ANDES
The Quiet Giant in RISC-V

RISC-V Virtual Hackathon

Softmax Challenge for NNs

Background and Challenge

❖ Softmax in Neural Networks:

- ➢ Softmax is a very common activation function for many networks including Transformers, CNNs, and RNNs.
- ➢ It is challenging and not well implemented by general-purpose CPUs and GPUs because it is a very specific computation for machine learning.
- ➢ It is an imperative function in neural network performance especially for LLMs which are seeing a huge increase in model size and sequence length and softmax function usage scales with these parameters.

❖ Your challenge:

Implement a softmax function on an Andes RISC-V vector processor while optimizing for accuracy and performance.

Preparation

- **Your preparation should include reviewing the following**
  - *Andes_Hackathon_Preparation.pdf* includes:
    - Primer on RISC-V Vector Extension
    - Primer on Andes Custom Extensions (ACE)
    - Primer on Debugging in the Andes Simulator
  - Review of RISC-V Vector ISA and Intrinsics documents
    - *RISC-V-Spec-1.0-rc2.pdf*
    - *RISC-V_Vector_(V)_Extension_Intrinsics_UM231_V1.5.pdf*
  - *Andes_Custom_Extension_Programmer's_Manual_Hackathon.pdf*
    - This is a shortened version for ease of learning for this hackathon
  - Understanding of Softmax

$$\sigma(\vec{z})_i = \frac{e^{z_i}}{\sum_{j=1}^{K} e^{z_j}}$$

σ = softmax

$\vec{z}$ = input vector

e^{z_i} = standard exponential function for input vector

K = number of classes in the multi-class classifier

e^{z_j} = standard exponential function for output vector

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Provisions and Guidelines

- **You will be provided:**
  - Andes AX45MPV Simulator and Development Tools, Including
    - AX45MPV 64b RISC-V Processor
      - Dual-issue, 8-stage in-order Processor
      - Includes RISC-V Vector ISA
    - Andes Custom Extension (ACE) and COPILOT
      - Tools for adding your own RISC-V custom instructions
  - A reference implementation in both pure-C and with a basic ACE instruction to get you started
- **You may use any optimization techniques you wish, including, but not limited to:**
  - Any algorithmic implementations
  - Vectorization (automatic or manual techniques)
  - Addition of custom instructions via ACE

Requesting a Cloud Environment

- **To request a cloud environment, please fill out the form here: https://forms.gle/uFSEmwH4mJHvGqtE7**

Hackathon Day

- **If previously requested, you will be provided with an AWS machine that contains**
  - Ubuntu Environment
  - Preinstalled Working Environment
  - Starting code development environment and test cases
- **Modify, Rewrite, and Experiment with your approach(es) to SoftMax**
- **Most Importantly, HAVE FUN!**

FAQ

- **Q: Will the hackathon participants have access to the cloud environment after the hackathon?**
  A: No. The cloud-based machine will be unavailable after the hackathon has ended.
- **Q: Is there a way for hackathon participants to access the tools used in the hackathon afterwards?**
  A: Yes. You can download Andes' IDE, AndeSight, here: AndeSight™ IDE Download - Andes Technology

- **For any additional questions, please ask them in the Andes Hackathon Slack Channel.**

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Thank You!