

Data assimilation using Adversarial Neural Networks to help determine COVID infection risks in enclosed spaces (CP110)

Final presentation

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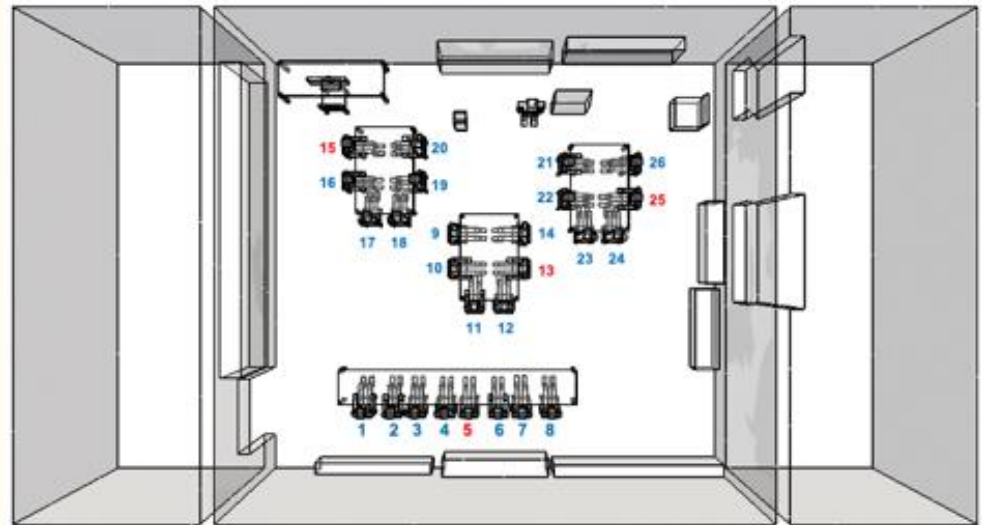
Shiqi Yin

Background

- COVID-19 spreads in the air
- Individuals in the classroom
- CFD model predicts too slow

Aim & Objective

- Make prediction using AAE
- Apply data assimilation to AAE and optimize the prediction results
- Predict the infection risk of the 27 individuals in the classroom



The dataset used in the project

Spatial data

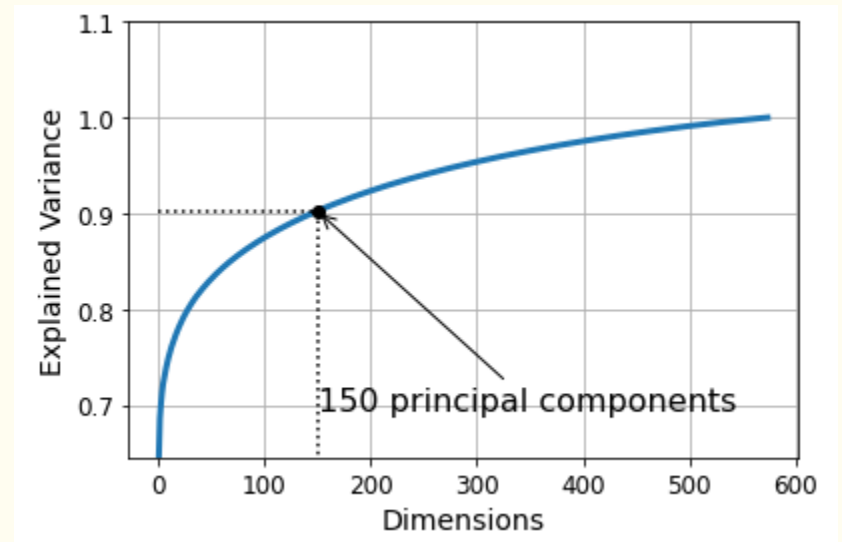
- 720 .vtu files in time series
- One-hour period
- 7 fields: Tracer (CO₂ concentration level), Velocity (x, y, z axes), Humidity, Temperature, Viral load
- 192060 nodes per field

Sensor data

- Experimental data contains 3 fields.
 - Time range: 1/12/2021 13:00-14:00
- Observation data contains 7 fields.

