Appendix

Algorithm 1 Graph Beam Search

Require: Relation graph G
Require: Labelled nodes $N_{labelled}$
Require: Unlabelled nodes $N_{unlabelled}$
Require: Beam width k

for node n in $N_{unlabelled}$ **do**
  $p_t(n_i, n_j) \leftarrow Weight_{Edge_{i,j}}$
  $beams \leftarrow \varnothing$
  $bestBeams \leftarrow \varnothing$
  $p_b(\varnothing, 0) \leftarrow 1$
  for $t = 1 \cdots T$ **do**
    if $beams \neq \varnothing$ **then**
      $bestBeams \leftarrow \arg\max_k(beams, \frac{\log(p_b(beam, t-1))}{length_{beam}})$
    $beams \leftarrow \varnothing$
    for $beam$ in $bestBeams$ **do**
      $successors \leftarrow$ labelled neighbors of $currentNode$
      if $successors = \varnothing$ **then**
        continue
      for suc in $\arg\max_k(successors, p_t(currentNode, suc))$ **do**
        $beam \leftarrow beam \cup successor$
        $p_b(beam, t) \leftarrow p_b(beam, t-1) + p_t(currentNode, suc)$
        if $outDegree(suc) = 0$ **then**
          $k \leftarrow k - 1$
    if all($length_{beam} = 0$) or $k = 0$ **then**
      break
  $bestBeam \leftarrow \arg\max(bestBeams, \frac{\log(p_b(beam, T))}{length_{beam}})$
  $domain \leftarrow \max\{\cdots\}\{n.domain$ for n in $bestBeam\}$
  $intents \leftarrow \{n.intent$ for n in $bestBeam\}$
  for each $intent$ in $intents$ **do**
    if $intent$ does not belong to $domain$ **then** $intents \setminus intent$
  $intent \leftarrow \max\{\cdots\}intents$