RingTool Reproduction

This repository is a fork of thuhci/RingTool, reproducing experiments for physiological signal prediction using wearable ring devices. The replication includes physics-based (Peak, fft) and supervised learning models (ResNet, InceptionTime, Mamba2, Transformer) with 5-fold cross-validation and test-mode evaluations, validated on the Kaggle Ring Dataset.

Experiment Setup

- **Environment**:
  - **OS**: Ubuntu Linux
  - **Hardware**: 4x NVIDIA RTX 4090, CUDA 12.4
  - **Python**: 3.10.16 (Conda environment: `ringtool`)
  - **Key Dependencies**:
    - `torch==2.1.2+cu121`
    - `mamba_ssm==2.2.4`
    - `numpy==1.26.4`
    - `pandas==2.2.3`
    - Full list in `requirements.txt`
- **Dataset**: Kaggle Ring Dataset
  - 7 subjects (`00005`, `00009`, `00012`, `00020`, `00022`, `00029`, `00031`)
  - Tasks: Heart rate (`hr`, `samsung_hr`, `oura_hr`), respiratory rate (`resp_rr`), SpO2 (`spo2`), blood pressure (`BP_sys`, `BP_dia`)
  - Stored in `/root/RingTool/data/rings/` (e.g., `00005_ring1_processed.pkl`)
- **Configurations**:
  - 33 supervised configs in `/config/supervised/` (ResNet, InceptionTime, Mamba2, Transformer)
  - Test-mode configs in `/config/only_test/`
  - Physical-based configs in `/config/physical-based/` (Peak, fft, Ratio)
  - Total: 148 experiments processed (merged into `all_results.csv`)
- **Scripts**:
  - `update_configs.ipynb`: Updates JSON configuration files with subject splits for 5-fold cross-validation
  - `resultsCollection.ipynb`: Merges results into `all_results.csv`
  - `dataAnalysis.ipynb`: Analyzes and visualizes results

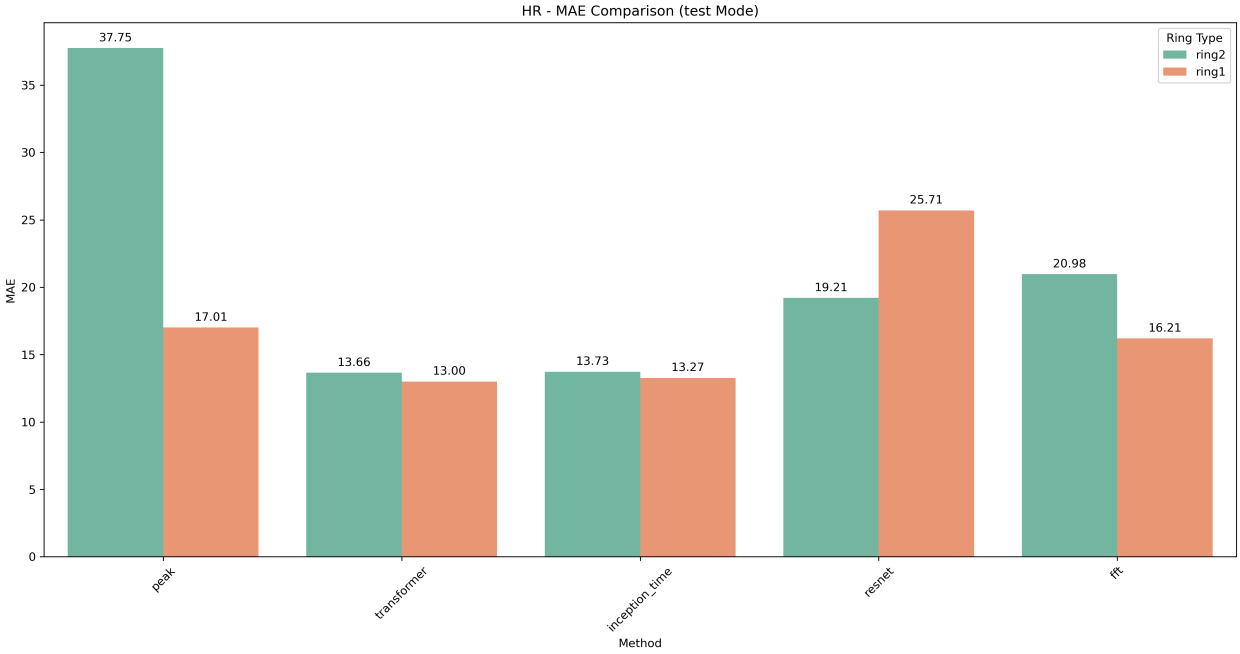
Results

- **Progress**: (33 supervised with 5-fold cross-validation, test-mode, and physical-based).
- **Metrics**: Analyzed in `dataAnalysis.ipynb`, stored in `all_results.csv` .
- **Key Findings**:
  - Performance Table (Test Mode)

