NDH AED

`%Š:[¤\1Š:˜ n,|û}q

b€ˆSe‡j”, {—lÕŠs‰ã

Version 2.5.3

2025 ^t 12 g

MAE vîj	**< 2.5 uÅNº**
MAPE vîj	**< 2.5%**
95% CI ‰†„Ës‡	**> 95%**

North District Hospital • S S@‘«–b

Hong Kong Hospital Authority

NDH AED ˜ n,|û}q v2.5.3

{, 1 ~

vÎ“

NDH AED ˜ n,|û}q v2.5.3

{, 2 ~

1 |û}qi,•ð

NDH AED ˜ n,|û}qf/N P N uL} v„`%Š:[¤\1Š:Nºex˜ n,^sSðÿ \ pº™™n/S S@‘«–b`%uÇ[¤Š-Š 0 |û}q}PT N†QH•2v„}qŠ

|û}qvîj
% %

- cÐO›n–xºv„kÏeå\1Š:Nºex˜ n,
- e/c g*O† 7 Y)TŒ 30 Y)v„˜ n,
- etT Y)l#0 PGg 0 mAa [c{À{IY ‘ÍVà}
- [æfB AI R g•e°€^TŒN‹Nö_q—ÿ
- cÐO›•nOáS@•“TŒN xº[š`'O0Š

exdÚWúy
% %

- kwSòexdÚ{ÄW ÿ 2014^t12g •ó 2025^t12g
- ~=Š “ exÿ 3,431+ Y)v„[Œet‰Àn,
- \1Š:Nºex{ÄW ÿ 111 - 394 Nº/Y)
- ^sWG\1Š:Nºexÿ 249.5 ± 45.0 Nº/Y)

b€ˆSryžÞ
% %

1. Y Và[PNXlÕ˜ n,j!W‹
2. nþRÕz—SãRÕaKVà[PŠ {—ÿ 180Y)ÿ
3. c exˆpn k ‘Íj_R6
4. g Ný-f g N¤N’eHaÉ
5. [æfBY)l#_q—ÿetT
6. AI šERÕv„N‹NöR g•
7. 9z.˜ n,^snÑe¹lÕ
8. XGBoost j_Vh[x•ÒXž_7

NDH AED ˜ n,|û}q v2.5.3

{, 3 ~

2 ˜ n,{—lÕg¶iË

h8_Ã˜ n,Ql_

g }B˜ n,P< = Wúy ˜ n,P< + nï_Œry_µŠ¿et + yûRÕ^sWGŠ¿et + •¨RâŠ¿et

QvN-ÿ Wúy ˜ n,P< = Wún–P< × f g Và[P × PGg Và[P × mAa [c{ÀVà[P × Y)l#Và[P × AIVà[P

{—lÕ†Ut mAz

1. **exdÚ• Qe**
   _žexdÚ^«srSÖg •Ñ180Y)v„kwSòexdÚ
2. **Và[PŠ {—**
   O•u(c exˆpn k ‘ÍŠ {—Qh\@^sWG0 g NýVà[P0 f g Và[P
3. **Wúy ˜ n,**
   aÉu(NXlÕj!W‹Š {—Wúy ˜ n,P<
4. **nï_ŒŠ¿et**
   R Qe Lag10 Lag7 TŒyûRÕ^sWGŠ¿et
5. **•¨RâŠ¿et**
   Wúe¼ 7Y)/30Y) yûRÕ^sWGŠ {—•¨RâŠ¿et
6. **up^8j¢n,**
   \ ˜ n,P<–PR6W(T t {ÄW ÿ 150-350Nºÿ
7. **•nOáS@•“**
   Š {— 80% TŒ 95% •nOáS@•“

NDH AED ˜ n,|û}q v2.5.3

{, 4 ~

x zvWúy

lÕW ‘«–b XGBoost x zv (2025)

MAE: 2.63-2.64 uÅNº

BMC Emergency Medicine

O•u(j_Vh[x•ÒTŒ•…SÃexŠ¿Q*•2ˆL`%Š:[¤Qe–b˜ n,

ry_µ]åz Xž_7˜ n,x zv (2024)

11P `%Š:[¤šW‹I

BMC Medical Informatics

eåfÆTŒl#Œa˜ n,Và[P + ry_µ]åz ‹Š‘Ï˜o„WcÐšØn–xº^¦

LSTM •ê•iaÉhFg¶ (2024)

Q*e¼ ARIMA TŒ Prophet

PubMed

q!— [ŒQh‘ÍŠ }ôÿ RÕaK•iaÉexdÚR OH‹ŠS

AI hFg¶dÁdà˜ n, (2025)

[æfB6\ fB˜ n,

JMIR Medical Informatics

Y exdÚ–ÆetT Xž_7Iz{VR6[šTŒŒÇn•R ‘M

NDH AED ˜ n,|û}q v2.5.3

{, 5 ~

3 h8_Ãex[xQl_

3.1 c exˆpn R k ^sWG

k ‘ÍŠ {—:	w b = e^(-;² r F ys_ago)
R k ^sWG:	;Å÷peighted = :2† GFVæF æ6QÖ" r qÖ"’ ò £(w b)

