Learning with Weak Supervision in Grounded Language Acquisition

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Grounded Semantics

ARSENAL **3** FT **1** CHELSEA
Alex Song (44')　　　　Branislav Ivanovic (57')
Cesc Fábregas (51')
Theo Walcott (53')

43' Essien is penalised for a challenge on Fabregas in midfield.

Time	Type	Qualifier	Team	Player
2592"	Pass	Throw In	Chelsea	Kalou
2594"	Tackle	Long Ball	Arsenal	Clichy
2594"	Disposses s	Through Ball	Chelsea	Essien
2596"	foul	Through Ball	Chelsea	Essien
2603"	pass	Free Kick	Arsenal	Fabregas
2605"	Pass	Chipped	Arsenal	Clichy
2609"	Pass	Through Ball	Arsenal	Koscielny
2615"	Pass	Long Ball	Arsenal	Song
2623"	Pass	Head	Arsenal	Nasri

- Grounded language acquisition:
  - Learn to correspond text to a part of world state

Related Work

- Approaches:
  - Supervised approaches
    [Ge & Mooney, 2005; Zettlemoyer & Collins, 2005; Lu et al., 2008]
  - Weakly supervised approaches
    [Chen & Mooney, 2008; Liang et al., 2009; Bordes et al., 2010,Goldwasser,et.al.,2012]
  - Clustering based
    [Poon & Domingos, 2009]
  - Reinforcement learning
    [Branavan et al., 2009,2010]
- Domains:
  - Robocup soccer   [Chen & Mooney, 2008, Hajishirzi et al., 2010]
  - Instructions   [2010, Artzi, Zettlemoyer,2013, Kay,Mooney,2013]
  - Weather reports   [Liang et al., 2009]

Professional Soccer Dataset

Commentary

Game Events

43' Essien penalised for a challenge on Fabregas in midfield.

44' Song began the move, exchanged with Wilshere on the edge of the box before stealing the ball off Fabregas' foot and sliding it home with his left foot from ten yards out. What a fantastic goal.

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[Hajishirzi et. al.'12]

Challenges

- 1. Hand-annotated alignment is too expensive

Commentary

Game Events

44' Song began the move [4], exchanged with Wilshere on the edge of the box [6,7] before stealing the ball off Fabregas' foot [8] and sliding it home with his left foot from ten yards out [9]. What a fantastic goal.

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Weak Supervision

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Challenges

- 2. Complex structure and paraphrases

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Challenges

- ## 3. Not all events are mentioned in the sentence

  (on average only 2 events per bucket size = 42)

Commentary

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Challenges

- 4. Some sentences correspond to no event
  - Statistics, game analysis

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Challenges

- 5. Comments correspond to combination of events (Macro events)

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"Arsenal is coming forward"

Challenges

- 6. Expensive to collect event logs
  - Can world knowledge help to extract event logs?

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Problem

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SHOT
GOAL
VIDEO HIGHLIGHT

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Sentence S_i

Events in Bucket $B(S_i)$

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Find the best set of events $\mathcal{E}_i$ (Macro-event) that corresponds to the sentence S_i

$$\arg \max_{\mathcal{E}_i \in \mathcal{P}(B(S_i))} \rho(S_i, \mathcal{E}_i)$$

$$\mid \mathcal{E}_i \mid \leq k$$

ρ ranks the correspondence between S_i and $\mathcal{E}_i$

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Pair-1:	S-43'	E-1
Pair-2:	S-43'	E-2
Pair-3:	S-43'	E-3
Pair-3:	S-43'	E-4
Pair-4:	S-43'	E-5
Pair-5:	S-43'	E-6
Pair-6:	S-43'	E-7
Pair-7:	S-44'	E-5
Pair-8:	S-44'	E-6
Pair-9:	S-44'	E-7
Pair-10:	S-44'	E-8
Pair-11:	S-44'	E-9
Pair-12:	S-44'	E-10
Pair-13:	S-44'	E-11
Pair-14:	S-44'	E-12

- **Solution**: rank pairs according to popularity among all the pairs
  - Popularity of a pair requires a notion of similarity between pairs

[Hajishirzi et. al.'12]

Similarity between Pairs

1: Chelsea looking for penalty as Malouda's header hits Koscielny.	Pass	Head	Chelsea	Malouda

1: Chelsea looking for penalty as Malouda's header hits Koscielny.	Foul	Head	Arsenal	Koschielny