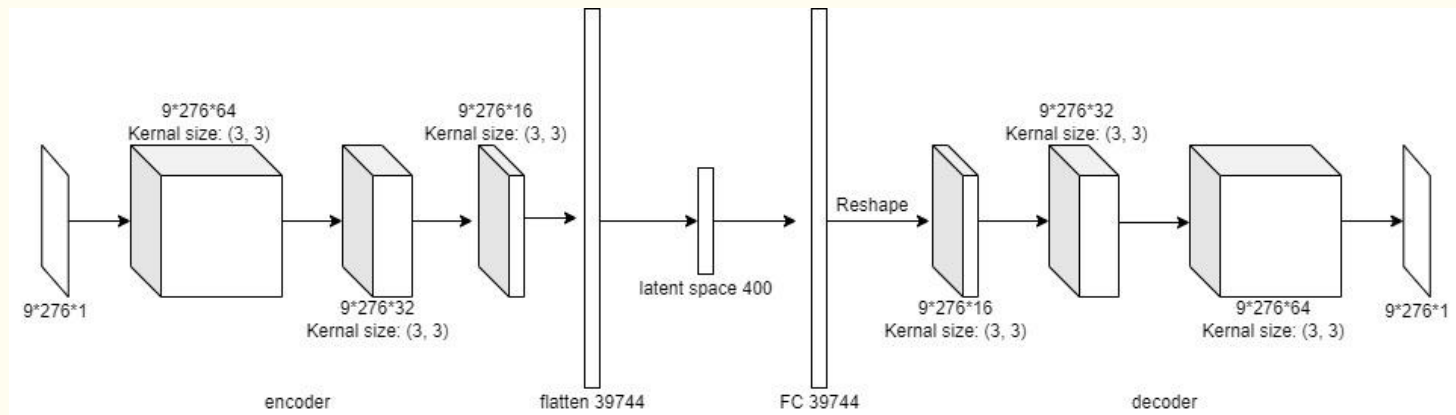
Data Pre-processing

- Divide the dataset into training set (80%) and test set (20%)
- Apply Min Max Scaler to normalize the data to range [0, 1]
- Apply PCA to reduce the dimension of data to 150 dimensions and keep 90.2% of the Explained Variance

