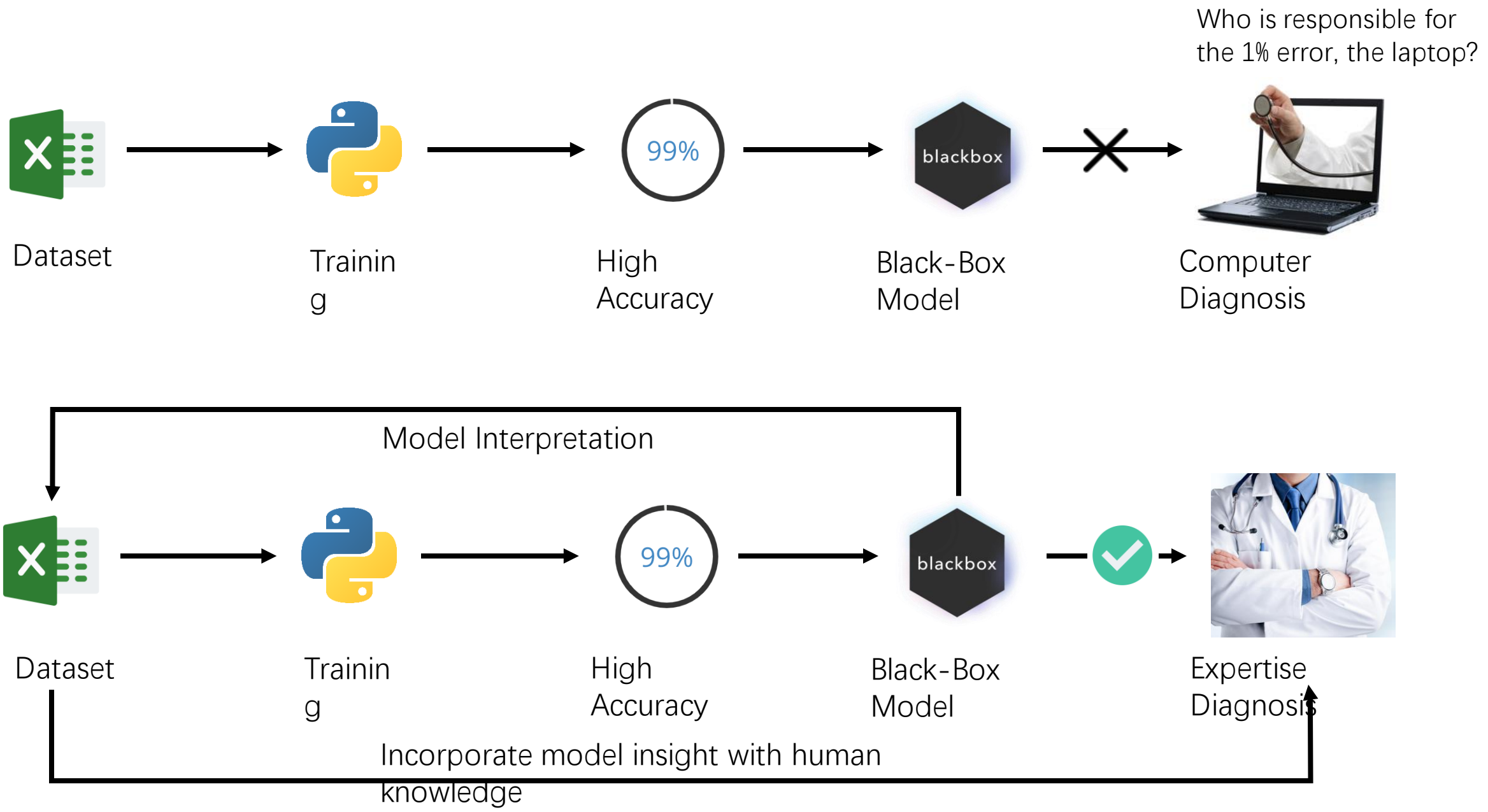
Interpretable Machine Learning for COVID-19:

An Empirical Study on Severity Prediction Task

- Background
- Dataset & Models
- Interpretation
- Conclusion

Background

Background


Who is responsible for the 1% error, the laptop?
99%
blackbox
Dataset
Trainin g
High Accuracy
Black-Box Model
Computer Diagnosis
Model Interpretation
99%
blackbox
Dataset
Trainin g
High Accuracy
Black-Box Model
Expertise Diagnosis
Incorporate model insight with human knowledge

