Event Mention Detection scoring

Overall workflow

We show an overall workflow of evaluation for event mention detection in Figure 1.

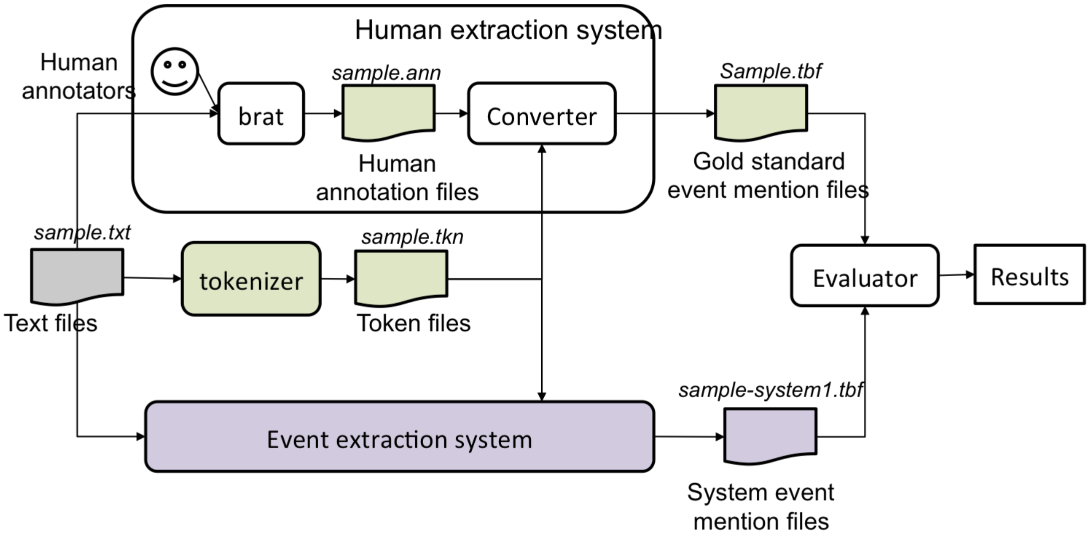


Figure 1: An overall workflow of event mention evaluation.

For each text file, human annotators use the **brat** rapid annotation tool to create a gold standard annotation file. We convert a brat annotation file to our evaluation file format. We assume that the output of an event extraction system should be given in the same file format as gold standard files. The evaluator (scorer) then reads the output of event mention detection systems and compares them to the gold standard.

The scorer reads the output of event mention detection systems and compares them to the gold standard.

Input of Scorer:

1. Gold standard annotation for documents, in format (one line per mention), all annotations are contained in one file only.
2. System output annotation for documents submitted by participants, in format (one line per mention), all annotations are contained in one file only.
3. Tokenization files associated with each document, one file per document.

Output of Scorer:

1. System output annotation as item 2 in Input, with addition of a mention detection score, realis status detection and mention type detection score for each mention appended to each line.
2. Overall performance report for system, as described in “Scoring” section.

Formats

System and gold standard annotation file format:

1. All event mention annotations for all documents in the corpus are written into one single file
2. A header will indicate the start of a new document
    a. Header := #BeginOfDocument<s><doc ID>
3. A footer will indicate the end of a document
    a. Footer := #EndOfDocument
4. Different event mentions should not include the same token

For each mention line, we follow the following format,

Definition of event mention format (one per line):

event-mention := <system ID><TAB><doc ID><TAB><mention ID><TAB><token ID list><TAB> <mention><TAB><event-type><TAB><realis status><TAB><score1><TAB> <score2><TAB><score3>

Explanation:
<system ID> := the name of the system
<doc ID> := the ID of the input document
<mention ID> := the ID of the mention, which should uniquely identify the mention within the current document
<token ID list> := list of IDs for the token(s) of the current mention,
in ascending order, separated by commas (,)
<mention> := the actual character string of the mention
<event-type> := the ACE hierarchy type
<realis status> := the REALIS label
<score1> := any score (confidence, etc.) the system wants to assign (ignored)
<score2> := score assigned in the evaluation
<score3> := additional possible score assigned by human
<TAB> := tab character

Scoring

Scoring for one document

We denote a gold standard mention with G, and a system mention with S, Overlap(G,S) is a token-based F1 function of G, S that returns a score between 0, 1. (see the OVERLAP subroutine in the Pseudo-code (Appendix 1) for detail). All invisible words are already removed from G and S (See **Note 1**).

To perform scoring for a document, system mentions are mapped to gold standard mentions based on the Overlap score. A system mention is always mapped to one and only one gold standard mention so that their Overlap score is the highest. However, it is possible to have multiple system mention to be mapped to one gold standard mention.

