width		Water
	L/R	F/B		200	250	?
1			◯ Easy ◯ Med ◯ Hard			
2			◯ Easy ◯ Med ◯ Hard			
3			◯ Easy ◯ Med ◯ Hard			
4			◯ Easy ◯ Med ◯ Hard			
5			◯ Easy ◯ Med ◯ Hard			
6			◯ Easy ◯ Med ◯ Hard			
7			◯ Easy ◯ Med ◯ Hard			
8			◯ Easy ◯ Med ◯ Hard			
9			◯ Easy ◯ Med ◯ Hard			

USGA Pace Data Research - Golfer Data

Group #:		Tee Time:				Cart #:		
◯ Riding	◯ Walking	◯ Caddie	◯ Forecaddie	Last Hole:				

Golfer	1		2		3		4	
GPS #								
Tee								
Handicap								
Driver Dist		y		y		y		y
9-Iron Dist		y		y		y		y
Rounds Last Year	(1) Under 10; (2) 10 - 19; (3) 20 - 29; (4) 30 - 39; (5) Over 39							
Age Category	(1) Under 25; (2) 25 - 34; (3) 35 - 44; (4) 45 - 54; (5) 55 - 64; (6) 65 - 74; (7) Over 74							
Gender								

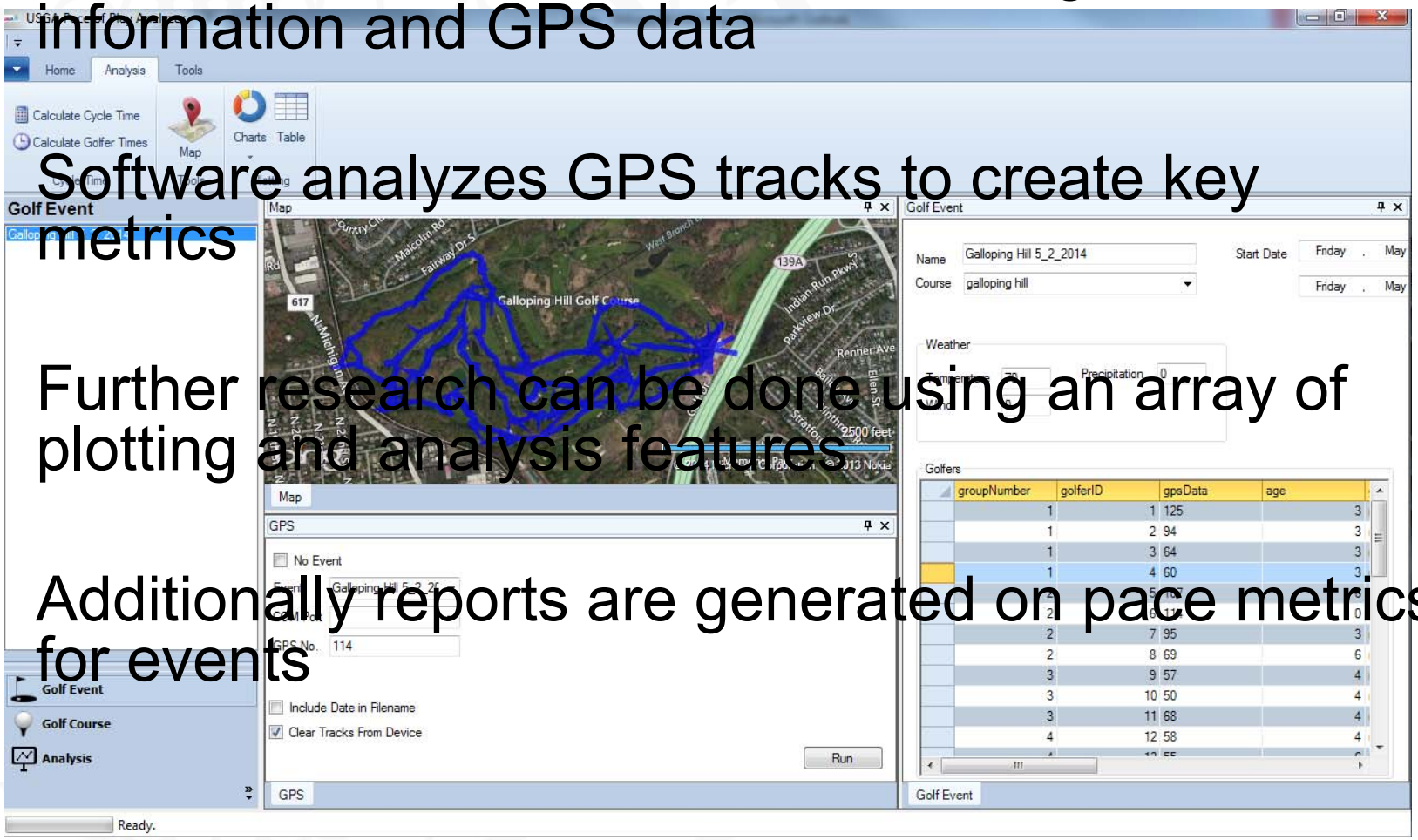
Group #:		Tee Time:				Cart #:		
◯ Riding	◯ Walking	◯ Caddie	◯ Forecaddie	Last Hole:				

Golfer	1	2	3	4
GPS #				
Tee				
Handicap				
Driver Dist				
9-Iron				
Rounds Last Year	(1) Under 10; (2) 10 - 19; (3) 20 - 29; (4) 30 - 39; (5) Over 39			
Age Category	(1) Under 25; (2) 25 - 34; (3) 35 - 44; (4) 45 - 54; (5) 55 - 64; (6) 65 - 74; (7) Over 74			
Gender				

PRESENTED BY THE USGA

Software - Database

- USGA created software to database golfer information and GPS data
- Software analyzes GPS tracks to create key metrics
- Further research can be done using an array of plotting and analysis features
- Additionally reports are generated on pace metrics for events