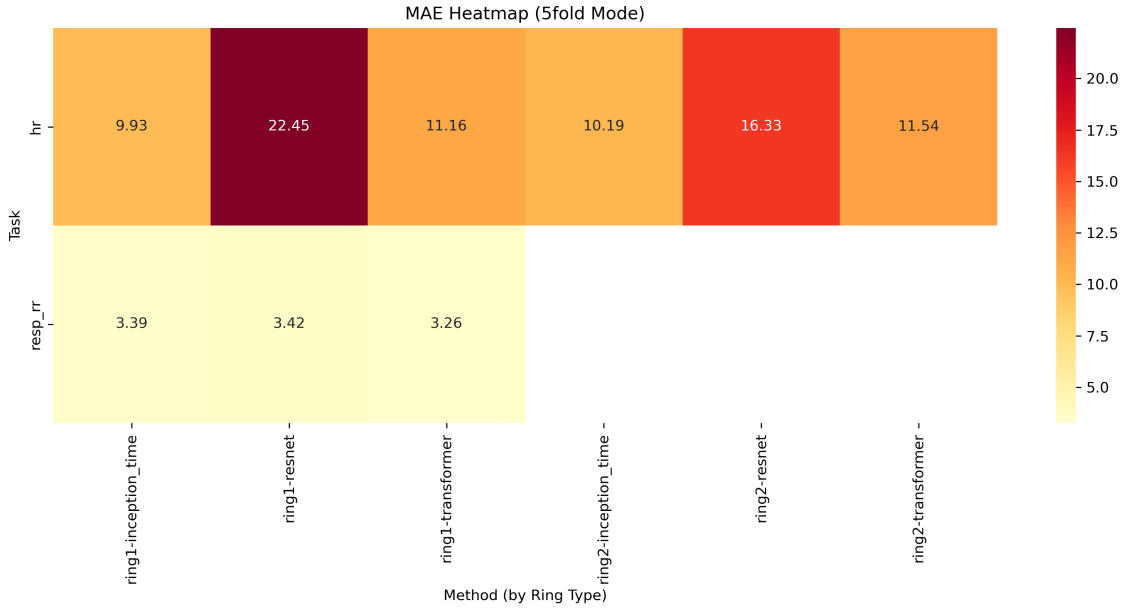
Task	Ring Type	Best Method	MAE	Task	Ring Type	Best Method	MAE
hr	ring1	fft	16.213333	hr	ring2	fft	20.976667
hr	ring1	inception_time	13.273333	hr	ring2	inception_time	13.733333
hr	ring1	peak	17.010000	hr	ring2	peak	37.753333
hr	ring1	resnet	25.706667	hr	ring2	resnet	19.213334
hr	ring1	transformer	13.003333	hr	ring2	transformer	13.660000
oura_hr	ring1	fft	20.903333	oura_hr	ring2	fft	25.443333
oura_hr	ring1	peak	17.040000	oura_hr	ring2	peak	19.093333
oura_hr_com	ring1	fft	17.590000	oura_hr_com	ring2	fft	19.350000
oura_hr_com	ring1	peak	17.590000	oura_hr_com	ring2	peak	19.350000
resp_rr	ring1	fft	5.400000	resp_rr	ring2	fft	4.875000

Task	Ring Type	Best Method	MAE	Task	Ring Type	Best Method	MAE
resp_rr	ring1	inception_time	3.800000	resp_rr	ring2	inception_time	3.953333
resp_rr	ring1	peak	3.630000	resp_rr	ring2	peak	3.953333
resp_rr	ring1	resnet	3.866667	resp_rr	ring2	resnet	3.953333
resp_rr	ring1	transformer	3.776667	resp_rr	ring2	transformer	4.875000
samsung_hr	ring1	fft	19.833333	samsung_hr	ring2	fft	31.386667
samsung_hr	ring1	peak	15.236667	samsung_hr	ring2	peak	21.496667
samsung_hr_com	ring1	fft	19.336667	samsung_hr_com	ring2	fft	18.533333
samsung_hr_com	ring1	peak	19.336667	samsung_hr_com	ring2	peak	18.533333
spo2	ring1	ratio	4.300000	spo2	ring2	ratio	3.290000