Similarity between Pairs

- Pattern of correspondence:
  Co-occurrence of words and arguments matter

| 1: Chelsea looking for penalty as Malouda's header hits Koscielny. | Pass | Head | Chelsea | Malouda |

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- Discriminative Similarity (Pair Model)
  – Learn the correspondence pattern in each pair
    - Discriminate the pair from the rest

Pair Models

S		E		$+$
1: Chelsea looking for penalty as Malouda's header hits Koscielny.	Pass	Head	Chelsea	Malouda

$$(S \quad , \quad \tilde{E})$$

$$(\tilde{S} \quad , \quad E)$$

Exemplar SVM [Malisiewicz, ICCV'11]

Pair Model (S,E): $\vec{W}_{(S,E)}$

Ranking Pairs

- Build a similarity graph
  - Nodes: pairs
  - Edges: similarity between pairs

$Sim(A, G)$
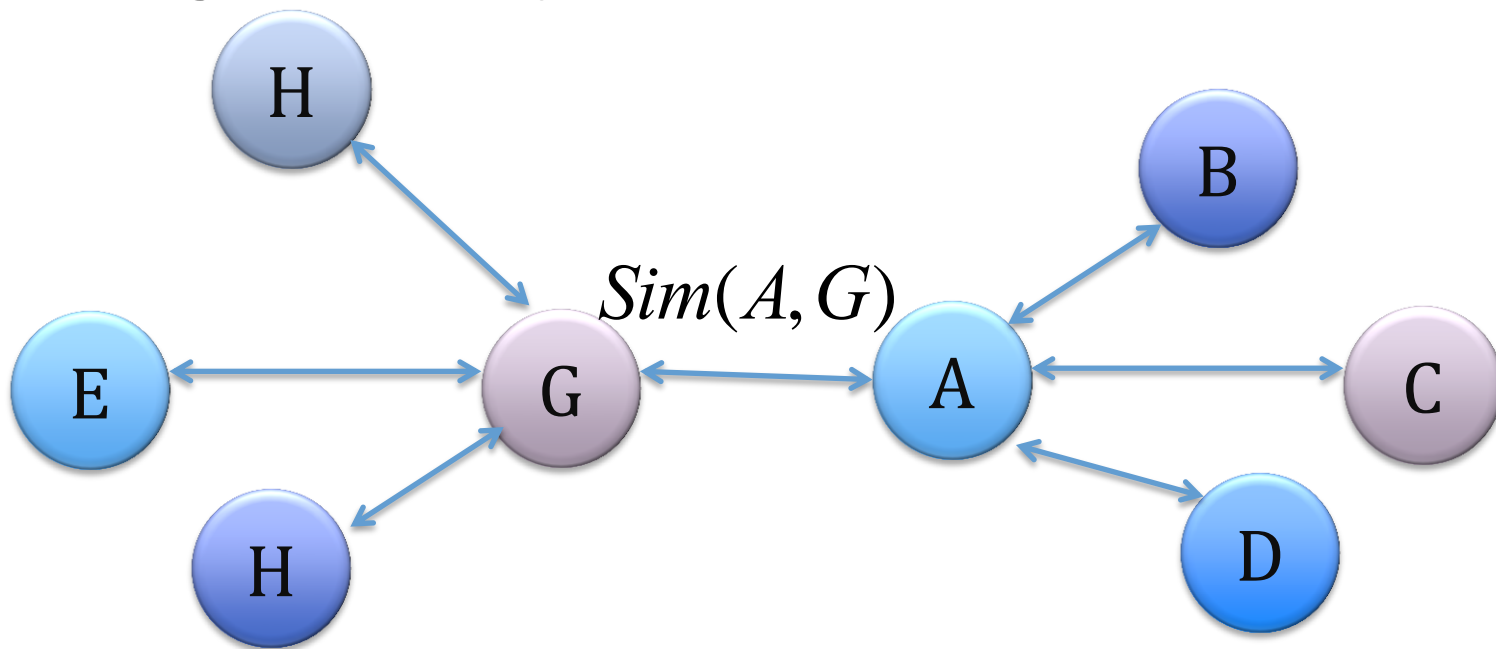
- A popular pair has many highly similar pairs that are popular ➔ PageRank algorithm