;² Ò ã " ˆ‡ á·8rŸðÄ÷öp ý W†M¦°© ÖoI-€

3.2 g NýVà[PŠ {—

monthFactor[m] = ;Å÷peighted(month=m) / ;ÅövÆö& À

{ÄW ÿ 0.85 - 1.25ÿ Q¬[c• ^8• šØÿ Y [c• ONÿ

3.3 f g Và[PŠ {—

dowFactor[d] = ;Å÷peighted(dow=d) / ;ÅövÆö& À

f g N g šØÿ ~1.10ÿ ÿ •1g+g ONÿ ~0.90ÿ

3.4 g Ný-f g N¤N’Và[P

monthDowFactor[m][d] = ;Â†ÖöçFƒÖÒÂ Fðw=d) / (;ÅövÆö& Â r ÖöçF„`actor[m])

Wúe¼x zvv|sþÿ N T g Nýv„f g j!_ [XW(]îup

NDH AED ˜ n,|û}q v2.5.3

{, 6 ~

3.5 nï_Œry_µŠ¿et

Lag1 Š¿et:	lag1_adj = (f(Y)\1Š: - ;ÅövÆö& Â’ r ã €
Lag7 Š¿et:	lag7_adj = (N •1T Y) - ;ÅövÆö& Â’ r ã
yûRÕ^sWGŠ¿et:	rolling_adj = (MA ‡ - MA ƒ €) × 0.14

~=Š¿et = lag1_adj + lag7_adj + rolling_adj

3.6 •¨RâŠ¿etÿ Wúe¼ Prophet x zvÿ

•¨Râ:	trend = (MA ‡ - MA ƒ €) / MA ƒ €
•¨RâŠ¿et:	trend_adj = Wúy ˜ n,P< × trend × 0.3

3.7 •nOáS@•“Š {—

Š¿etj n–]î:	<5ö F¢ Ò Ö ,ƒÃ_weighted × 1.2, 25)
80% CI:	[;Â Ò ãR r Ã_adj, ;Â ² ãR r Ã_adj]
95% CI:	[;Â Ò "ãR r Ã_adj, ;Â ² "ãR r Ã_adj]

O•u(fôOÝ[ˆv„NXexÿ 1.5, 2.5ÿ NåxºOÝ‰†„Ës‡

NDH AED ˜ n,|û}q v2.5.3

{, 7 ~

4 ry_µ]åz Šs‰ã

|û}qO•u(50+ P]åz ry_µ•2ˆL˜ n,ÿ NåN f/N;‰•ry_µ˜^R%ÿ

ry_µ˜^R%	S T+ry_µ
fB•“ry_µ	Year, Month, Day_of_Week, Day_of_Month, Week_of_Year, Quarter, DayOfYear
_ªt°}èx¼	Month_sin, Month_cos, DayOfWeek_sin, DayOfWeek_cos
nï_Œry_µ	Lag1, Lag7, Lag14, Lag30, Lag60, Lag90, Lag365
nþRÕ}qŠ	Rolling7, Rolling14, Rolling30, Std7, Std14, Std30, Max/Min
N‹Nöc j	Is_COVID, Is_Omicron, Is_Winter_Flu, Is_Summer, Is_Weekend, Is_Monday
N¤N’ry_µ	COVID_AND_Winter, Monday_AND_Winter, Weekend_AND_Summer
•¨Râry_µ	Days_Since_Start, Trend_Normalized, Era_Indicator
‹ŠS s‡	Daily_Change, Weekly_Change, Monthly_Change
PGg ry_µ	Is_Holiday, Days_To_Next_Holiday
AI Và[P	AI_Factor, Has_AI_Factor, AI_Factor_Type

NDH AED ˜ n,|û}q v2.5.3

{, 8 ~

4.1 _ª t°}èx¼Šs‰ã

j n–}èx¼q!lÕcUcI_ª t°exdÚv„•#~Œ`'ÿ 12g TŒ1g W(j n–}èx¼N-]î•Ýg Y'ÿ OF[æ–›N f/vø‘0v„ÿ 0