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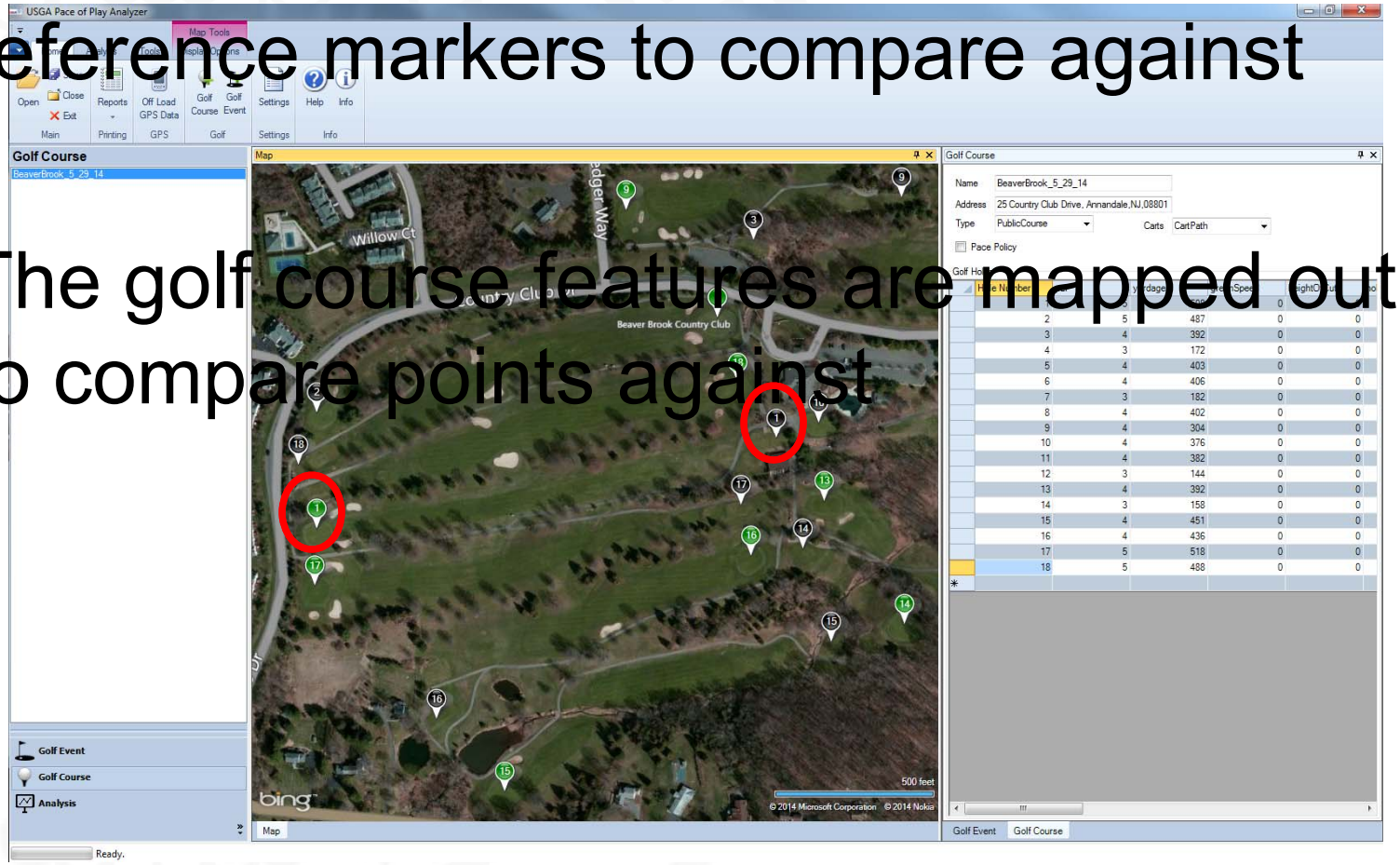
Software - Algorithm

- In order to process pace data we need reference markers to compare against
- The golf course features are mapped out to compare points against



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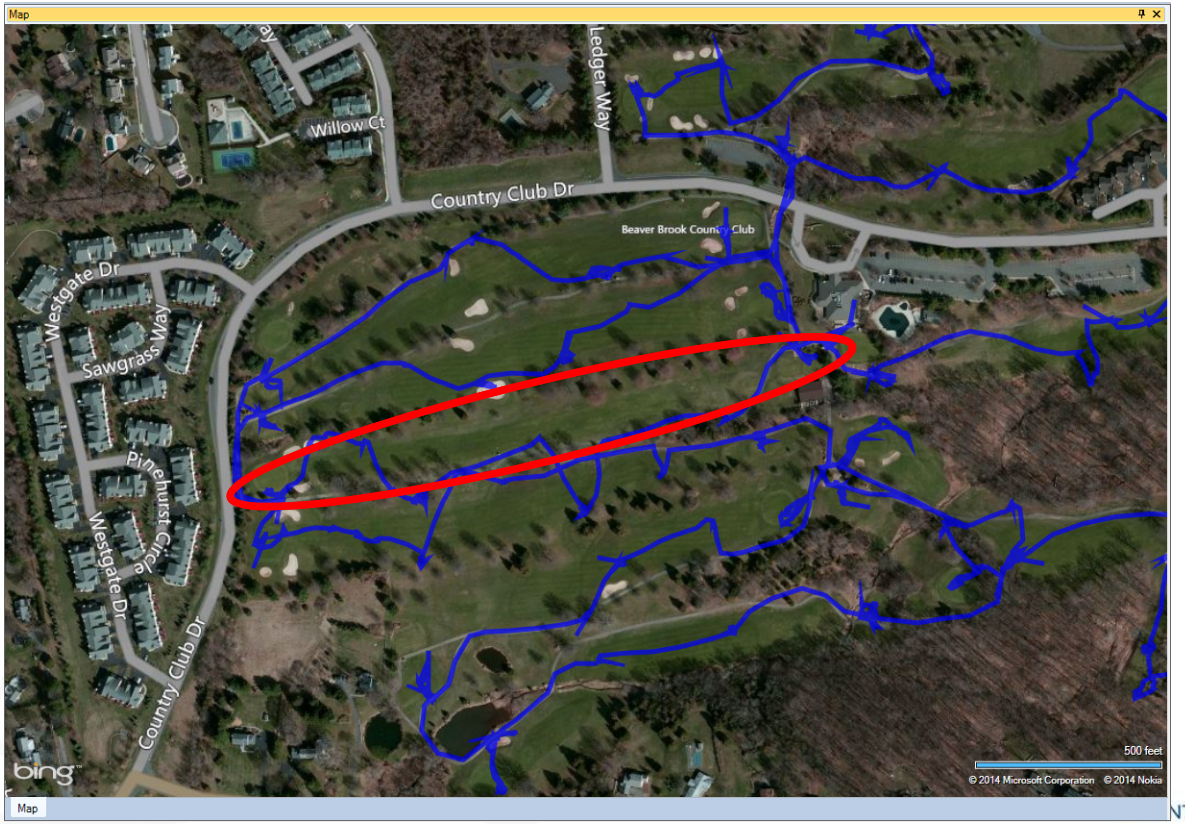
Software - Algorithm

