Towards Climate Awareness in NLP Research

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EMNLP 2022

https://arxiv.org/abs/2205.05071
Climate impact of NLP

Models grow exponentially and take longer to train

Efficient Methods for Natural Language Processing: A Survey (Treviso et al., 2022)
1. Model publicly available?

Models 87,997

- CompVis/stable-diffusion-v1-4
  - Updated about 10 hours ago
  - Downloads: 809k
  - Likes: 3.15k

- bigscience/bloom
  - Updated 24 days ago
  - Downloads: 12.2k
  - Likes: 1.71k

- CompVis/stable-diffusion-v1-4-original
  - Updated 5 days ago
  - Likes: 1.4k

- runwayml/stable-diffusion-v1-5
  - Updated 5 days ago
  - Downloads: 194k
  - Likes: 1.23k

https://huggingface.co/models
Climate performance model card

1. Model publicly available?
2. Time to train final model
3. Time for all experiments

REDUCE

https://wandb.ai/
Energy consumption scales with size

<table>
<thead>
<tr>
<th>Model</th>
<th>Consumption [MWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3B</td>
<td>2.1</td>
</tr>
<tr>
<td>2.7B</td>
<td>4.8</td>
</tr>
<tr>
<td>6.7B</td>
<td>11.8</td>
</tr>
<tr>
<td>13B</td>
<td>22.9</td>
</tr>
</tbody>
</table>

A Holistic Assessment of the Carbon Footprint of Noor, a Very Large Arabic Language Model (Lakim et al., BigScience 2022)
Climate performance model card

1. Model publicly available?
2. Time to train final model
3. Time for all experiments
4. Power of GPU and CPU

<table>
<thead>
<tr>
<th></th>
<th>A100 80GB PCIe</th>
<th>A100 80GB SXM</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPU Memory</td>
<td>80GB HBM2e</td>
<td>80GB HBM2e</td>
</tr>
<tr>
<td>GPU Memory Bandwidth</td>
<td>1,935 GB/s</td>
<td>2,039 GB/s</td>
</tr>
<tr>
<td>Max Thermal Design Power (TDP)</td>
<td>300W</td>
<td>400W ***</td>
</tr>
</tbody>
</table>

Measuring the Carbon Intensity of AI in Cloud Instances (Dodge et al., FAccT 2022)
Climate performance model card

1. Model publicly available
2. Time to train final model
3. Time for all experiments
4. Power of GPU and CPU
5. Location for computations
6. Energy mix at location

https://lowcarbonpower.org/map-gCO2eq-kWh
Climate performance model card

1. Model publicly available
2. Time to train final model
3. Time for all experiments
4. Power of GPU and CPU
5. Location for computation
6. Energy mix at location
7. CO₂eq for final model
8. CO₂eq for all experiments

Select an Experiment

Select an Experiment

Showing results for experiment:
Infrastructure Hosted at United States
Power Consumption: 0.0003 kWh
Carbon Equivalent: 0.0001 kg

https://codecarbon.io/
Automated reporting

Convenient and reproducible

But measures vary significantly between tools

Evaluating the carbon footprint of NLP methods: a survey and analysis of existing tools (Bannour et al., SustaiNLP 2021)
Greenhouse Gas Protocol

https://www.greenelement.co.uk/blog/carbon-footprint-scope-1-2-3/
Climate performance model card

1. Model publicly available?
2. Time to train final model
3. Time for all experiments
4. Power of GPU and CPU
5. Location for computations
6. Energy mix at location
7. CO₂eq for final model
8. CO₂eq for all experiments
9. Average CO₂eq for inference per sample
Climate awareness is increasing but is still "niche"
Greenwashing?

"Better than some alternative" ≠ sustainable
Principles of climate performance assessment

RELEVANCE  COMPLETENESS  CONSISTENCY

TRANSPARENCY  ACCURACY
Pragmatic reporting

1. Lower bar for reporting
2. Estimate and quantify confidence
3. Extrapolate to indirect impact
4. Highlight (potential) positive impact
5. Facilitate fair comparison and decision making by users
6. Enable policies to regulate climate performance
Carbon offsetting?

Compensating for emissions is controversial

Mitigation by reduction is essential and feasible
## Model card example

<table>
<thead>
<tr>
<th>ClimateBert</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Model publicly available?</td>
<td>Yes</td>
</tr>
<tr>
<td>2. Time to train final model</td>
<td>8 hours</td>
</tr>
<tr>
<td>3. Time for all experiments</td>
<td>288 hours</td>
</tr>
<tr>
<td>4. Power of GPU and CPU</td>
<td>0.7 kW</td>
</tr>
<tr>
<td>5. Location for computations</td>
<td>Germany</td>
</tr>
<tr>
<td>6. Energy mix at location</td>
<td>470 gCO$_2$eq/kWh</td>
</tr>
<tr>
<td>7. CO$_2$eq for final model</td>
<td>2.63 kg</td>
</tr>
<tr>
<td>8. CO$_2$eq for all experiments</td>
<td>94.75 kg</td>
</tr>
<tr>
<td>9. Average CO$_2$eq for inference per sample</td>
<td>0.62 mg</td>
</tr>
</tbody>
</table>

ClimateBert: A Pretrained Language Model for Climate-Related Text (Webersinke et al., 2021)
## Model card example

### MCWQ mT5-base+RIR

<table>
<thead>
<tr>
<th>Information</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Model publicly available?</td>
<td>Yes</td>
</tr>
<tr>
<td>2. Time to train final model</td>
<td>592 hours</td>
</tr>
<tr>
<td>3. Time for all experiments</td>
<td>1315 hours</td>
</tr>
<tr>
<td>4. Energy consumption</td>
<td>2209.2 kWh</td>
</tr>
<tr>
<td>5. Location for computations</td>
<td>Denmark</td>
</tr>
<tr>
<td>6. Energy mix at location</td>
<td>191 gCO2eq/ kWh</td>
</tr>
<tr>
<td>7. CO2eq for final model</td>
<td>189.96 kg</td>
</tr>
<tr>
<td>8. CO2eq for all experiments</td>
<td>421.96 kg</td>
</tr>
</tbody>
</table>

*Compositional Generalization in Multilingual Semantic Parsing over Wikidata* (Cui et al., TACL 2022)
Some avenues for positive climate impact

Detecting greenwashing (e.g., Bingler et al., 2022)

Analyzing public discourse (e.g., Hansen & Hershcovich, NLP4PI 2022)

Understanding consumer behavior

Facilitating behavior change

How Good Is NLP? A Sober Look at NLP Tasks through the Lens of Social Impact (Jin et al., Findings 2021)
Summary

**Climate awareness should be mainstream**

Consistent and pragmatic reporting via model cards

Efficient is not enough – net positive impact needed

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Code and templates: [github.com/danielhers/climate-awareness-nlp](https://github.com/danielhers/climate-awareness-nlp)

Contact: [danielhers.github.io dh@di.ku.dk](http://danielhers.github.io dh@di.ku.dk)