Dataset & Models

Dataset & Models

Dataset Description

https://covid.wuhanstudio.cc/hy-features.html

Source Code

https://github.com/wuhanstudio/interpretable-ml-covid-19

Preprocessing

1. Remove clinical irrelevant columns ['MedNum', 'No']
2. Remove columns that have no data ['LVEF', 'SO2', 'PO2', 'YHZS', 'RML', 'RUL', 'RLL', 'LUL', 'LLL']
3. Remove columns with fewer records ['Onset2Admi', 'Onset2CT1', 'Onset2CTPositive1', 'Onset2CTPeak']
4. Remove patients that have incomplete records. [Height == "", cTnI == ""]

Train Test Split (86 patients, 21 severe, 65 normal, with 55 features)

1. 90% as Training Set, 10% as Testing Set
2. Five folds Cross Validation

In this research, we focus on model **interpretation**. **Interpretation** gives us valuable insights even if these are not 99% perfect models.

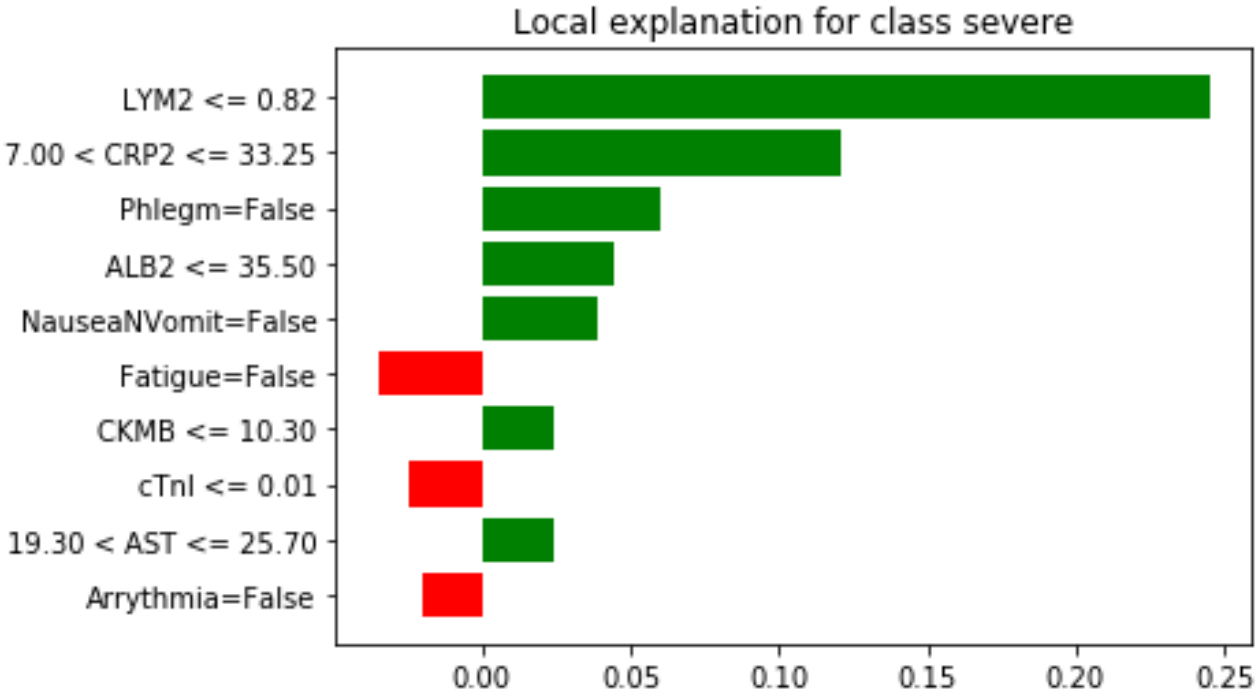
Classifier	Cross Validation	Test Set			95% confidence-interval
----------	F1	Precision	Recall	F1	----------
Decision Tree	0.56	0.67	0.50	0.57	0.307
Random Forest	0.64	0.56	0.25	0.33	0.324
XGBoost	0.62	0.78	1.00	0.80	0.271

Interpretation

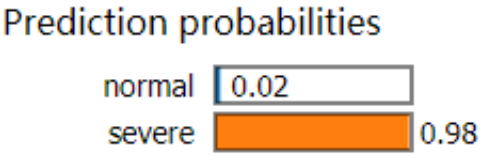
Correct Predictions

病人 7 - Severe

Correct



Feature	Value
LYM2	0.46
CRP2	22.20
Phlegm=False	True
ALB2	35.30
NauseaNVomit=False	True
Fatigue=False	True
CKMB	8.30
cTnI	0.01
AST	19.70
Arrythmia=False	True