To score mentions detection, a mention-based F1 score is computed in the following way:

1. For each gold standard mention G_i, we choose the system mention S_j to find $\max Overlap(G_i, S_j)$, denote $TP_i = \max Overlap(G_i, S_j)$. Let set J be a set that contains all these system mentions S_j
2. True Positive = $\sum_i TP_i$
3. False Positive = #System Mention - $|J|$
4. Precision = True Positive /(True Positive + False Positive)
5. Recall = True Positive / #Gold Mention
6. F1 = H (Precision, Recall), where H is the harmonic average function

To score realis status and mention type detection, we use the same mapping:

1. For each gold standard mention G_i, we count the number of system mention S_j that are mapped to it as N_i,
2. We use X_i_realis and X_i_mention to define the realis status and mention type of the mention X_i respectively.
3. Initialize with realis_score = 0; mention_score = 0
4. If G_i_realis = S_j_realis , realis_score = realis_score + $1/N_i$;
5. Similarly, if G_i_mention = S_j_mention , mention_score = mention_score + $1/N_i$;
6. realis_detection_accuracy = realis_score / #GoldStandardMentions
7. type_detection_accuracy = mention_score / #GoldStandardMentions

Note 1: Invisible words are ignored in scoring. They include: determiners {the, a, an}, pronouns {I, you, he, she, we, my, your, her, our}, relative pronouns {who, what, where, when}, ...?
Note that "it" and "that" and pronouns including {his, ours, mine, yours, ours, they} are removed from the list because they can occasionally be resolved as nominal event mentions.

Examples:

Rule 1: do not accept prepositions but include particles

- "[look] up a chimney" vs. "[look up] a dictionary"
- "[climb] up the ladder"
- [take responsibility for]
- sing [all the way] to school
- [go] to school

Rule 2: consider the maximum extent of an event mention, but don't worry about determiners (they are invisible)

- [takes a shower] ==> it is okay for annotators to include "a" in their annotation; we can ignore "a" in evaluation
- [make a quick decision] ==> it is okay for annotators to annotate the whole phrase; we can ignore "a" and include "quick" in evaluation

Summarization score

After all documents are scored, we will also report scores that give a summarized performance on the whole corpus by taking the average across documents. We use the standard Micro and Macro average definition:

Macro Average Scores (Numerical average over the document scores):

Precision_macro = sum of all Precision / #document
Recall_macro = sum of all Recall / #document
F1_macro = 2* Precision_macro * Recall_macro / (Precision_macro + Recall_macro)
Type_detection_accuracy_macro = sum of all type_detection_accuracy / #document
Realis_detection_accuracy_macro = sum of all realis_detection_accuracy / #document

Micro Average Scores (Sum up the individual true positives, false positives, and false negatives of each mention and calculate the overall F-Score)

Precision_micro = (sum of TP on all doc)/ (sum of TP on all doc + sum of FP on all doc)
Recall_micro = (sum of TP on all doc) / (total number of gold standard mention in all documents)
F1_micro = 2* Precision_ micro * Recall_ micro / (Precision_ micro + Recall_ micro)
Type_detection_accuracy_micro = sum of num_type_correct / (total number of gold standard mention in all documents)
Realis_detection_accuracy_micro = sum of realis_detection_score / (total number of gold standard mention in all documents)

Appendix 1: Pseudo-code for scoring one document:

```
Let mappingScores = {}

#STEP 1 : Compute overlap scores for each pair of Gold/System Mention

FOR each system mention S := {S_mid, S_tokens, S_realis, S_type} (one per line)
  Let S_mid := mention id of S
  Let S_tokens := token IDs associated with S
  Let S_tokens := S_tokens – {token IDs of invisible words} #See NOTE 1
  Let S_realis := realis status of S
  Let S_type := mention type of S

  FOR each gold mention G:= {G_mid, G_tokens, G_realis, G_type}
   Let G_mid := mention id of G
   Let G_tokens := token IDs associated with G
   Let G_tokens := G_tokens – {token IDs of invisible words}
   Let G_realis := realis status of G
   Let G_type := mention type of G

   Let overlap := OVERLAP(S_tokens, G_tokens)
   IF overlap > 0
       mappingScores := mappingScores + (G, S, overlap)
   END IF
  END FOR
END FOR

#STEP2: After the calculation of all pairs, we can find the best mapping between
#System Mention and Gold Standard Mentions

Sort mappingScores based on overlap

Mapping = {} # create a empty mapping table to hold mappings
WHILE mappingScores != {}:
  (G, S, overlap) = mappingScores.pop() #get the item with the highest overlap

  #if G and S have not been mapped,
  #it means there are no better overlap than this one
  IF G has not been mapped and S has not been mapped
         THEN Mapping := Mapping + {G,S, overlap}
  ELSE IF G has been mapped but S has not been mapped
         THEN Find the row R that contains G, append S to its system mentions.
  END IF
END WHILE

#Append system score to the gold standard file
```

```
FOR each gold mention G:
      Score := Mapping[G].overlap
      append Score to the end of the line of G_mid in Gold Standard, in position <score2>
END FOR

#STEP3.1: Compute document level errors and corrects on mention detection
TP := 0
FOR EACH System Mention S
 IF S is contained in Mapping
   TP := TP + Mapping[S].overlap
 ELSE
   FP := FP + 1
 END IF
END FOR

#STEP3.2: Compute document level precision, recall for mention detection:
Precision := TP / (TP+FP)
Recall := TP / #GoldStandardMentions
F1_Score := 2*Precision*Recall/(Precision+Recall)

#STEP3.3: Compute mention and realis type detection score:
num_type_correct := 0
num_realis_correct := 0
FOR EACH LINE (G,{S}, overlap) in Mapping
    Mapping_num:= |{S}|
    Single_score := 1/ Mapping_num
    FOR EACH LINE S in {S}
      IF G_type == S_type
        type_correct := type_correct + Single_score
      END IF
      IF G_realis == S_realis
        realis_correct := realis_correct + Single_score
      END IF
    END FOR
END FOR

Type_detection_accuracy := num_type_correct / #GoldStandardMentions
Realis_detection_accuracy:= num_realis_correct  / #GoldStandardMentions

# Return and report the following measures for this document:
Measures for this doc = {TP, FP, num_type_correct, num_realis_correct, Precision, Recall, F1_Score, Type_detection_accuracy, Realis_detection_accuracy }    #Note 2
```