- Algorithm developed to divide GPS into segments by hole or other features



Software - Algorithm

Hole Start
(Tee)

Hole End
(Green)

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Software - Algorithm

End Point Identified
- Hole Time

Start Point Identified
- Tee Time

Software - Algorithm

- Once the start and end points are determined on each hole for every golfer we can calculate our metrics

- Pace

$$Pace\ (Hole\ n) = Hole\ Time(Hole\ n) - Tee\ Time(Hole\ n)$$

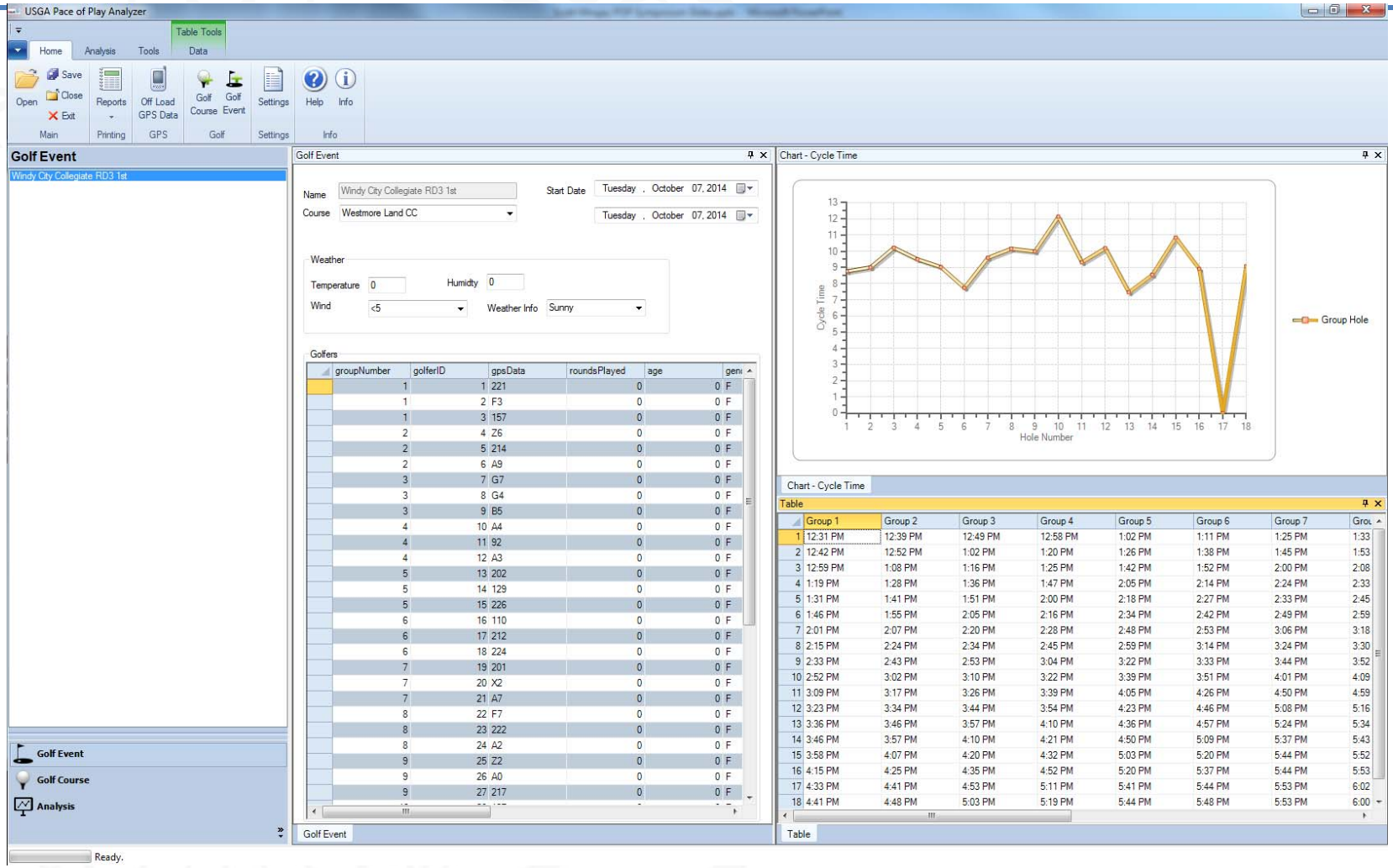
- Cycle Time

$$Cycle\ Time\ (Group\ n) = Hole\ Time(Group\ n + 1) - Tee\ Time(Group\ n)$$

Metrics Generated

- Cycle Time
- Pace
- Tee Time
- Hole Time
- Round Times
- Time from X distance to green