Pair Models

Pair-1:	S-43'	E-1
Pair-2:	S-43'	E-2
Pair-3:	S-43'	E-3
Pair-3:	S-43'	E-4
Pair-4:	S-43'	E-5
Pair-5:	S-43'	E-6
Pair-6:	S-43'	E-7
Pair-7:	S-44'	E-5
Pair-8:	S-44'	E-6
Pair-9:	S-44'	E-7
Pair-10:	S-44'	E-8
Pair-11:	S-44'	E-9
Pair-12:	S-44'	E-10
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Pair-15:	S-44'	E-13
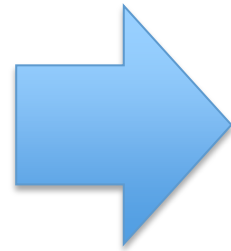
Popularity Ranking

Pair-5:	S-43'	E-5
Pair-2:	S-43'	E-2
Pair-1:	S-43'	E-1
Pair-3:	S-43'	E-3
Pair-4:	S-43'	E-4
Pair-7:	S-43'	E-7
Pair-6:	S-43'	E-6

Macro-event ?

|		
Pair-10:	S-44'	E-10
Pair-8:	S-44'	E-8
Pair-15:	S-44'	E-15
Pair-12:	S-44'	E-12
Pair-11:	S-44'	E-11
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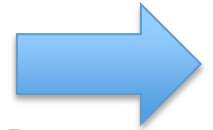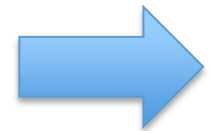
Macro-event ?

Discovering Macro-events

- Our ranking function is sub-modular
- Greedy approach to generate macro-events In each bucket
  - Start with best scoring event
  - Merge events that maximize marginal benefit

$$\mathcal{E}^l = \mathcal{E}^{l-1} \oplus \mathcal{A}^*$$

$$\mathcal{A}^* = \arg \max_{A \in B(S) \setminus D} \rho(S, \mathcal{E}^l \oplus A) - \rho(S, \mathcal{E}^l)$$

Game-by-Game Accuracy
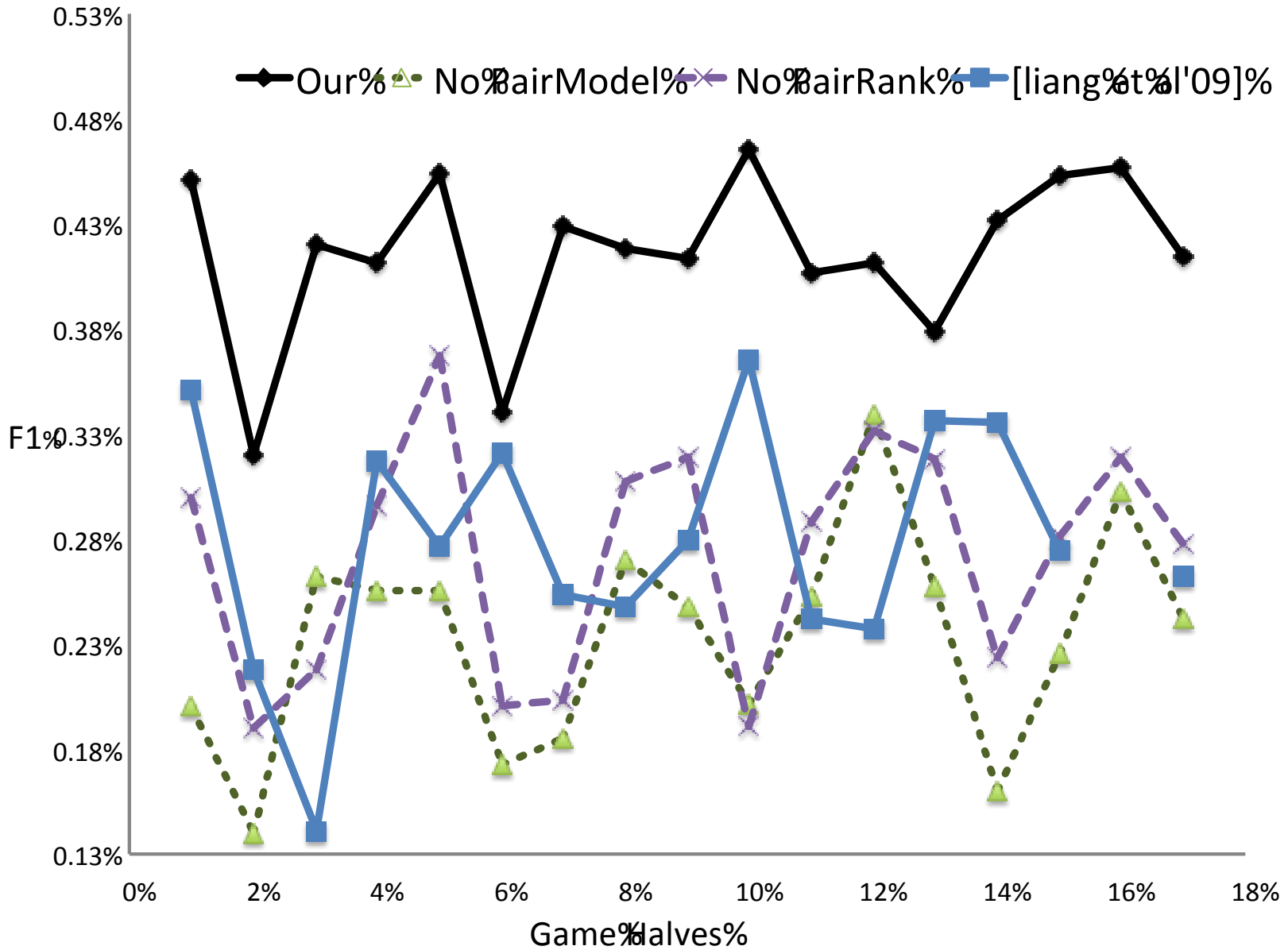
Qualitative Results