Subroutine OVERLAP(G,S):

```
 IF G == S, THEN  score := 1.0
```

```
  IF G∧S == {}, THEN score := 0.0
  ELSE
        precision_m := (|S∧G|)/|S|
        recall_m := (|S∧G|)/|G|
        score := 2*precision_m*recall_m / (precision_m + recall_m)
  RETURN score
End Subroutine
```

Appendix 2: Example of scoring computation:

Sample System output:

System Id	Doc Id	Event Mention Id	Token Id List	Mention Text	Event Type	Realis Status	System Confidence
sue	sample	E1	17	advice	Communicate	Other	1
sue	sample	E2	19	reassurance	Communicate	Other	1
sue	sample	E3	33	came	Transport-Person	Actual	1
sue	sample	E4	52	going	Transport-Person	Actual	1

Gold annotations:

System Id	Doc Id	Event Mention Id	Token Id List	Mention Text	Event Type	Realis Status	System Confidence
gold	sample	E1	52	going	Transport-Person	Actual	1
gold	sample	E2	33	came	Transport-Person	Actual	1
gold	sample	E3	87	got	Transport-Person	Actual	1
gold	sample	E4	14,17,18,19	offer advice or reassurance	Communicate	Other	1

In the following tables, the “Event Type” and “Realis Status” are omitted for clarity

STEP 1 : Compute overlap scores for each pair of Gold/System Mention

There are no invisible words, so no removal will be done

Compute the “mappingScore” table as followed:

Gold Mention	System Mention	Overlap
(E1, [52])	(E4, [52])	1
(E2, [33])	(E3, [33])	1
(E4, [14,17,18,19])	(E1, [17])	2/5 (See #)
(E4, [14,17,18,19])	(E2, [19])	2/5 (Same as above)

# Example calculation of overlap:

Prec(G_E4,S_E1) = (|E1 ^ E4|) / |E1| = 1/1 = 1;

Recall(G_E4,S_E1) = (|E1 ^ E4|) / |E4| = ¼ = ¼;

Overlap(G_E4,S_E1) = 2 * Prec(G_E4,S_E1) * Recall(G_E4,S_E1) / (Prec(G_E4,S_E1) + Recall(G_E4,S_E1)) = 2 * 1 * ¼ / (1 + ¼) = 2/5

STEP2: After the calculation of all pairs, we can find the best mapping between System Mention and Gold Standard Mentions

Sort the "mappingScore" table based on overlap (Ties are currently break on their appearance in data):

Gold Mention	System Mention	Overlap
(E1, [52])	(E4, [52])	1
(E2, [33])	(E3, [33])	1
(E4, [14,17,18,19])	(E1, [17])	2/5
(E4, [14,17,18,19])	(E2, [19])	2/5

We select mappings from the table above from top to bottom:

1. On row1, Select Gold, E1 to map to System, E4, we also record the overlap score 1.
2. On row2, Select Gold, E2 to map to System, E3, we also record the overlap score 1.
3. On row3, Select Gold, E4 to map to System, E1, we record the overlap score 2/5
4. On row4, Select Gold, E4 to map to System, E2, we can see that Gold E4 has already been mapped to a mention System E1, we do not record overlap score, but we record the system mention here so we know that E4 is mapped to 2 system mention