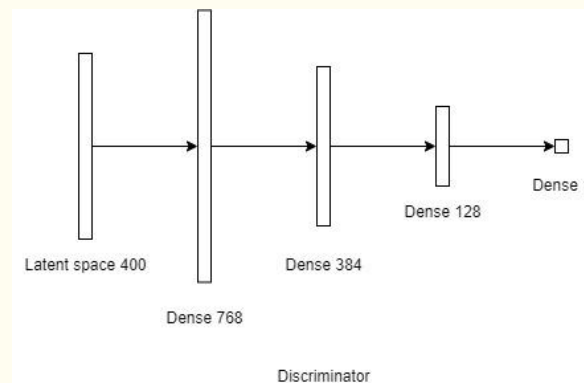


Architecture of DA-Pred-AAE

Autoencoder

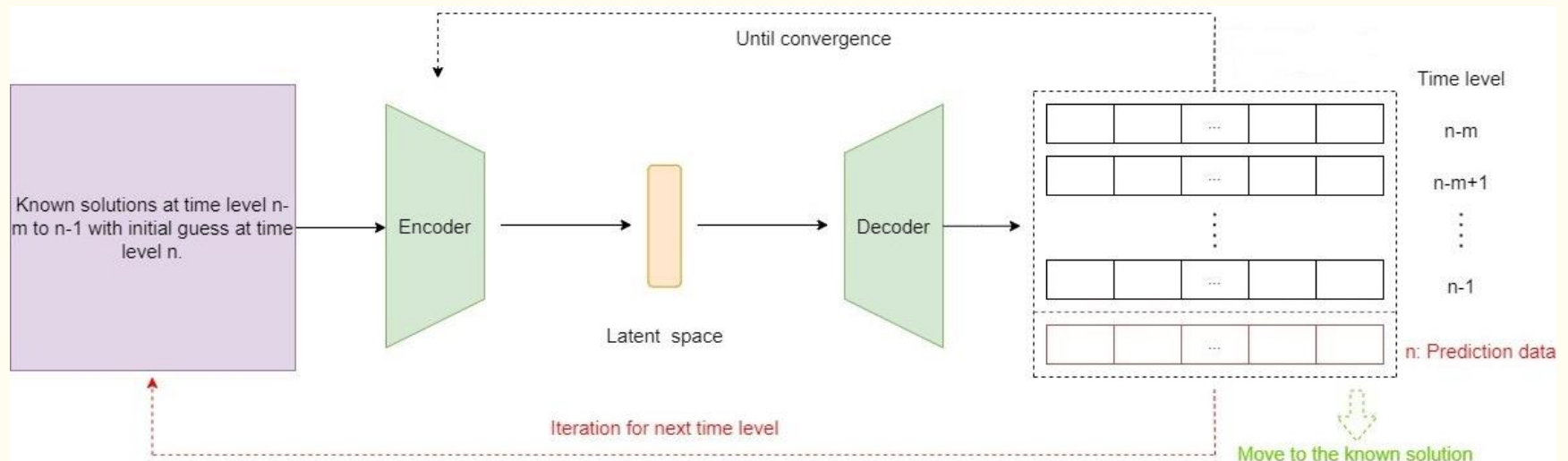


Discriminator



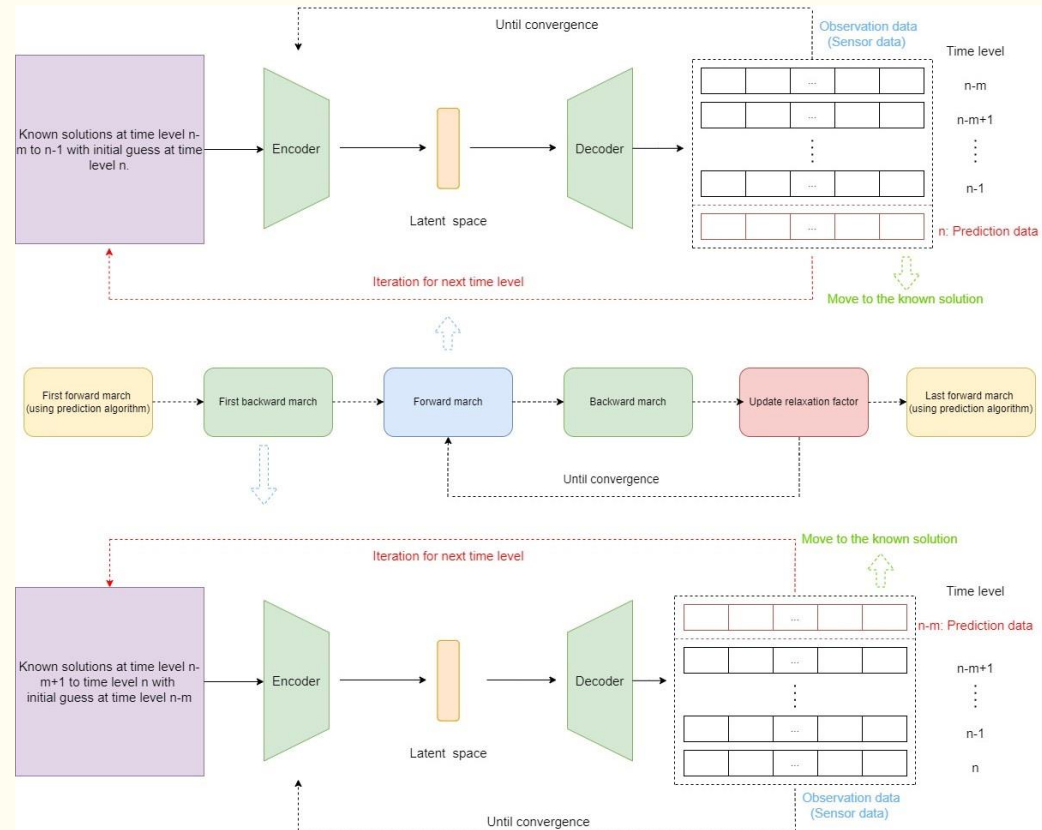
Prediction algorithm

- The data at the first $m-1$ time levels need to be known to predict the value for time level m
- The initial guess of the last time level is set to the value at the penultimate time level
- the newly predicted value at time level m will be used to predict the value at time level $m + 1$