Software - Algorithm



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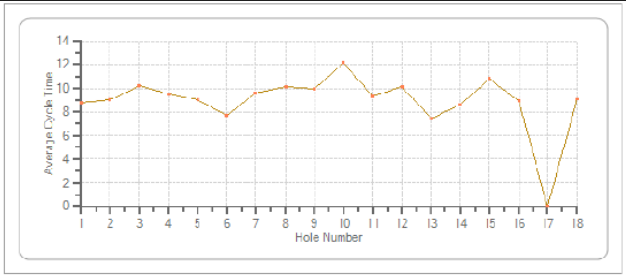
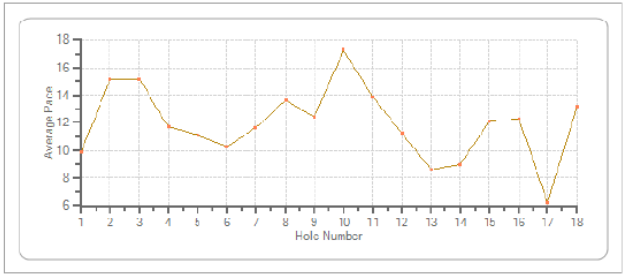
Software Report

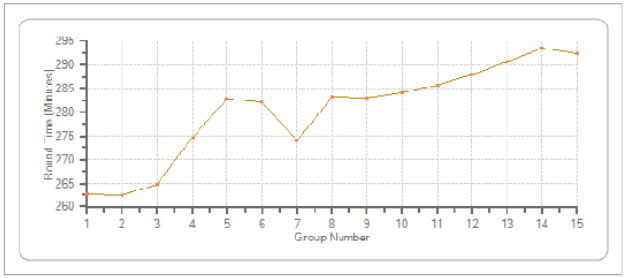
USGA Pace of Play Report

Name: Windy City Collegiate RD3 1st
Course: Westmore Land CC
Date: 10/7/2014 9:08:05 AM

Weather Info: Sunny
Temperature: 0
Wind: 0 - 5
Humidity: 0







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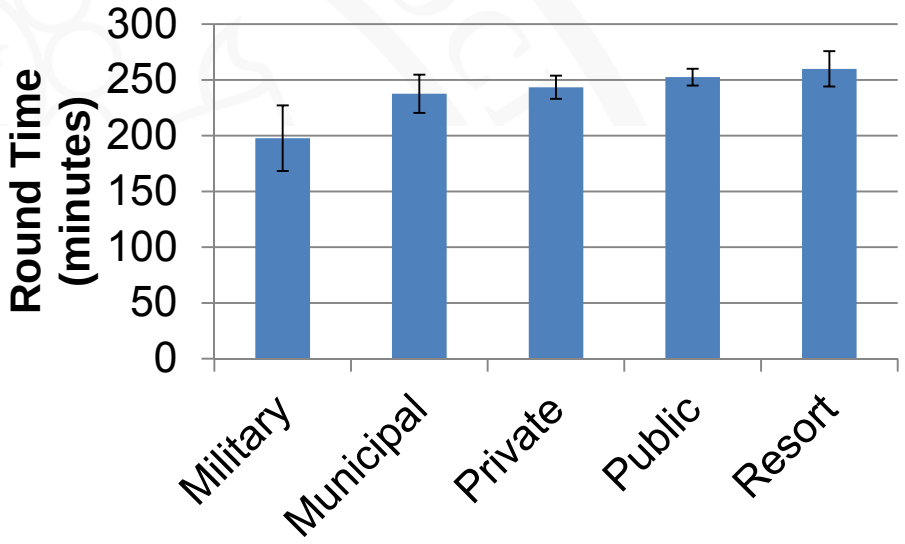
Program Statistics

Number of Events	135
Total Golfers	5396
Average Golfer Per Event	40
Men	4355
Women	642

Data Analysis – Cycle and Round Times

- Visited multiple different courses types ranging from Military to Resort
- Average Tee Start Interval -10.4 minutes
- Average Round time – 4:09
- Longest Round Time – 5:48
- Average difference from first to last round – 29 minutes

Data Analysis – Cycle and Round Times



Par	Cycle Time Average (Min)
3	10.5
4	10.3
5	10.1

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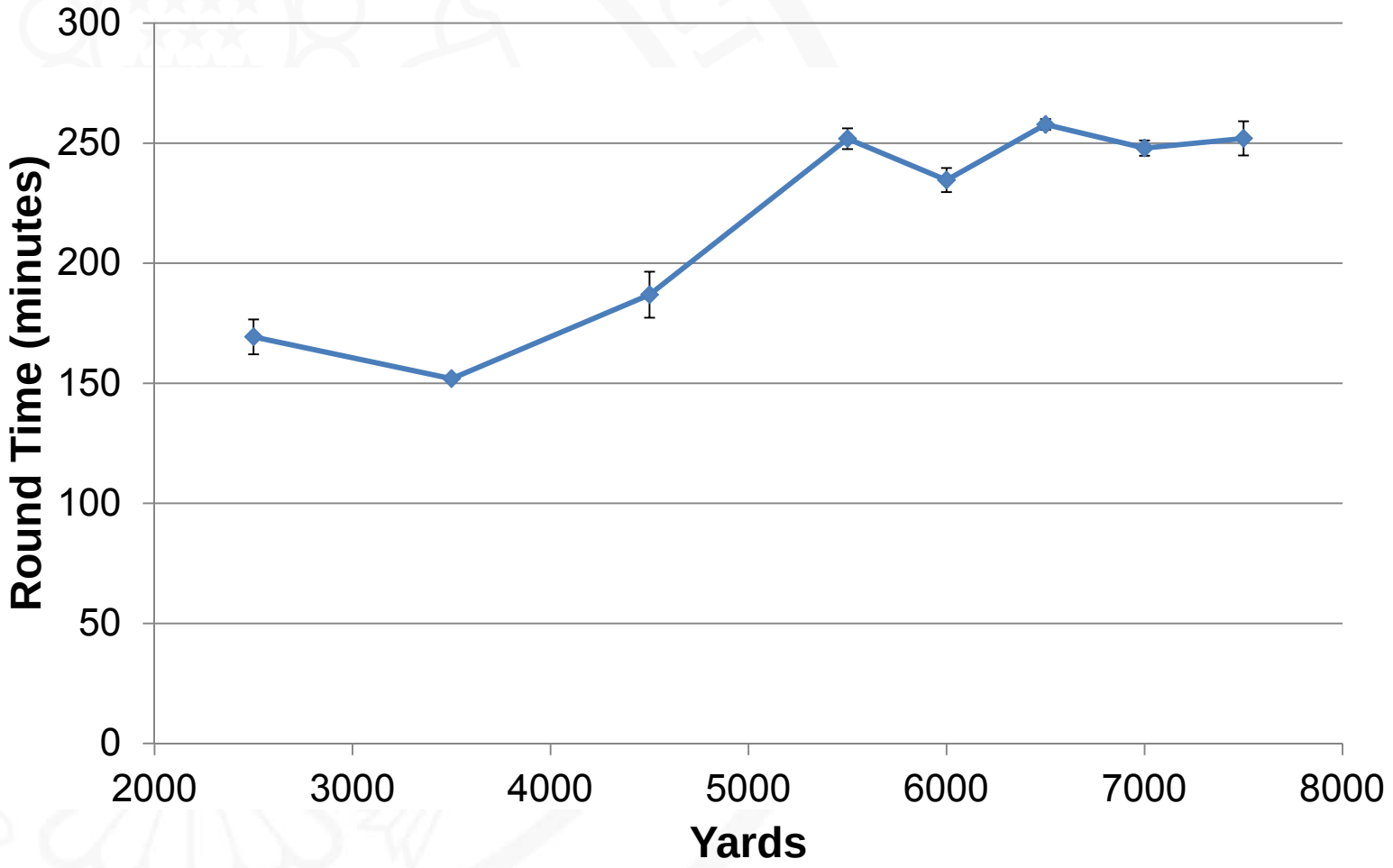
Data Analysis – Round Times by Yardage