We have the following mapping table (mappingScore table):

Gold Mention	System Mention	Overlap
(E1, [52])	(E4, [52])	1
(E2, [33])	(E3, [33])	1
(E4, [14,17,18,19])	(E1, [17]) , (E2,[19])	2/5

STEP3.1: Compute document level errors and corrects

TP is the sum of the overlap in the mappingScore table:

TP = 1 + 1 + 2/5 = 2.4

S{E2} is not contained in the mappingScore table, so

FP = 1

STEP3.2: Compute document level precision, recall:

Precision := TP / (TP+FP) = 2.4 / (2.4+1) = 0. 7059
Recall := TP / #GoldStandardMentions = 2.25/4 = 0.6
F1 := 2*Precision*Recall/ (Precision+Recall) = 2*0. 7059*0.6/ (0. 7059+0. 6) = 0.6487

#STEP3.3: Compute mention type and realis status detection score:

For each row in the mapping table, we check whether the system mention have the same realis status and mention type with the gold mention.

G_E1 – S_E4 and G_E2 – S_E3 are both one to one mapping, so N will be 1. Both mention types and realis status are correct, so that we have type_score = 2, realis_score = 2.

G_E4 is mapped to 2 mentions {S_E1, S_E2}, so N = 2. Both mention types and realis status are correct, so that we have type_score = ½ + ½ = 1, realis_score = ½ + ½ = 1.

The sum of type score is 2 + 1 = 3, and the total realis score 2+1 = 3. We than can calculate the accuracy:

Type_detection_accuracy := 3 / #GoldStandardMentions = 0.75

Realis_detection_accuracy:= 3 / #GoldStandardMentions = 0.75

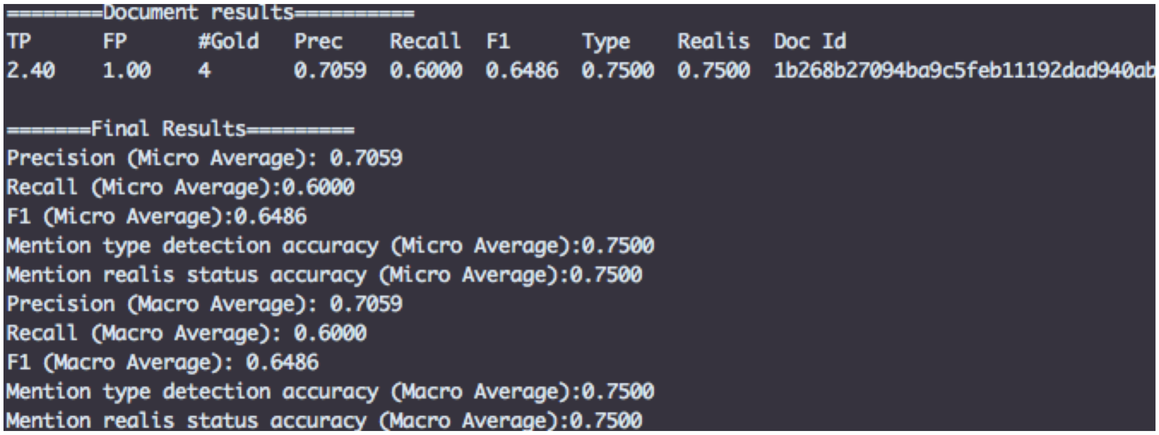
Final Output:

Output1: The score appended gold standard file will be like the following

System Id	Doc Id	Event Mention Id	Token Id List	Mention Text	Event Type	Realis Status	System Confidence	Sue Mention score
gold	sample	E1	52	going	Transport-Person	Actual	1	1
gold	sample	E2	33	came	Transport-Person	Actual	1	1
gold	sample	E3	87	got	Transport-Person	Actual	1	-
gold	sample	E4	14,17,18, 19	offer advice or reassurance	Communicate	Other	1	0.4

Output2: Individual document performance and averaged performance

We only take one document as example, which make the micro and macro measures to be the same.



```
========Document results==========
TP      FP      #Gold   Prec    Recall  F1      Type    Realis  Doc Id
2.40    1.00    4       0.7059  0.6000  0.6486  0.7500  0.7500  1b268b27094ba9c5feb11192dad940ab

=======Final Results=========
Precision (Micro Average): 0.7059
Recall (Micro Average):0.6000
F1 (Micro Average):0.6486
Mention type detection accuracy (Micro Average):0.7500
Mention realis status accuracy (Micro Average):0.7500
Precision (Macro Average): 0.7059
Recall (Macro Average): 0.6000
F1 (Macro Average): 0.6486
Mention type detection accuracy (Macro Average):0.7500
Mention realis status accuracy (Macro Average):0.7500
```