Algorithm 1: Alpha computation

Data: $out_{m \times n}$ (result of softmax), where m=$\bar{W}_{padded}/4$, w=$\bar{W}_{unpadded}/4$, n=$|\hat{A}|$,
label (encoded by alphabet),
bl=0 (blank index)

begin
- $l = len(label)$
- $L = 2 \times len(label) + 1$
- $T = w$
- $T_{padded} = m$
- $a = zeros(T_{padded}, L)$
- $a_0^0 = out_0^{bl}$
- $a_0^1 = out_0^{label_0}$
- $c = a_0^0 + a_0^1$
- **if** $c > 0$ **then**
  - $a_0^0 = \frac{a_0^0}{c}$
  - $a_0^1 = \frac{a_0^1}{c}$
- **for** $t := 1$ **to** T **do**
  - $start = \max(0, L - 2 \times (T - t))$
  - $end = \min(2 \times t + 2, L)$
  - **for** $s := start$ **to** L **do**
    - $i = \frac{s-1}{2}$
    - $a_t^s = a_{t-1}^s$
    - **if** $s > 0$ **then**
      - $a_t^s = a_t^s + a_{t-1}^{s-1}$
    - **if** s ***mod*** $2 = 0$ **then**
      - $a_t^s = a_t^s \times out_t^{bl}$
    - **else if** $s = 1$ ***or*** $label_i = label_{i-1}$ **then**
      - $a_t^s = a_t^s \times out_t^{label_i}$
    - **else**
      - $a_t^s = (a_t^s + a_{t-1}^{s-2}) \times out_t^{label_i}$
  - $c = \sum_{i=start}^{end} a_t^i$
  - **if** $c > 0$ **then**
    - **for** $i := start$ **to** end **do**
      - $a_t^i = \frac{a_t^i}{c}$
- **return** a

Algorithm 2: CTC Loss computation

Data: $out_{m \times n}$ (result of softmax), where m=$\bar{W}_{padded}/4$,
w=$\bar{W}_{unpadded}/4$, n=$|\hat{A}|$,
label (encoded by alphabet),
bl=0 (blank index)

begin

  $Loss = 0$

  $a = ComputeAlpha(out, label, bl)$

  $b = ComputeAlpha(fliplr(out), reverse(label), bl)$

  $b = flipud(fliplr(b))$

  $ab = a * b$

  for $s := 0$ **to** L **do**

    if s ***mod*** $2 = 0$ **then**

      for $t := 0$ **to** T **do**

        $ab_t^s = \frac{ab_t^s}{out_t^{bl}}$

    else

      for $t := 0$ **to** T **do**

        $i = \frac{s-1}{2}$

        $ab_t^s = \frac{ab_t^s}{out_t^{label_i}}$

  $absum = zeros(T)$

  for $t := 0$ **to** T **do**

    $absum_t = \sum_{s=1}^{L} ab_t^s$

  $Loss = -\sum_{t=1}^{T} \ln absum_t$

  return $Loss$