I. Introduction

• We aim to improve concept (action) detection using the temporal dependence from one concept to the next, which we define as causality.
• The task is to temporally locate concepts in a long video and identify them.
• We implement this using a Markov chain-inspired graph-based approach.
• We have applied our method to both:
  1. A self-annotated soccer dataset
  2. The 25 events of the TRECVID dataset

II. Datasets

1. Soccer Dataset
   • 14 different concepts
     1. Arguing
     2. Attempt at Goal
     3. Card (Red or Yellow)
     4. Celebration
     5. Corner
     6. Foul
     7. Free Kick
     8. Goal
     9. Goal Kick
    10. Injury
    11. Offside
    12. Penalty
    13. Substitution
    14. Throw In

2. TRECVID Dataset (EC11 and EC12)
   • 25 events and 185 different concepts
     • EC11 Events
       1. Attempting a Board Trick
       2. Attempting a Goal
       3. Attempting to Get a Vehicle Unstuck
       4. Argument
       5. Bathroom Cleaning
       6. Birthday Party
       7. Celebrating a Goal
       8. Changing a Vehicle Tire
       9. Climbing a Tree
       10. Commercial
       11. Dealing Cards
       12. Doing Homework
       13. Drinking Wine
       14. Enjoying the Sun
       15. Flash Mob Gathering
       16. Giving Directions
       17. Giving Directions to a Location
       18. Giving Directions to a Restaurant
       19. Getting a Vehicle Unstuck
       20. Grooming an Animal
       21. Grooming an Animal and identify them
       22. Helping a Friend
       23. Helping a Friend
       24. Helping a Friend
       25. Helping a Friend

     • EC12 Events
       1. Attempting a Board Trick
       2. Attempting a Goal
       3. Attempting to Get a Vehicle Unstuck
       4. Argument
       5. Bathroom Cleaning
       6. Birthday Party
       7. Celebrating a Goal
       8. Changing a Vehicle Tire
       9. Climbing a Tree
       10. Commercial
       11. Dealing Cards
       12. Doing Homework
       13. Drinking Wine
       14. Enjoying the Sun
       15. Flash Mob Gathering
       16. Giving Directions
       17. Giving Directions to a Location
       18. Giving Directions to a Restaurant
       19. Getting a Vehicle Unstuck
       20. Grooming an Animal
       21. Grooming an Animal
       22. Helping a Friend
       23. Helping a Friend
       24. Helping a Friend
       25. Helping a Friend

III. Features for Soccer Dataset

• STIP – Space Time Interest Points
• MBH – Motion Boundary Histograms
• MFCC – Mel-Frequency Cepstral Coefficients

IV. Causality

We define the causality between two concepts, A and B, by the equation:

\[ p(B|A) = \frac{|B \cap A|}{|A|} \]

- \(|B \cap A|\) is defined as the number of times where B is the first concept that occurs within t seconds of A
- \(|A|\) is defined as the number of times that concept A occurred

VI. Process

- Input Video
- Apply SVM
- Apply Clustering
- Detect Clips
- Analyze Clips
- Compute Causality
- Apply Causality
- Recover Sequence
- Detect Concepts

V. Graphical Model

Matrix Representation

\[
P(K_{t+1}) = \begin{bmatrix} C_{1,1} & \cdots & C_{1,N} \\ \vdots & \ddots & \vdots \\ C_{N,1} & \cdots & C_{N,N} \end{bmatrix} \begin{bmatrix} P_{K_{t-1},1} \\ \vdots \\ P_{K_{t-1},N} \end{bmatrix} + \begin{bmatrix} S_{K_{t-1},1} \\ \vdots \\ S_{K_{t-1},N} \end{bmatrix}
\]

VII. Results

<table>
<thead>
<tr>
<th>Event Number</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC11</td>
<td>83.04%</td>
</tr>
<tr>
<td>EC12</td>
<td>84.04%</td>
</tr>
</tbody>
</table>

VIII. Conclusion

Temporal relationships between concepts can be utilized to increase the accuracy of concept detection across an event. We see improvements on 22 of the 25 events using one of the above methods (our method, iterative approach, dynamic programming). Each event has a unique set of concepts that may have a different causal timespan between them. The best timespan for each event was determined empirically and used to attain the best results possible for each individual event. The improvement using temporal relationships may vary depending on the strength of the causality between concepts in an event.

Special thanks to: Dr. Mehrdad Shah, Dr. Nils Lehn, Amir Roshan Zamir, Afshin Afshin, Shayan Shayan Modiri, Assam, the CREC staff, and the NSF