4: Cole is sent off for a lunge on Koscielny, it was poor, it was late but I'm not entirely sure that should have been red.

Foul	Long Ball	Liverpool	J. Cole
Foul	Through Ball	Arsenal	L. Koscielny
Card	None	Liverpool	J. Cole

Experiment with a Benchmark Data: RoboCup Soccer

Approach	F_1
[Chen and Mooney, 2008]	67.0
[Chen *et al.*, 2010]	73.5
[Liang *et al.*, 2009]	75.7
[Hajishirzi *et al.*, 2011][1]	77.9
[Hajishirzi et al., 2012] [2]	81.6

1. Incorporating dynamics: evolution of narratives
   Can domain knowledge replace the need of event logs?

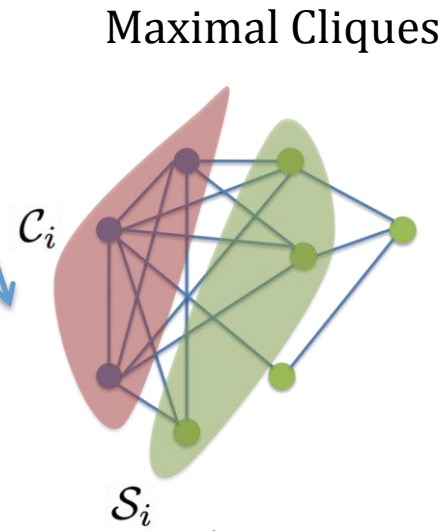2. Use pair models and ranking with weak supervision
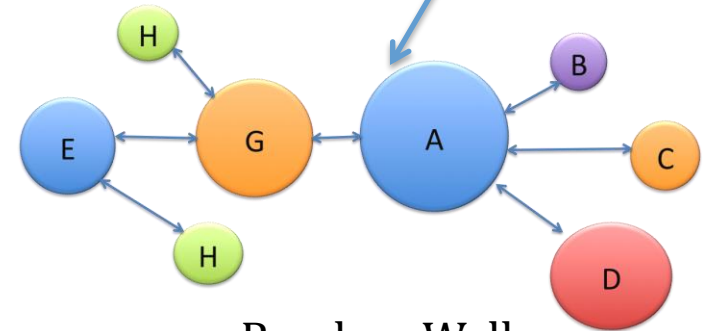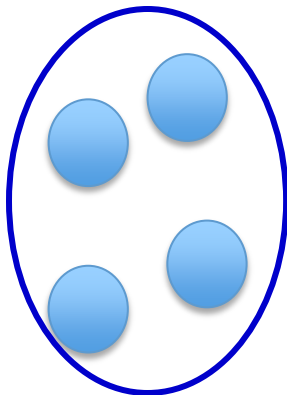
Multiple Instance Learning