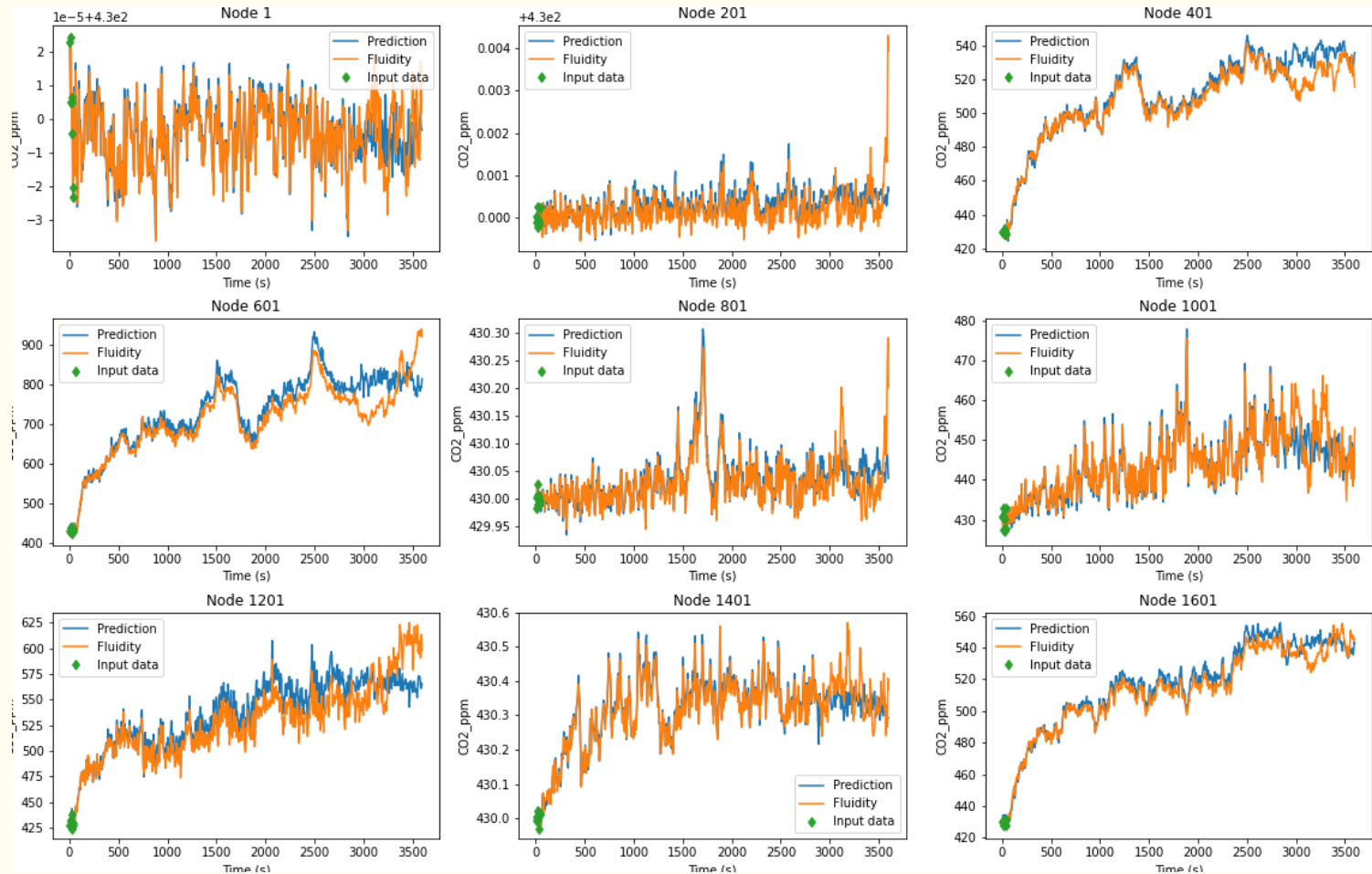


Data assimilation algorithm

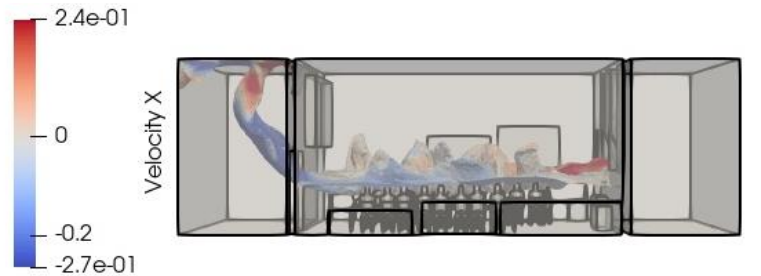
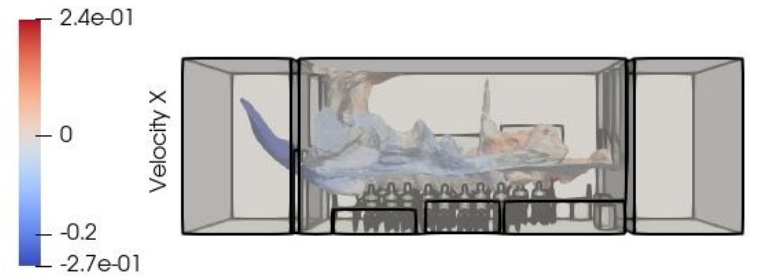
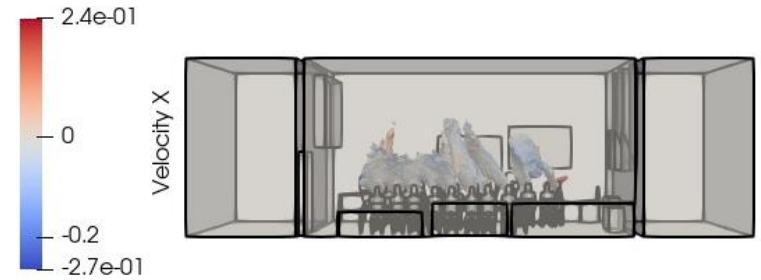
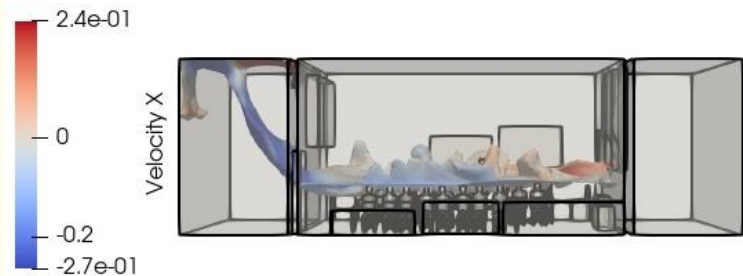
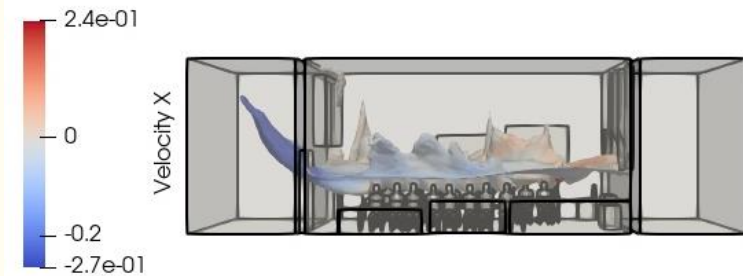
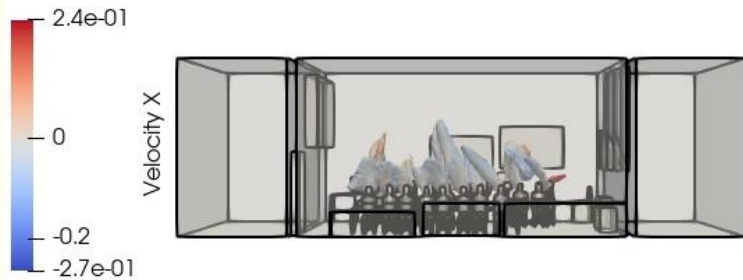
- Do forward march first
- Apply backward march, replace the sensor data with observation data
- Start 40 iterations of forward and backward march until converge
- Apply relaxation (if dynamic relaxation method is selected)
- Do the last forward march



