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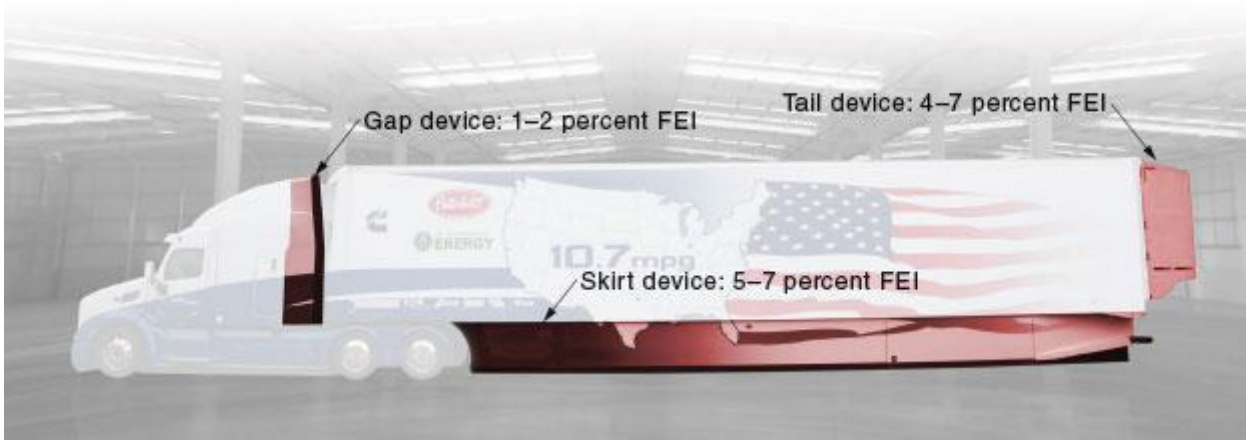
Will you and why will you need HPC in your research?

Currently, my research is connected with speeding up transformers' training procedures. To do that we use some theoretical approaches for adjusting the learning rate of the SGD optimizer on each layer by calculating the variance of the gradients obtained during backpropagation. It is estimated that by using such a method it is possible to make training more efficient by approximately 10%. This number is of course impressive enough since lots of money and energy are spent on training transformers, so even 10% could make it cheaper and less energy-consuming. But ideally, it is not the limit, and the training procedure may be even more efficient. To achieve that more likely we don't need to use some advanced mathematical tricks. The biggest impact in making the deep learning industry more efficient may be provided by building proper high-performance computing systems. And after fulfilling my goal of optimizing training procedures using theoretical methods, I wish to move forward to optimize them using knowledge of high-performance computing. Moreover, this knowledge is highly applicable not only in academic research but also in industrial tasks. Besides that, I need to use HPC even in the current stage of my research because I need to train transformer models and calculate variances, these procedures firstly take a lot of time on regular computing powers and secondly require some memory that is not usually accessible by a home computer. Therefore, I have to train and provide all calculations with help of a cluster. To do that I have to learn how to use nvidia-docker and how to work with NVIDIA GPUs on the cluster. So, HPC is widely used in current deep learning research area and there is a room for speeding up processes in this area which can be filled with help of high-performance computing.

Find an interesting/fun application of HPC and supercomputers and briefly describe it

Speaking about applications of HPC I found one relatively old (2015) but still interesting example in truck industry. Experiments were provided by the Department of Energy's SuperTruck initiative which tried to boost fuel efficiency of the truck. It is relevant problem since according to 2015 statistics trucks burn 36 billion gallons of fuel annually (11 to 12 percent of the U.S.'s total petroleum consumption). And beside that, more than half of that fuel trucks spend on overcoming aerodynamic resistance at high speeds. With help of Livermore researchers, collaborators at academic institutions such as the University of

Southern California and the California Institute of Technology, industry partners, and the NASA Ames Research Center (NASA Ames) and using supercomputer at Lawrence Livermore Laboratory the optimal and aerodynamic add-ons for trucks were calculated. But before that researches used NASA Ames' wind-tunnel facilities to find out that a truck's underbody, back end, and gap between the tractor and trailer produce the most drag. So, they added so-called "skirts" to the truck to shorten the gap between the trailer and the ground and reduce air currents along its sides and underside. Besides "skirts", researchers added tail to rear edges of the trailer and panels to fill gap between tractor and trailer. All these add-ons with their fuel economy improvement value are represented on the picture:



Suggested improvements were tested by HPC systems to evaluate their effectiveness in real-life scenario and road conditions. These testing resulted in considerable fuel savings. By estimate these improvements can save up to $5000 per truck annually which significantly affects the cost of cargo. In 2015 annual worth of freight was estimated $604 billion across all the USA. So, considering that in 2015 there were about 15 million trucks that research saved $75 billion in a year (almost 10% of economy).

Resources: one, two, three