Positive

Negative
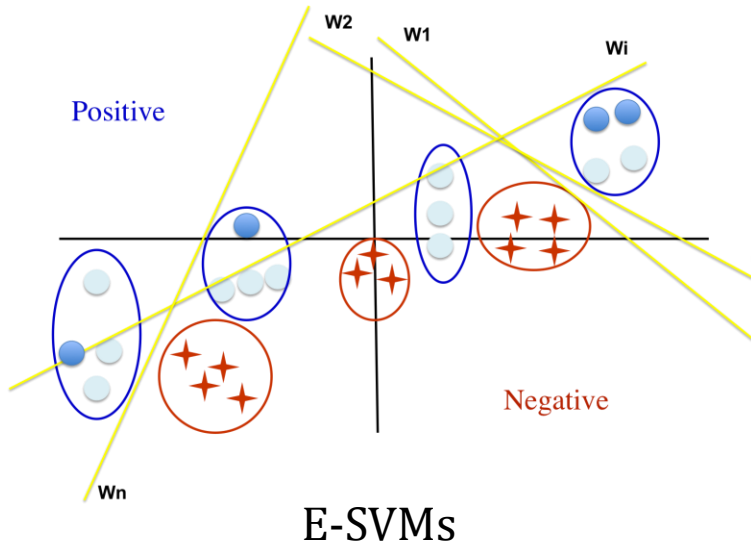
E-SVMs
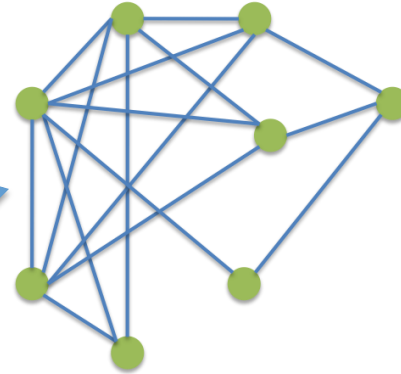
DSG

Maximal Cliques

$\mathcal{C}_i$

$\mathcal{S}_i$

Random Walk

Standard Benchmarks

Accuracy (%) on Benchmark Tasks					
Algorithm	Musk1	Musk2	Elephant	Fox	Tiger
Ours	91.2±1.5	**92.4**±2.1	**89.7**±0.8	**68.1**±2.3	**88.1**±1.5
miGraph	88.9±3.3	90.3±2.6	86.8±0.7	61.6±2.8	86.0±1.6
MIGraph	90.0±3.8	90.0±2.7	85.1±2.8	61.2±1.7	81.9±1.5
MI-Kernel	88.0±3.1	89.3±1.5	84.3±1.6	60.3±1.9	84.2±1.6
MI-SVM	77.9	84.3	81.4	59.4	84.0
mi-SVM	87.4	83.6	82.0	58.2	78.9
MissSVM	87.6	80.0	N/A	N/A	N/A
SMILE	91.3	91.6	85.8	67.7	86.5
GPMIL	89.47	87.25	83.8	65.75	87.37
MIForest	85	82	84	64	82
MILboost	82.3	85.7	80.7	55.2	80.7
DD	88.0	84.0	N/A	N/A	N/A
EM-DD	84.8	84.9	78.3	56.1	72.1
PPMM	**95.6**	81.2	82.4	60.3	82.4
APR	92.4	89.2	N/A	N/A	N/A
SVR-SVM	87.9±1.7	85.4±1.8	85.3±2.8	63.0±3.5	79±3.4
IL-SMIL	84.17±4.8	83.8±4.2	82.0±2.7	57.1±4.5	80.3±3.3
MI-CRF	88.0	84.3	85.0	67.5	83.0
MILES	86.3±1.4.7	87.7±1.4	N/A	N/A	N/A

[Hajishirzi et al., 2013]

What's Next?

- Larger Scale Macro-events:
  - "Arsenal is coming forward"

- Segmentation
  - Sentence-level not good enough for generation

- Story generation given a video
  - Automatic commentary generation

Spoken Language Interaction with Children

Multi-party Interaction

- Who produces the speech?
  - Talking at the same time
  - Mouth occlusion

- What do they mean?
  - Unexpected vocabulary
  - Indirect reference

- Who is the speech directed to?
  - Side conversations
- When to take the turn?

Addressee Identification and Turn Taking in Multi-child Interactions

- Are there any regularities in children's behavior?

- How children's behavior differ from adults?

- How autonomous character can take advantage of the regularities?

- Can we take advantage of temporal and group behavior?

- Take or Wait? Learning Turn-taking from Multi-party Data

[Hajishirzi et. al.'12 and Liete et. al.'13]

Thank You!

Addressee Identification in Multi-child Interactions

- Regularity in children behavior
- Models for automatic AID in multi-child interactions
  - Multi-modal features help in AID
  - Group and history models help in AID

[Hajishirzi et. al.'12]