CourtTime: Generating Actionable Insights into Tennis Matches Using Visual Analytics

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Background

- 3D ball and player tracking technology becoming commonplace
- Smart courts provide instant feedback
- Full advantage of these technologies is not taken
  - Improve specific shots
  - Help identify player's strengths and weaknesses
  - Helps identify successful strategies
Existing tools

- Use summary statistics to describe a match
  - Points scored
  - Games won
  - Serve accuracy

- Use temporal and spatial information of a player
  - Player heatmaps
  - Ball landing plots

But these tools don't take into account the context of the game
CourtTime

- Use match metadata with spatial and temporal information
  - Game score
  - Who is serving
  - Serve side
  - Location of ball
  - Location of player ...

More information than summary statistics + spatial and temporal techniques
Overview of CourtTime

● Data extraction
  ○ Semi automated data collection
  ○ Annotated two matches: one professional and one amateur

● Visual analysis
  ○ Point selector
  ○ Point analyzer
  ○ Shot analyzer

● Video player: play points and videos of interest
Data (What)

- Two types of events (bounce events and hit events)
  - Location of ball
  - Location of player
  - Timestamp
  - Score
  - Serving player
  - Number of shots in point
  - Point outcome (winner, unforced error)
Deriving the Shot

- Aggregate bounce and hit events into a shot item
- \((\text{bounce-hit})\) or \((\text{hit-hit})\) -> shot
- Attributes
  - Sequence number
  - Reverse sequence number (number of shots until last shot)
  - Hitting player
  - Forehand or backhand
  - Location of ball and player for each event
- A collection of shots forms a point
Visualization

3 main components

- Point selector: Identify points to be analyzed
- Point analyzer: Used to further analyze selected points
- Shot analyzer: Used to further analyze a shot
Point selector

A search and overview task

- Explore and locate points to be further analyzed
  - Search by who is serving
  - Search by points scored from a second serve

- Also gives summary level stats
  - Number of points lost with a specific stroke type
  - Number of second serves missed
service break game
Point analyzer

Allows users to look at one point with many different views

- 1-D line charts of player and ball locations for all shots in a point
- Left/right dimension or depth dimension
- Order points to help user find patterns
  - Order based on similarity of features
  - Users can select the features used in ordering
- Point analyzer + point selector help find what shots to analyze
Weak-Side Cross-Court Battle

Moving the Opponent Side-to-Side

Player One Attacking the Net
Shot analyzer

Allows users to make a more granular analysis

- Uses player location, ball location, and shot trajectory
- Also allows ordering of shots
  - Similarity metric used
  - User can select features
- Helps users see the why
  - Trends
  - Outliers
  - Correlations
  - etc...
Strengths

- Detailed information
- Reasonable tools to help users direct analysis
  - Game-> Point -> Shot
  - Ordering
- Good use of colour as identity channel
  - Easy way to distinguish between player 1 and player 2
- 1D encoding of depth and left/right reduces cognitive load
Weaknesses

- Too many channels used
  - Hard to remember everything
- Hard to gather data
  - 3+ hours per video
  - Manually annotated
Validation

● Observe target users using the tools
  ○ Did they understand the needs of users?
  ○ Did they show the right thing?

● Is their visual encoding/interaction idiom the right one?
  ○ Seems promising but..
  ○ No comparison to existing solutions
    ■ Is context data necessary?