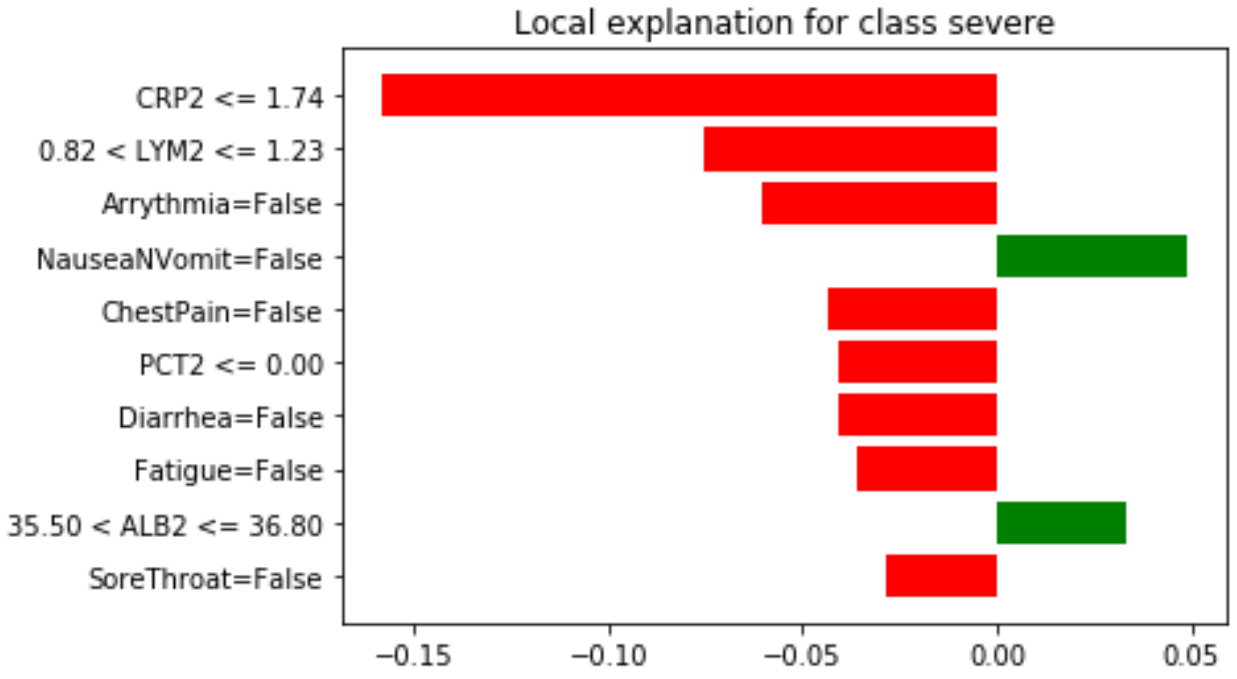
病情加重依据	病人数据	正常区间	结论
LYM <= 0.82	0.46	(1.1, 3.2)	偏低
CRP (7.00, 33.25)	22.20	(0, 5)	偏高
No Phlegm	**不咯痰**	**X**	
ALB <= 35.50	*35.30*	*(35, 55)*	*正常*
No NauseNVomit	**不恶心呕吐**	**X**	
CKMB <= 10.30	*8.30*	*(0, 18)*	*正常*
AST (19.30, 25.70)	19.70	(29, 35)	偏低

病人因为没有恶心呕吐，咯痰，判断会发展为重症
是不是咯痰，恶心呕吐可以帮助排毒？

病情正常依据	病人数据	正常区间	结论
No Fatigue	不乏力	X	正常
cTnI <= 0.1	0.01		
No Arrythmia	无心率失常	X	正常

病人 0 - Normal

Correct



Feature	Value
CRP2	0.46
LYM2	0.84
Arrythmia=False	True
NauseaNVomit=False	True
ChestPain=False	True
PCT2	0.00
Diarrhea=False	True
Fatigue=False	True
ALB2	36.50
SoreThroat=False	True

Prediction probabilities

normal	0.97
severe	0.03

患病的人淋巴细胞都会降低?