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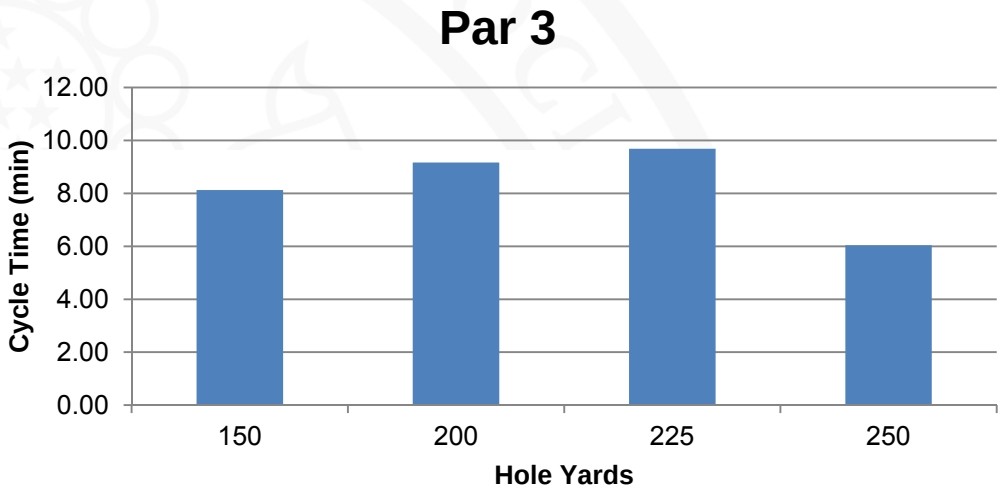
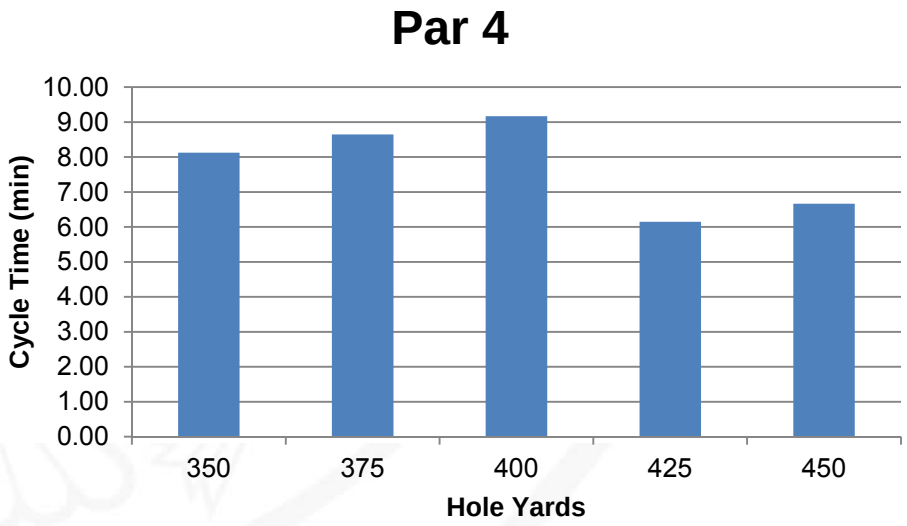
Data Analysis – Cycle Time by Par Yardage

- Group Par 3 and Par 4 by yardage
- Performed theoretical analysis of how cycle time would vary with distance
- Compared theory to collected data

