

2026 5 26

				ERA5-Land		LSTM-Attention
	1	2010-2024		ERA5-Land	-	2 LSTM
	1-3	7	30	3 XGBoost		4 Flask
ECharts		Web				
	LSTM-Attention					
		LSTM-Attention				

Abstract

With global warming, frequent heatwave events pose serious threats to the health of the elderly population. This study takes Jiaozuo and Zhengzhou as research areas, utilizes ERA5-Land meteorological reanalysis data and population health statistics to construct an LSTM-Attention based multi-time-scale heat health risk early warning model, and develops a visualization dashboard system.

The main contributions include: (1) acquisition and preprocessing of ERA5-Land meteorological data (2010-2024) for both cities, combined with census and health statistics data; (2) design of a deep learning model combining LSTM with multi-head self-attention for risk prediction at three time scales (short/medium/long term); (3) comparative experiments with XGBoost baseline to validate the deep learning approach; (4) development of a Flask+ECharts web dashboard with dark tech-blue theme for multi-dimensional visualization.

Experimental results show that the LSTM-Attention model outperforms traditional methods in short and medium-term early warning tasks, providing effective decision support for heatwave health risk management.

Keywords: Heatwave; Elderly Population; Multi-time-scale Early Warning; LSTM-Attention; Visualization

1.1



1.2

1.2.1

J V Gasparrini 2015 Lancet - Chen
2018 Lancet Planetary Health

1.2.2

HHWS NOAA

1.2.3

ARIMA LSTM Vaswani 2017 Transformer

1.3

- 1. ERA5
- 2. LSTM-Attention + XGBoost
- 3. Flask + ECharts
- 4.

1.4

2.1 LSTM

Long Short-Term Memory LSTM Hochreiter Schmidhuber 1997
RNN RNN
LSTM gating mechanism forget gate input gate output gate
LSTM

2.1.1 LSTM

LSTM cell state hidden state

2.2

Attention Mechanism
Vaswani 2017 Transformer Multi-Head Self-Attention

2.2.1

Scaled Dot-Product Attention Query Key
Softmax Value

2.2.2

2.3 XGBoost

XGBoost eXtreme Gradient Boosting Chen Guestrin 2016

XGBoost 1 2 3 4 5

2.4

WMO

3

32°C

35°C

3

2.4.1

2.5 Flask ECharts

Flask

Python Web

Web

Flask

RESTful API

ECharts

JavaScript

ECharts

Web

3.1

				14-15°C	7	27-28°C	40°C
4071	352	65	12.8%		7446	1274	11.6%
65%							

3.2

3.2.1 ERA5-Land

ERA5-Land ECMWF 0.1°×0.1° 9 km 1
Copernicus Climate Data Store (CDS) API 2010-2024

- 2m 2m temperature
- 2m 2m dewpoint temperature
- surface pressure
- 10m U V
- total precipitation
- surface solar radiation downwards

3.2.2

2020

3.2.3

2010-2024

3.3

3.3.1

ERA5-Land

3.3.2

CDS API 30

3.3.3

±3

3.3.4

- 32°C/35°C
-
- 35°C
-
- /
- 1 3 7

3.4

3.4.1

30 N T 7 1-3 30 7 90

3.4.2

2010-2019 2020-2022 2023-2024

3.4.3

Z-score 0 1

4.1

LSTM-Attention

LSTM

4.2 LSTM

4.2.1

LSTM LSTM LSTM 50 LSTM
50

4.2.2 Dropout

LSTM Dropout 0.3

4.3

4.3.1

LSTM head=4

4.3.2

Transformer

4.4

Multi-Task Learning LSTM
32

4.5

4.5.1

Cross-Entropy Loss

$$\mathcal{L}_{\text{total}} = \mathcal{L}_{\text{short}} + \mathcal{L}_{\text{medium}} + \mathcal{L}_{\text{long}}$$

4.5.2

Adam	0.001	ReduceLROnPlateau	10 epoch
Early Stopping	25 epoch		

4.6 XGBoost

	XGBoost	XGBoost	LSTM-Attention
XGBoost	n_estimators=200	max_depth=6	learning_rate=0.1
subsample=0.8	5		

4.7

- Accuracy
- Precision
- Recall
- F1 F1-Score
- Macro Average

5.1

5.1.1

5.1.2

1 2 5 3 3 4

5.2

B/S Browser/Server

-
- Flask Web RESTful API
- HTML+CSS+JavaScript Web ECharts

5.3

5.3.1 Flask

Flask Blueprint

- api/data
- api/predict
- api/history

5.3.2

API JSON

```
{
  "code": 200,
  "message": "success",
  "data": { ... }
}
```

API

5.3.3

PyTorch TorchScript Flask

5.4

5.4.1

4+1

5.4.2

ECharts

- / /
-
-
-
-
-

5.4.3

#0a1628 #00d4ff #1e90ff

5.5

Gunicorn WSGI 5005 Flask Nginx
<http://localhost:5005>

6.1

- Windows 11
- Python 3.13
- PyTorch
- CPU Intel Core i7
- 32 GB
- CPU

6.2

6.2.1

LSTM-Attention	20 epoch	60 epoch
Dropout		

6.2.2 XGBoost

XGBoost	5	LSTM-Attention
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6.3

6.3.1 1-3

LSTM-Attention	F1	XGBoost
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6.3.2 7

LSTM-Attention

XGBoost

6.3.3 30

30

LSTM-Attention XGBoost

6.4

LSTM-Attention

6.5**6.5.1****6.5.2****6.6****6.7**

7.1

1. 2010-2024 ERA5-Land -
2. **LSTM-Attention** LSTM / /
XGBoost
3. Flask ECharts Web
- 4.

7.2

1. ERA5-Land 0.1° 9 km
- 2.
3. LSTM-Attention 30
- 4.

7.3

- 1.
2. 120
3. Transformer Informer Autoformer
- 4.
- 5.

A

B

B

B.1

Python 3.13 uv PyTorch XGBoost Flask ECharts

B.2

1. `uv pip install -e .`
2. `python -m src.data.download_era5`
3. `python -m src.data.preprocess`
4. `python -m src.models.train`
5. `python -m src.web.app`
6. `http://localhost:5005`