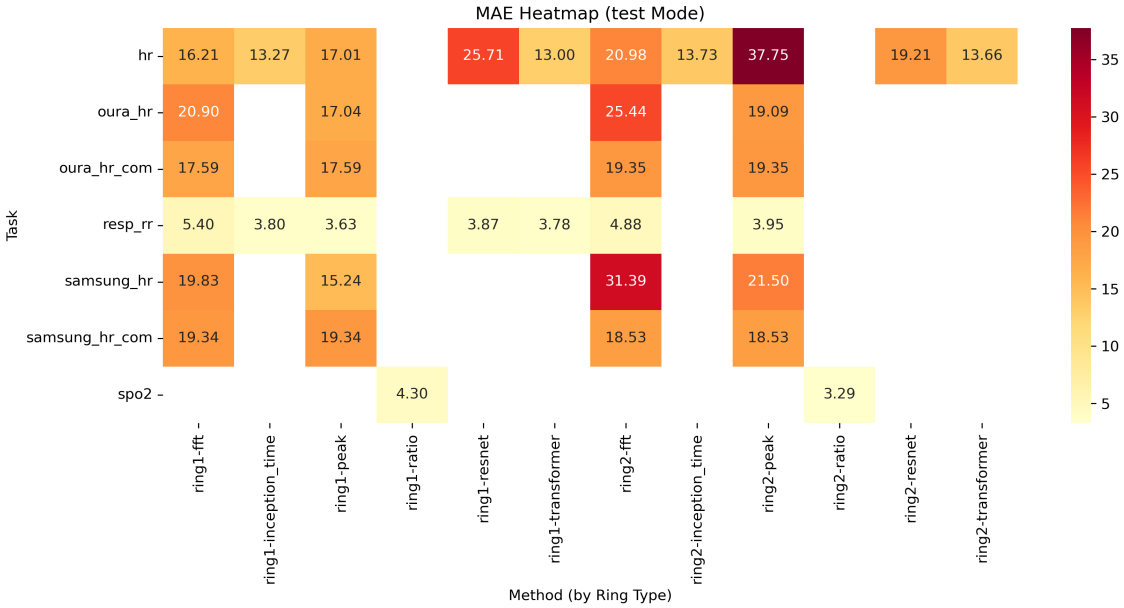
- **Visualizations**:
  - MAE barplots per task/mode (e.g., `output/mae_barplot_hr_test.png`):



  - MAE heatmaps per mode (e.g., `output/mae_heatmap_5fold.png`):



- MAE heatmaps per mode (e.g., `output/mae_heatmap_test.png`):



- **Logs**: Experiment progress in `experiment.log`, model outputs in `logs/`, completed configs in `completed_configs.txt`.

How to Run

1. **Setup Environment**:

```
conda create -n ringtool python=3.10.16
conda activate ringtool
pip install -r requirements.txt
pip install torch==2.1.2 torchvision==0.16.2 torchaudio==2.1.2 --index-url
https://download.pytorch.org/whl/cu118
pip install mamba-ssm==2.2.4 --no-build-isolation
```

2. **Download Dataset**:
   - Download from Kaggle.
   - Unzip and place in `/root/RingTool/data/rings/`:

```
mkdir -p /root/RingTool/data/rings
mv path/to/ring-dataset/* /root/RingTool/data/rings/
```

3. **Update Configurations**:
   - Run the notebook to update JSON configs with 5-fold splits:

```
jupyter notebook update_configs.ipynb
```

4. **Run Physics-Based Methods**:

```
python3 main.py --data-path /root/RingTool/data/rings --batch-configs-dirs config/physical-based
```

5. **Run Supervised Methods**:

```
nohup python3 main.py --data-path /root/RingTool/data/rings --batch-configs-dirs
config/supervised > $(date +%Y%m%d%H%M%S)-nohup-train.log 2>&1 &
```

6. **Run Test-Mode Experiments**:

```
nohup python3 main.py --data-path /root/RingTool/data/rings --batch-configs-dirs
config/only_test > $(date +%Y%m%d%H%M%S)-nohup-test.log 2>&1 &
```

7. **Analyze Results**:

```
jupyter notebook resultsCollection.ipynb
jupyter notebook dataAnalysis.ipynb
```

Acknowledgments

- Gratitude to the thuhci/RingTool team at Tsinghua University for their codebase and documentation.
- This work utilized the Kaggle Ring Dataset for validation.
- Conducted by Fu Jingyu as part of a replication study.