Data Analysis – Cycle Time by Par Yardage





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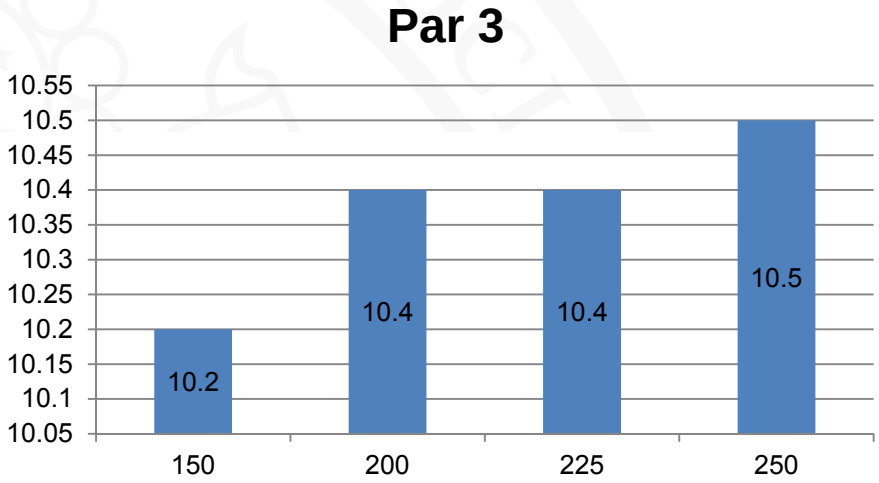
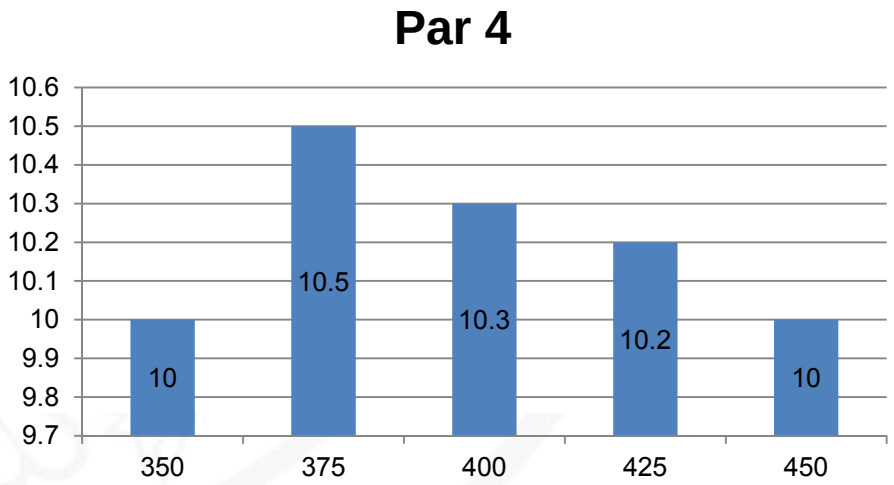
Data Analysis – Cycle Time by Par Yardage





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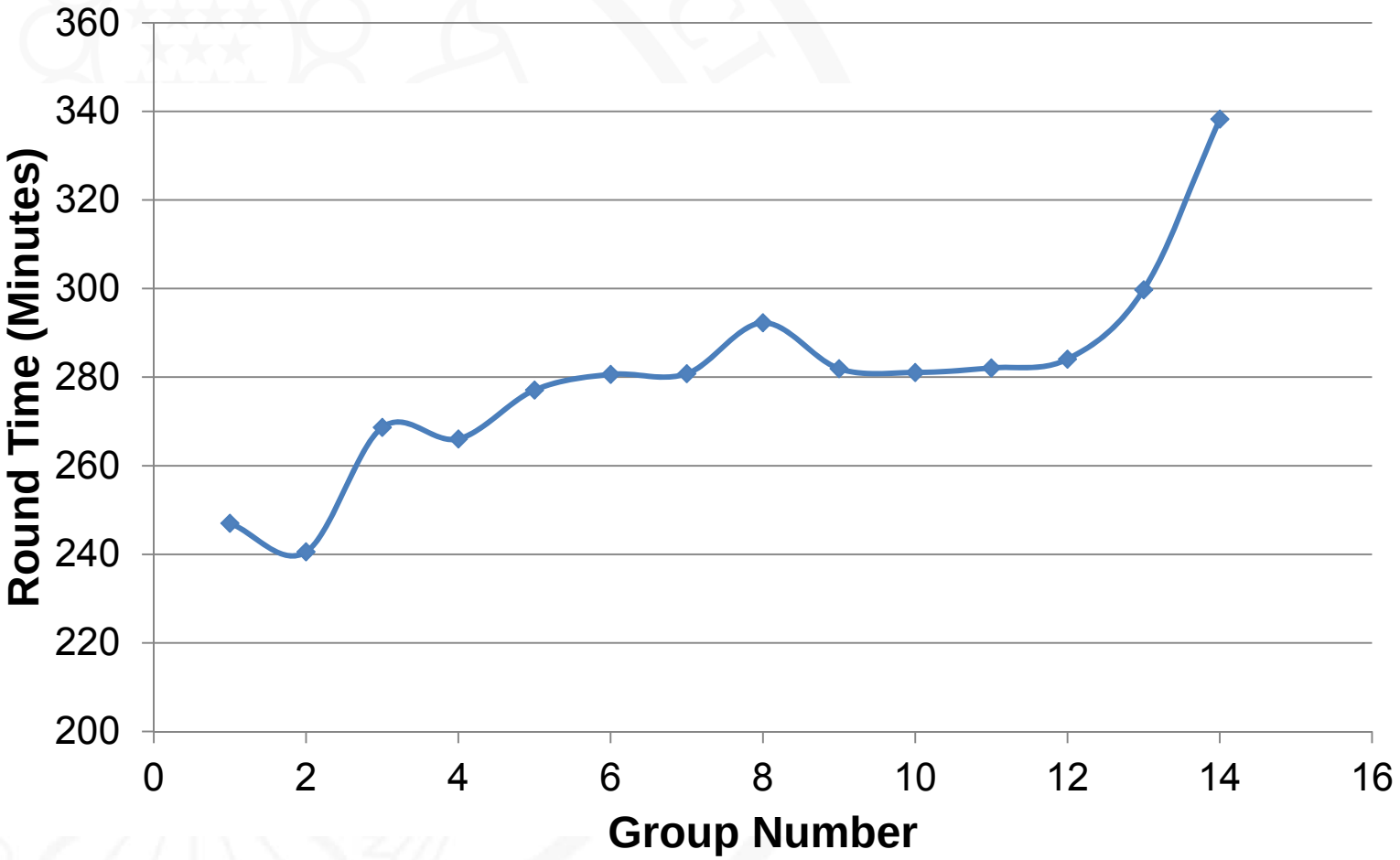
Data Analysis – Sample Golf Course

- The data presented is a course that we visited this summer
- The average cycle time for a hole on this course is 9.1 minutes
- The first group plays in 4:06 and the last group plays in 5:37

