
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

$l = \text{len}(\text{label})$

$L = 2 \times \text{len}(\text{label}) + 1$

$T = w$

$T_{padded} = m$

$a = \text{zeros}(T_{padded}, L)$

$a_0^0 = out_0^{bl}$

$a_0^1 = out_0^{label_0}$

$c = a_0^0 + a_0^1$

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 $s \bmod 2 = 0$ **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
 $Loss = 0$
 $a = ComputeAlpha(out, label, bl)$
 $b = ComputeAlpha(fliplr(out), reverse(label), bl)$
 $b = transpose(rot90(b, 2))$
 $ab = a * b$
 for $s := 0$ **to** L **do**
 if $s \bmod 2 = 0$ **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 $Loss$