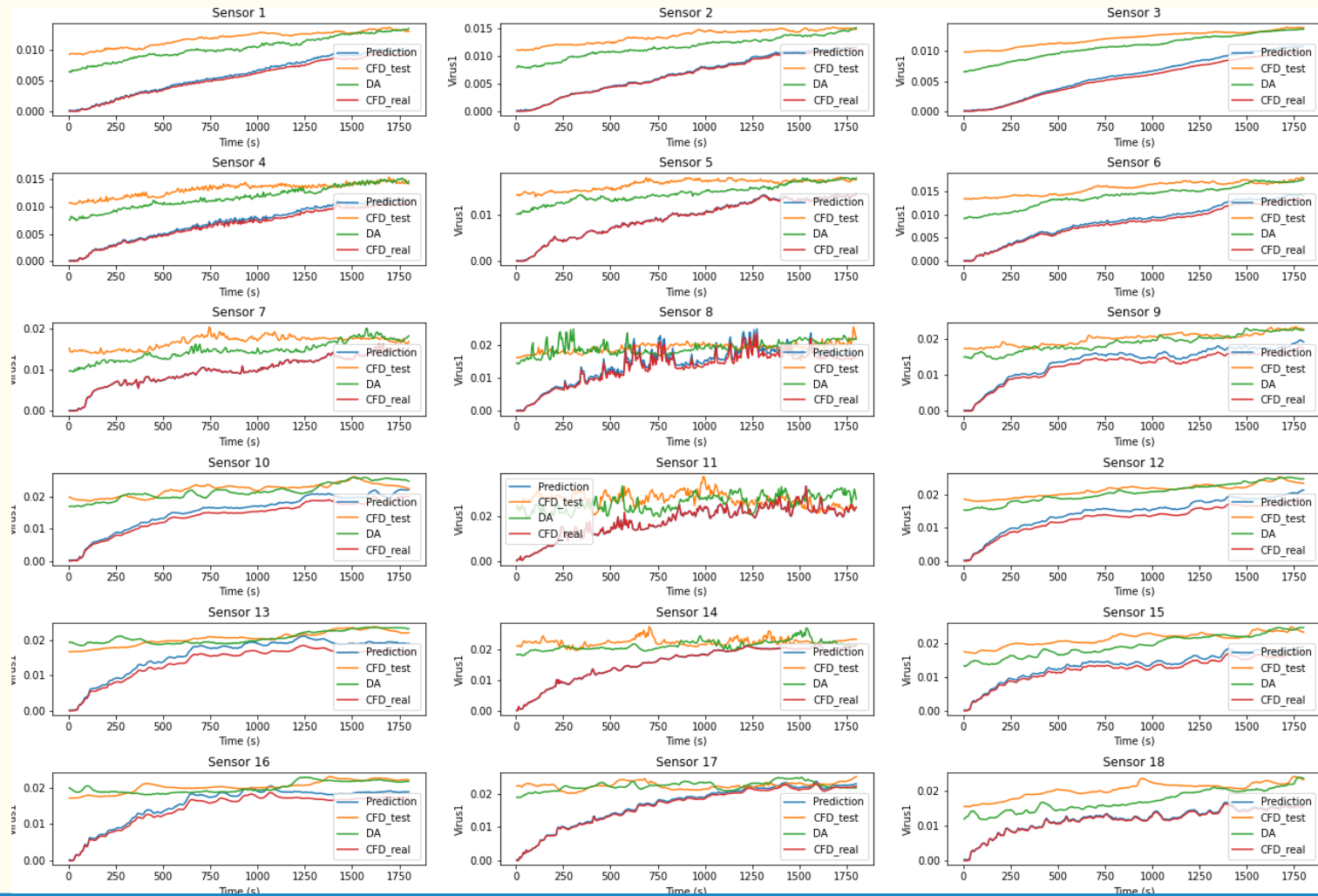
Pred-AAE results



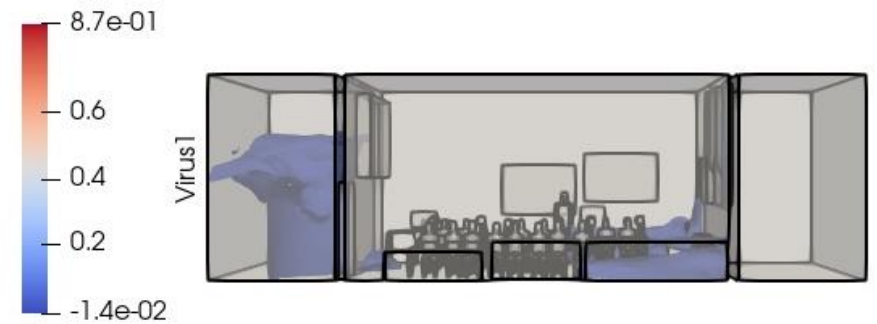
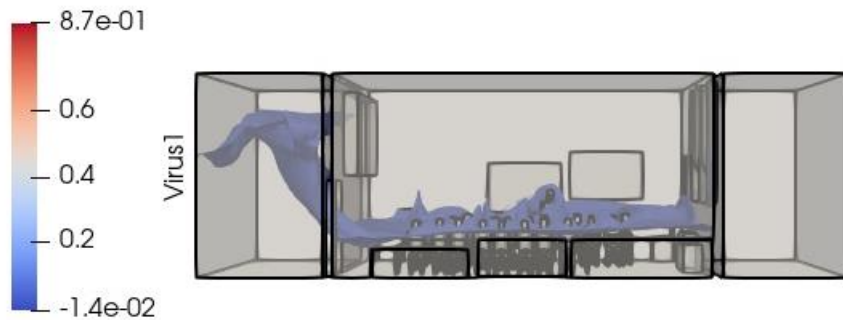
Visualization results (at time = 215s, 1625s and 3305s)



Result for data assimilation

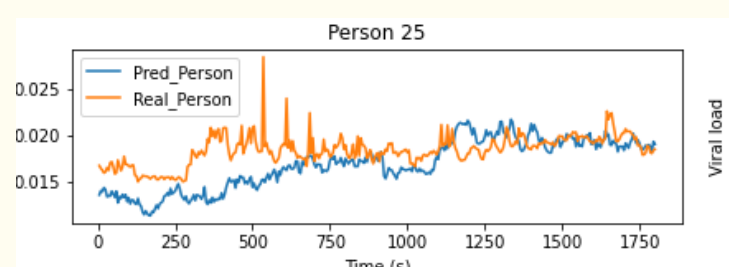
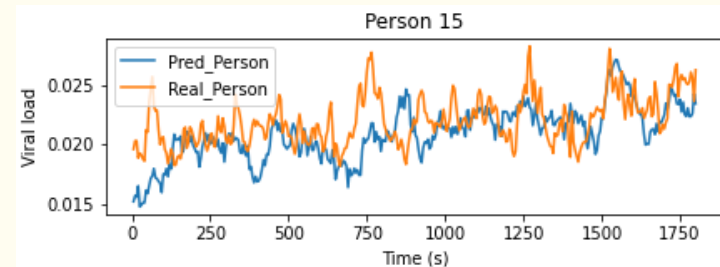
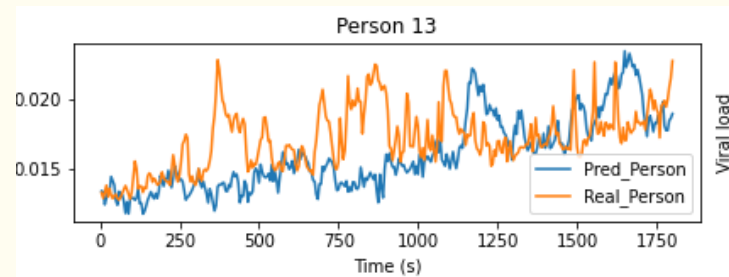
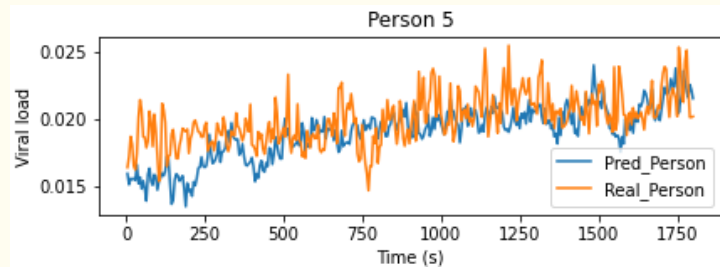


Visualization results (at time = 1800s, 2400s, 3200s and 3600s)



Result for viral load

- 27 individuals in the classroom
- The data of viral load is extracted using their coordinates in the classroom



Conclusion

- The created Pred-AAE and DA-Pred-AAE can predict good results.
 - Forward and backward march can optimize the results of prediction.
 - DA-Pred-AAE can predict the infection risks of individuals in the classroom
 - Limitation of forward and backward march: sufficient observation data required.
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End of the presentation

Thanks for listening
