Algorithm 1: CTC Loss alpha computation

Data: $out_{m \times n}$ (result of softmax), where m=$\bar{W}/4$, n=$|\hat{A}|$,
l (label encoded by alphabet),
bl=0 (blank index)
begin
  $Loss = 0$
  $L = 2 \times len(l) + 1$
  $T = m$
  $a = zeros(T, L)$
  $a_0^0 = out_0^{bl}$
  $a_0^1 = out_0^{l_0}$
  $c = \sum_{i=0}^{1} a_0^i$
  for $i := 0$ **to** 1 **do**
    $a_0^i = \frac{a_0^i}{c}$
  $Loss = Loss + c$
  for $t := 1$ **to** T **do**
    $s = \max(0, L - 2 \times (T - t))$
    $e = \min(2 \times t + 2, L)$
    for $s := 1$ **to** L **do**
      $i = \frac{s-1}{2}$
      $red = a_{t-1}^s$
      $blue = 0$
      if $s > 0$ **then**
        $blue = a_{t-1}^{s-1}$
      if s ***mod*** $2 = 0$ **then**
        $a_t^s = (red + blue) \times out_t^{bl}$
      else if $s = 1$ ***or*** $l_i = l_{i-1}$ **then**
        $a_t^s = (red + blue) \times out_t^{l_i}$
      else
        $orange = a_{t-1}^{s-2}$
        $a_t^s = (red + blue + orange) \times out_t^{l_i}$
    $c = \sum_{i=s}^{e} a_t^i$
    for $i := s$ **to** e **do**
      $a_t^i = \frac{a_t^i}{c}$
    $Loss = Loss + c$
  return Loss

Algorithm 2: CTC Loss gradient computation

Data: $out_{m \times n}$ (result of softmax), where m=$\bar{W}/4$, n=$|\hat{A}|$,
l (label encoded by alphabet),
bl=0 (blank index),
a, b (alpha and beta from paper)
begin
  $L = 2 \times len(l) + 1$
  $T = m$
  $grad = zeros(T, n)$
  $ab = a * b$
  for $s := 1$ **to** L **do**
    if s ***mod*** $2 = 0$ **then**
      for $t := 1$ **to** T **do**
        $grad_t^{bl} += ab_t^s$
        $ab_t^s = \frac{ab_t^s}{out_t^{bl}}$
    else
      for $t := 1$ **to** T **do**
        $i = \frac{s-1}{2}$
        $grad_t^i += ab_t^s$
        $ab_t^s = \frac{ab_t^s}{out_t^i}$
  $absum = zeros(T)$
  for $t := 1$ **to** T **do**
    $absum_t = \sum_{s=1}^{L} ab_t^s$
  for $t := 1$ **to** T **do**
    for $i := 1$ **to** n **do**
      $grad_t^i = out_t^i - \frac{grad_t^i}{out_t^i * absum_t}$
  return grad