1678 Scouting Workshop

Moneybots

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Introduction to our system

OVERVIEW

Principles of Moneybot scouting

- Combining quantitative and qualitative data
- Statistical analysis has become increasingly prevalent in sports everywhere
  - Has become similarly popular in FRC
- The beginning: Sabermetrics

What is Sabermetrics?

- Idea pioneered by Bill James for quantitative analysis of Baseball

- What stats actually produce wins?

- Discover overlooked data

- Determines "value" of a player to it's team/alliance

Robotics vs Baseball

- Constant vs Dynamic teams
- FRC quick turnaround, need stats immediately
- Indirect point contributions
  - Teams can contribute to an alliance without scoring any points
  - 2014: assists
  - Defense
  - 2015: capping stacks

Beginning of build season

ANALYZING THE GAME

The union of strategy and scouting

- Your strategy defines what you scout for
  - 2008: Trusser vs Lapper
  - 2013: FCS, Cycler, Ground pick up
  - 2014: Inbounder, Midfielder, Finisher
  - 2015: Landfill vs HP, value of canburglars

Understanding the game

- Know the game rules inside and out
  - 2014: Knowing "assist" definition
  - Strategies don't work if they're illegal

Scoring

- Consider every method of scoring points
  - 2008: 148 driving laps
  - 2012: 118's bridge mechanism
  - 2014: Fax and rebound bots
  - 2015: Value of cans

De-Scoring

- Consider every method of preventing opponents from scoring
  - Every year: DEFENSE
  - 2000 & 2012: stealing balls
  - 2004: capping goals
  - 2013: tall blocking robots
  - 2015: canburglars

Game Analysis cont.

- Determining most effective scoring method decides what you scout for
- Understanding ranking/tie breakers
  - 2012: coopertition points
  - 2013: Auto points
  - 2014: assists
  - 2015: average score
- Win margin =/= seeding order

Efficient match strategy

- Difficulty vs. points awarded
  - What is the most cost-effective scoring method?
  - Marginal cost/utility
- Preventing 10 points is just as valuable as scoring 10 points
  - Defense is worth the same as offense
  - Remember, protected scoring zones are not defendable

Abstract counting

- Cannot scout score directly, instead scout for ability and execution
- Quantifying assists
  - Redefined as possessions and passes
- 2012: Robot dimensions for bridge triple balance and driving ability
- 2012: timing robots getting on bridge

Which numbers you should, and shouldn't ignore

REPORTED STATISTICS

Understanding Reported Statistics

- What are OPR, and CCWM; are they useful?
  - OPR = Average offensive contribution
    - Heavily affected by teammates' scores
  - CCWM = Average share of winning (or losing) margin
    - Affected by teammates scoring, and opponent scoring
  - Calculated using linear algebra

Reported Statistics - OPR

- Actual scoring vs. OPR
  - ~0.95 correlation in 2012, 2013, 2015
  - Not so close in 2014
- 2013 example
  - 1678:
    - OPR = 42.8
    - Avg Score = 69.5
    - Other teams averaged 28.5 fewer points with us than without.
    - 69.5 – 28.5 = 41 ≈ OPR

Reported Statistics - DPR

- What is DPR and why isn't it useful?
  - DPR = OPR – CCWM
  - Influenced by many other unrelated factors
  - CCWM is poorly correlated with win-loss records unlike OPR
- Correct DPR calculation:
  - Should be "change in opponent score relative to OPR prediction"

What information do we want

OUR STATISTICS

Simplicity

- Easily understood
- Observable in the field
- Approximation is often acceptable
  - Strength of ordinal ranking

What we report

- Quantitative:
  - Most offensive stats
  - Everything that can be counted (discrete numbers)
- Qualitative:
  - Subjective
  - Driver ability
  - Robot aspects (e.g. speed, torque)
  - Most defensive stats (e.g. blocking)

Quantitative Attributes

- Offense
  - Auto
  - Teleop
  - Pyramid climbs
- Balls blocked (goalie)
- Converting abstract values into discrete values
- Passes made
  - Successful passes/receive from HP or ground

Qualitative Attributes

- Driver ability
  - Ordinal ranking
  - Successful evasions
- Drive train speed/traction
- Successful blocks
  - Ranked depending on # of blocks, and length of successful blocks

Qualitative Ranking

- Getting quantitative values out of qualitative data
  - Ordinal ranking
  - Within a match based on transitive property
    - A > B, B > C, therefore A > C
  - Proposed replacement: Z score ranking

Quantifying Qualities (1)

