Lab 9: Carbon footprint

The goal of this lab is for you to estimate the carbon footprint of your class project.

Group name: How Do you turn this on.

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1: Inference

1. Plug your device in to the Kill-a-watt and run inference using your model to get a measurement of the energy draw. What is its baseline energy draw, and how does that compare to running inference?

   The baseline is around 2.4 watt when we only boot the Raspberry Pi 4. When we are running the inference, the energy draw becomes about 5.2 watt.

2. Multiply energy draw by inference time to get an estimate of energy required per inference (you can average over input size).

   For each model, we use the averaged time of inferencing 100 sample. The full Transformer model requires in average 91.180 seconds and the pruned model required 45.940 seconds. Therefore the energies required per inference are 474.136 J and 238.888 J for the full model and pruned model respectively.

3. Multiply this by the carbon intensity of the location of your device. You can use [this resource](https://www.epa.gov/egrid/power-profiler#/).

   Since the CO2 intensity in Pittsburgh is 1067.7 lbs/MWh, we have emission rate 1067.7 / 3600 = 0.296 lbs/MWs. Therefore the carbon emission per inference of the full model is 0.00014 lbs and the emission of the pruned model is 0.000070 lbs.

2: Training

1. Did your project require training a model? If so, compute that estimate as well.

   Yes, our project requires a fine-tuning of the model. We use both AWS to do the training. For AWS, we use the instance type g4dn.xlarge and it takes about 1 day to finetune the model. The g4db.xlarge instance has 1 NVIDIA T4 tensor Core GPU. According to the

provided resource, the carbon emitted is 0.62 kg of CO_2 which is equivalent to 2.5 km driven an average car.

3: Extra

1. Everything else: Do you have logs you can use to estimate the amount of energy + carbon that went in to all project development? Other ways of estimating? Was your device plugged in and running for the entire semester?

   Yes, we kept most of the training and inference logs of our models and there are timestamps in our logs. Timestamps in logs might not be accurate due to multiple factors such as the catching of writing files but it could at least serve as an estimation. Besides logs from our models, maybe system logs can provide information about the power consumption of developing models and running servers since our device was plugged in and running for the entire semester.

2. Supply chain / lifecycle analysis: Can you estimate the additional footprint due to manufacturing hardware? Lifetime energy use of your project if it was deployed in the real world?

   We estimate the carbon footprint based on the estimation of Raspberry Pi A+ [1]

   - Chip: 1.6kg fossil oil, namely 0.6 Gal gasoline. According to [2], it produces 5.1kg CO_2.
   - Transportation Pi from China to the US: It takes about 197781/35656308 liter gasoline. It seems to be negligible.

   [1] http://www.designlife-cycle.com/raspberry-pi
   [2] https://www.eia.gov/environment/emissions/co2_vol_mass.php

3. If you have a Pi or Jetson 4GB: Compare Kill-a-watt measurements to command line energy measurements, and discuuss.