Data Analysis – Sample Golf Course



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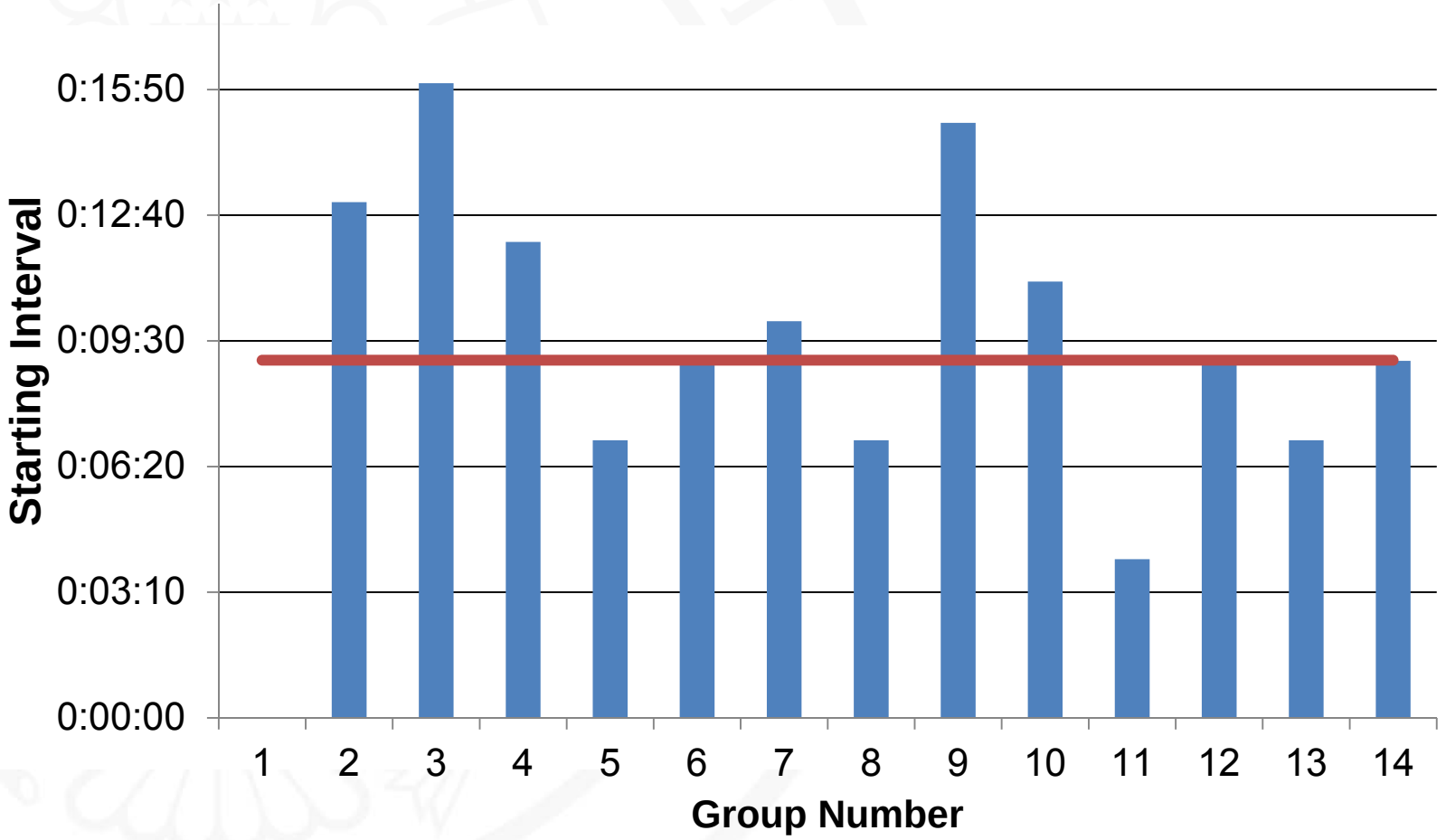
Data Analysis – Sample Golf Course



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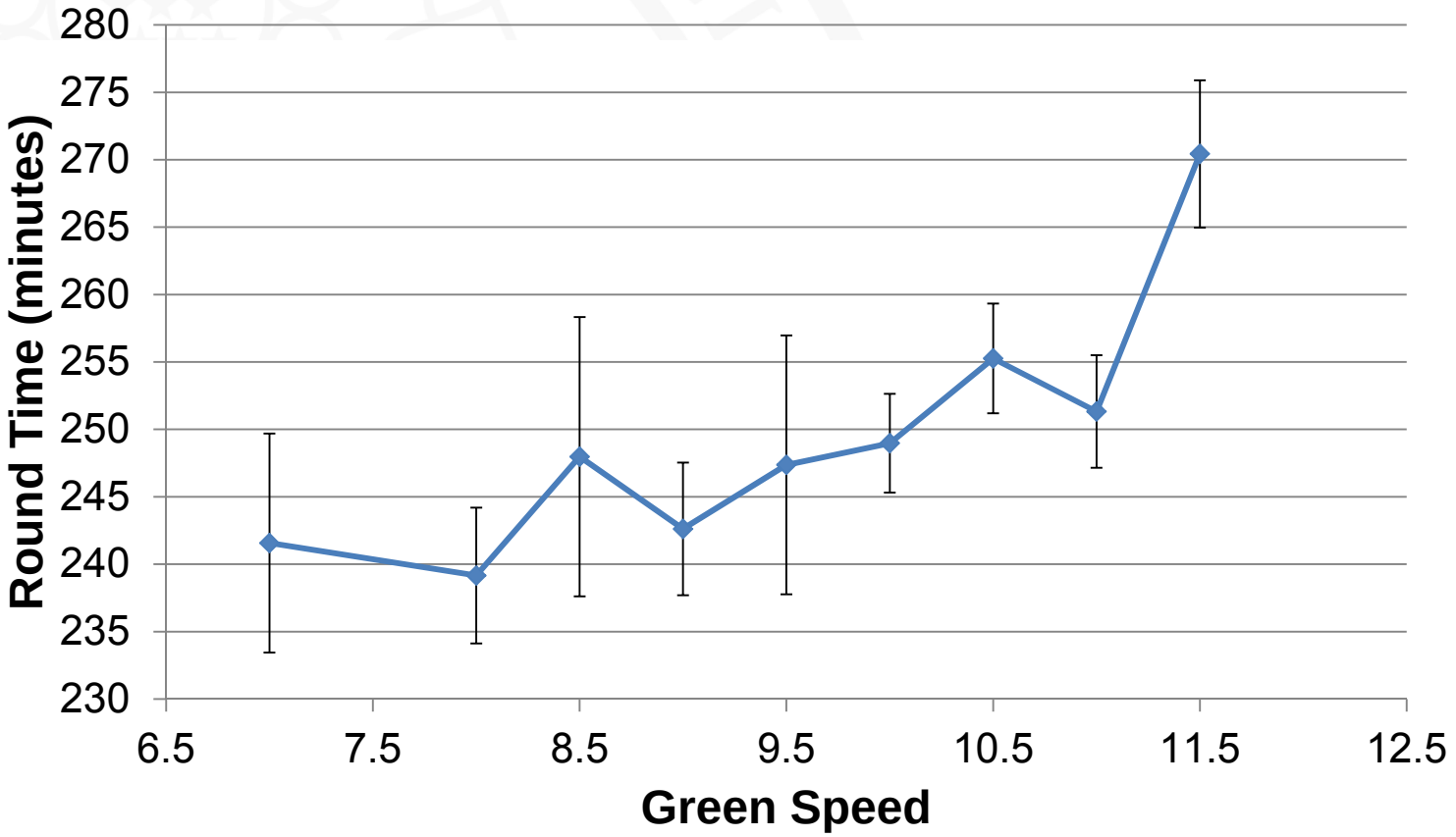
Data Analysis – Sample Golf Course