病情加重依据	病人数据	正常区间	结论
No NauseNVomit	**不恶心呕吐**	**X**	
ALB (35.50, 36.80)	*36.50*	*(35, 55)*	

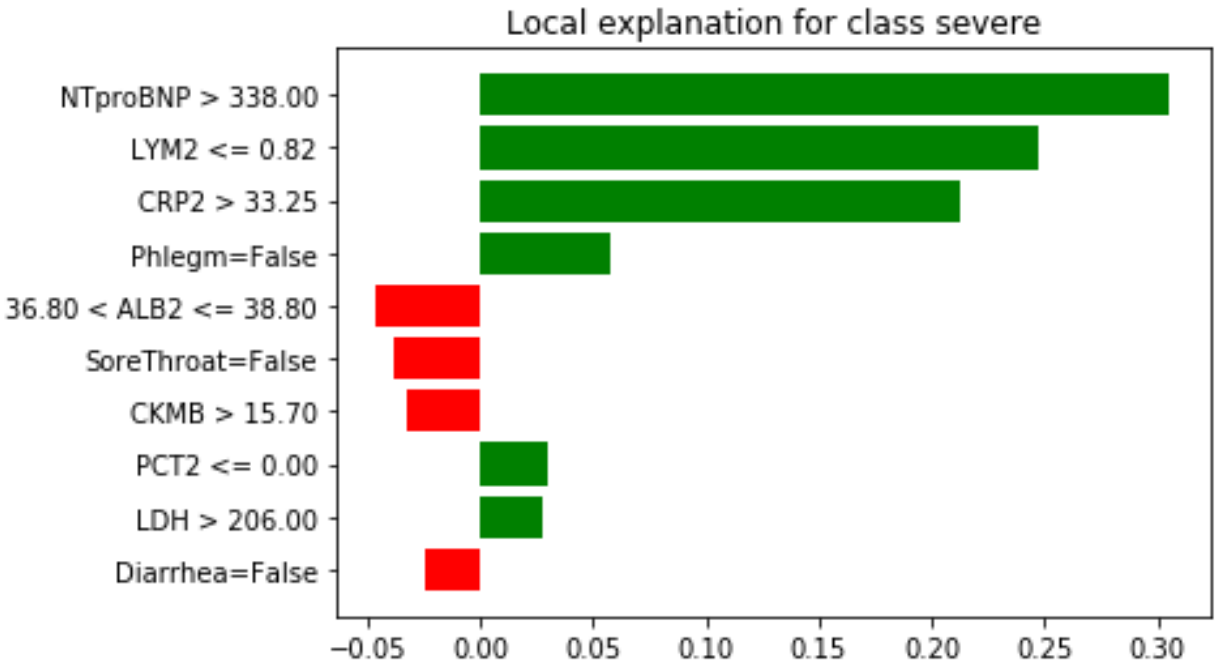
病人因为没有恶心呕吐，判断会发展为重症
是不是恶心呕吐可以帮助排毒?

病情正常依据	病人数据	正常区间	结论
CRP <= 1.74	0.46	(0, 5)	正常
LYM (0.82, 1.23)	**0.84**	**(1.1, 3.2)**	**偏低**
No Arrythmia	无心率失常	X	
No ChestPain	无胸痛	X	
PCT <= 0.00	0.00	(0, 0.5)	正常
No Diarrhea	无腹泻	X	
No Fatigue	不乏力	X	
No SoreThroat	无喉咙痛	X	

Wrong Predictions

病人 3 - Severe

Wrong



Feature	Value
NTproBNP	475.00
LYM2	0.81
CRP2	78.76
Phlegm=False	True
ALB2	37.60
SoreThroat=False	True
CKMB	17.90
PCT2	0.00
LDH	263.00
Diarrhea=False	True

病情加重依据	病人数据	正常区间	结论
NTproBNP > 338.00	475.00	(0, 300)	偏高
LYM <= 0.82	0.81	(1.1, 3.2)	偏低
CRP > 33.25	78.76	(0, 5)	偏高
No Phlegm	**不咯痰**	**X**	
PCT	*0.00*	*(0, 0.5)*	*正常*
LDH	263.00	(109, 245)	偏高

病情正常依据	病人数据	正常区间	结论
ALB (36.80, 38.80)	37.60	(35, 55)	正常
No SoreThroat	无喉咙痛	X	正常
CKMB > 15.70	17.90	(0, 18)	正常
No Diarrhea	无腹泻	X	正常

Conclusion

Conclusion

- ✓ 年龄越大，越容易成为重症

  严重程度 0-3，年龄平均值：36.8，47.5，54.3，69.4

- ✓ 增加症状总数，以及基础疾病总数后，预测精度 **略有提升**

- ● 影响较大的症状：不咯痰，不腹泻呕吐，更容易重症
- ● 影响较大的血常规指标：LYM 减少
- ● 影响较大的生化指标：LDH 增加（肝功能受损，心功能）ALB 偏小
- ● 影响较大的炎症指标： CRP 偏高 （病毒感染）