- How much are these values really worth?
- Iterative multi-step process
- Initial step using previous year's data
- Update with early event results
- Compare draft list with quantitative analysis
- Update weights to match preferred qualities

Quantifying Qualities (2)

- Calculate from match results
  - Derive "defensive" value
    - How much does score deviate from predicted based on offensive stats from scouting system
    - "True" DPR
  - Calculate best weights that explain "defense"
    - Minimize squared error on predicted match scores using Solver
  - Estimate updated weights and defensive values regressing on preferred draft order

Combining values

- Combining our recorded numbers into meaningful values
- Value added
  - 2013: auto + pyramid + driver ability
  - 2014: possessions + driver ability + ball control
- Offense
  - 2013: Auto + teleop + pyramid
  - 2014: Auto + goals + T&C + possessions
- Driver ability
  - Speed + blocking + evasion + torque

Hardware and software

OUR SYSTEM

Simplicity

- Ease of use
  - Scouting interface
- Robustness
- Easy troubleshooting

Choosing hardware

- Tablets
- Bluetooth
- Smart phones
- Server

Choosing software

- Android tablets input
- On-server processing
- iOS and android output apps
- Internet communication protocol

Applied scouting

AT COMPETITION

Pre-comp preparation

- Training and organizing scouts
    - Scout week 1 events
- Updating statistical weightings
- Score prediction
- Pre-match strategy sheets

Training and Organization

- Scouting team layout
  - Head scout
  - Programmers
  - Scouts
  - Super scouts/strategy team
- Train by scouting old matches
- Schedule scouts, give breaks

Prediction and strategy

- Using score predictions to identify difficult matches

- Watching other teams to determine future match strategies

- Develop match strategy and help allied robots

- Used 1114 and 2834 world data bases for predictions

Using data in real time

- Drive team uses data for match planning
- Identifying roles of opposing alliance robots
  - Who is the strongest shooter/trusser, what positions will they likely play

Pit scouting

- Pictures
  - Much easier to identify robots during draft night
- Team organization
  - Is their pit crew organized and can they fix a robot?
- Game-specific attributes
  - 2012 bridge balance
  - 2014 inbound speed
  - 2015 cheescake

Gaming it out

DRAFT NIGHT

Draft night preparation

- Compiling materials
- Picking draft team
  - No hivemind, play devil's advocate
- Get food to-go, don't waste time eating

Gaming out scenarios

- Possible seeding order
  - Make pick list for each possible outcome
  - Some pick lists may be the same for different scenarios
- Know which robots will be pairing together
  - Figure out how to break up good alliances or how to beat them
  - Know who you are facing quarters and semis
    - 2015 can races

First pick robot

- Robot that best complements your strategy
  - Midfielders pick finishers, and vise-versa
- Reliability
- Consistency
- Versatility

Second pick robot

- Robot that fills gaps
- Will likely not be scoring any points or playing offense
  - Remember limiting number of game pieces (2008, 2013, 2014, 2015)
  - This is where value added matters
  - Driver ability defines defense
- Examples
  - 2008: lapping
  - 2013: defense + climb + auto
  - 2014: Inbound + defense + auto

Preparing final list

- DESTROY ALL NON-FINAL LISTS
  - Make sure the only list your captain has is the one they will use
- Have lists for every scenario, destroy them when seeding is finalized
- Have 2 - 3 people adjusting/perfecting lists if robots perform better or worse

What we can do better

RESULTS AND IMPROVEMENTS

2013 Central Valley Regional

- 8th seed, moved to 6th, decline 3rd seed, picked FCS
- Won CVR protecting main scorer

2013 Curie division

- 1st seed, declined 4 times
  - Broke up rival alliances
- Picked FCS + climber, protected main scorer

2014 Newton division

- Weighting safe fender vs non-fender shot
- Goalie (picked 2)
  - Prevent opponents from picking strong counter-strategies
- Versatile 2nd and 3rd picks

2015 regionals

- Cheesecakeable bot
- Motivated drive team/pit crew

2015 CMP

- Cheesecakeable bot
  - Hard counter to 1114
- Back-up scoring bot
  - 1671 saved us when 118 got stuck

In the end…

- Sometimes you may completely throw the system out and go with your gut
- No system is perfect, numbers can sometimes cause you to overlook good teams
- Computers need your sanity checks, they don't have their own

Improvements

- Z-score/relative rankings
- Comparing non-allied robots relative to their common allies.

Lessons learned

- Scrapped original scouting system
- Changing to Bluetooth network
- Server issues
- Real-time data upload
- Make draft list night before final day
  - Bring in dinner!

"It's about getting things down to one number. Using the stats the way we read them, we'll find value in players that no one else can see."