- Last group studied takes 1:30 longer to play than first group
- Relative stable periods when tee interval is above cycle time
- When tee interval is below cycle time we see sudden spikes in round time

Data Analysis – Green Speed

- Green speeds were collected for each round of golf
- Range of speeds collected from 7 – 11.5
- We look at the average round times for each bracket of green speed
- Note that some values are reported green speeds

Data Analysis – Green Speed



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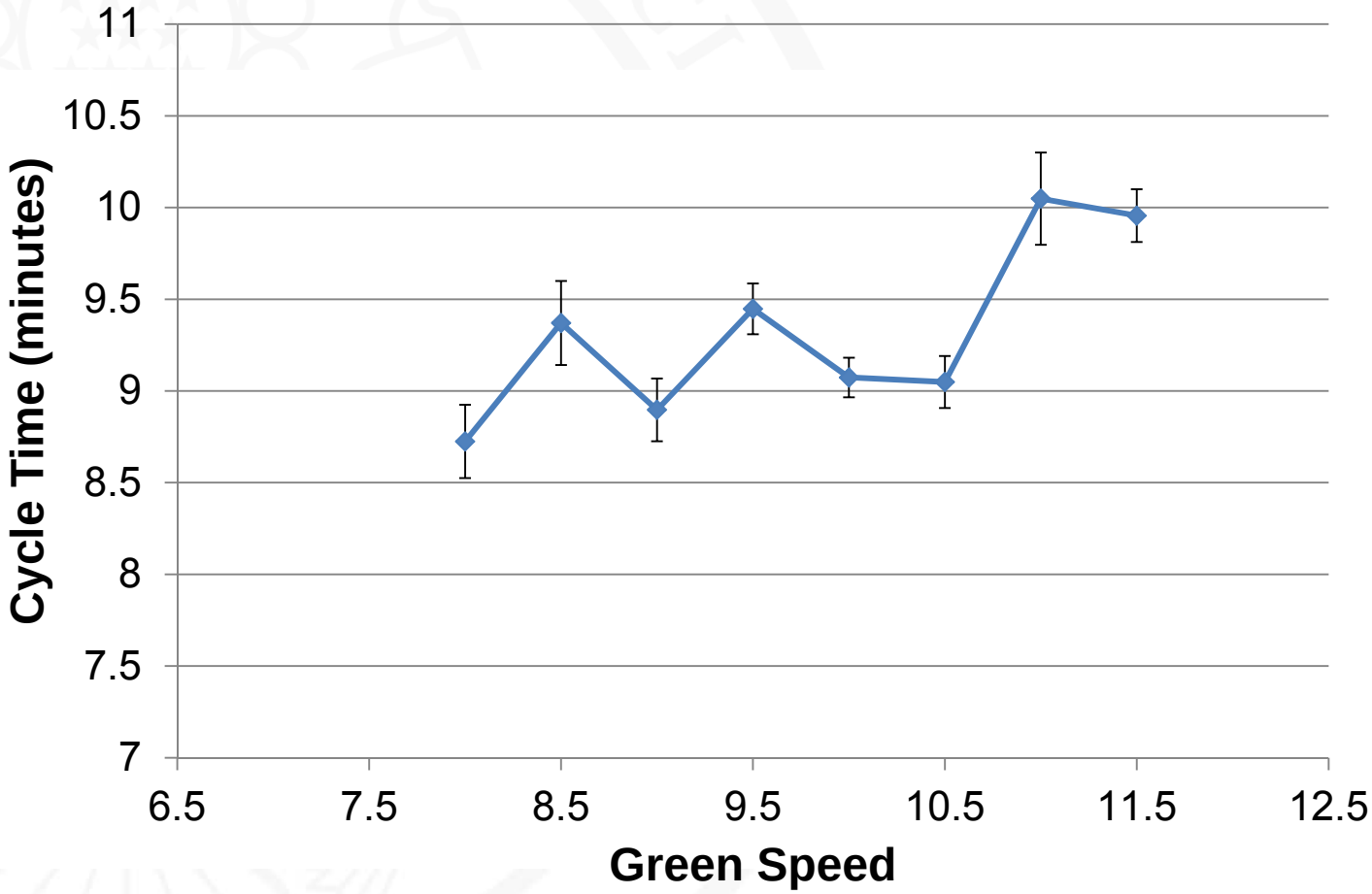
Data Analysis – Green Speed



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Next Steps

- Continually adding events to the data set
- Studying other factors that may influence pace of play
- Use of L1 Technologies mapping database to study additional geographical and course design features
- Run more controlled studies at Robert Trent Jones Golf Trail in Alabama

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