

A APPENDIX

Algorithm 1 PLPP

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1: function BATCH-UPDATING( $I, Prompts$ )
2:   # Get The Features of the current batch, labels and output distribution of prompts.
3:    $I_f \leftarrow image\_encoder(I)$ 
4:    $T_f \leftarrow text\_encoder(Prompts)$ 
5:    $\tilde{T}_f \leftarrow text\_encoder\_before\_proj(Prompts)$ 
6:    $prompts\_label \leftarrow generate\_label(prompts)$ 
7:    $output \leftarrow lm\_head(\tilde{T}_f)$ 
8:
9:   # Calculate the losses.
10:   $L_{CE} \leftarrow CE(I_f @ T_f.transpose(), label)$ 
11:   $L_{PPL} \leftarrow TEXT-PPL-LOSS(output, prompts\_label)$ 
12:   $L_{PLPP} \leftarrow L_{CE} + \lambda L_{PPL}$ 
13:
14:  # Update the prompts.
15:   $Prompts \leftarrow BACKWARD-UPDATE(output, prompts\_label)$ 
16: end function
17:
18: function TEXT-PPL-LOSS( $output, prompts\_label$ )
19:   $loss \leftarrow CE(output, prompts\_label)$ 
20:   $ppl \leftarrow e^{loss}$ 
21:  return  $ppl$ 
22: end function

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Table 4: Visualizing prompts trained by our PLPP

#	UCF101	Flowers102	Caltech101	StanfordCars	FGVCAircraft
1	verify	hooper	learning	headquarters	humor
2	exhilarating	hike	6	minis	discuss
3	igne	beh	shoot	rebound	existed
4	discuss	accurate	reduces	ator	city
5	gi	core	uta	sport	pakistan
6	fx	signing	2	ville	direct
7	visited	vs	inspired	stats	imma
8	night	iq	fields	machine	ays
9	real	manager	cartoon	back	injury
10	drop	per	mark	amount	womensday
11	controls	hike	bubble	drew	ho
12	suggestions	website	hike	sa	hel
13	bec	year	babe	2	lemans
14	smile	und	threatened	herself	its
15	edge	2	shoutout	version	kick
16	jersey	seventeen	cs	colored	papa