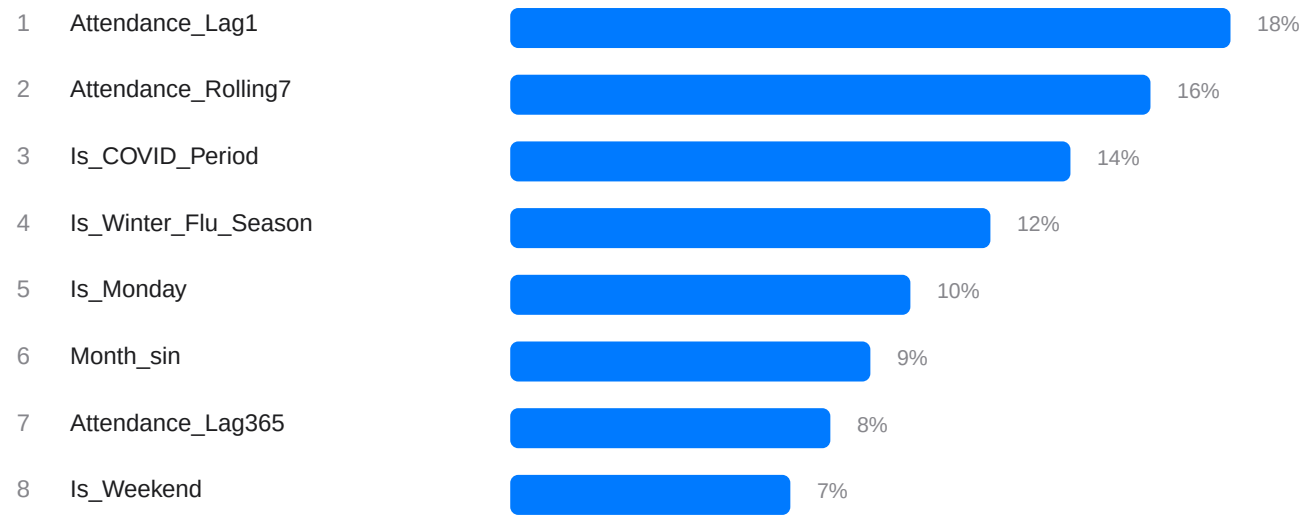
g Ný_ª t°}èx¼:

Month_sin = sin(2< r ÖöçF, ò "•

Month_cos = cos(2< r ÖöçF, ò "•

12g TŒ1g sþW(g vøO<v„}èx¼P<ÿ kcxºSÍf [ƒP v„fB•“c¥•Ñ`'

4.2 ry_µ‘Í‰•`'c’T ÿ XGBoostÿ



Top 5 ry_µ‰ã‘Ë ~70% v„j!W‹‹Šup

NDH AED ˜ n,|û}q v2.5.3

{, 9 ~

5 j_Vh[x•Òj!W‹

5.1 XGBoost h¯^¦cÐSGj9

XGBoost f/|û}qv„h8_Ãj_Vh[x•Òj!W‹ÿ Wúe¼lÕW ‘«–bx zv[æsþÿ •TR0N uLg Os MAE0

SÃex	P<	Šªf
n_estimators	500	j9v„ex‘Ï
max_depth	6	g Y'mñ^¦
learning_rate	0.05	[x•Òs‡
subsample	0.8	j#g,c¡j#s‡
colsample_bytree	0.8	ry_µc¡j#s‡
alpha (L1)	1.0	L1 kcRGS
lambda (L2)	1.0	L2 kcRGS
early_stopping	50	eéP\•*ex

5.2 Š }ômAz

1. _žexdÚ^«• QekwSòexdÚ
2. ry_µ]åz ÿ 50+ ry_µÿ
3. fB•“^•R R Rrÿ 80% Š }ôÿ 20% n,Šfÿ
4. j!W‹Š }ôÿ h¯^¦cÐSGÿ
5. eéP\šW‹I
6. `'€ýŠUO0ÿ MAE, RMSE, MAPEÿ
7. j!W‹OÝ[X

NDH AED ˜ n,|û}q v2.5.3

{, 10 ˜

6 ˜ n,^snÑe¹lÕ

|û}qkÏY)•2ˆL 48 k!˜ n,ÿ kÏ 30 R ” N k!ÿ ÿ O•u(9 z.^snÑe¹lÕ}œT _—Qúg }B˜ n,P<0

1. |!U®yûRÕ^sWG

SMA = :2‡ &VF–7F–öç2’ ò à

b@g 48 k!˜ n,v„{—ˆS^sWGP<ÿ Wún–e¹lÕÿ

2. c exR k yûRÕ^sWG (EWMA)

S_t = ; r ÷B ² ƒ Ó±) × S_{t-1}

; Ò ãc_ðÈð6e§hI• âÆ°© ÖoI-€

3. Oá_Ã^¦R k ^sWG

W_avg = :2… ö’ r 6öæeö’’ ò £(conf_i)

h9dÚ˜ n,Oá_Ã^¦R k

4. fBkµR k –Æb

W_i = 1 / MAE_timeSlot

h9dÚkwSòn–xº^¦\ N T fBkµ˜ n,R k

5. OîRj^sWG (Trimmed Mean)

TM = mean(sorted[10%:90%])

yû–d˜ •èTŒ^••è 10% v„up^8˜ n,

6. e¹]î•Noþ

filter: |P - median| ''d 1.5<0

c’–d•…•N 1.5<2 hGW ã‰• âÅøÄ÷÷R, UtÔ

7. Sar>füoþlâ

K = P_pred / (P_pred + R)

•^kxg Q*rÀaKO0Š ÿ Q=1.0, R=10.0

8. –Æb QCe¹lÕ +P

EM = 0.30×EWMA + 0.25×TW + 0.20×TM + 0.25×KF

}œT Y z.e¹lÕv„R k }Pgœÿ c¨…¦ÿ

NDH AED ˜ n,|û}q v2.5.3

{, 11 ~

9. zi[š`'R g•

CV = <2 ò ¼

Š {—‹ŠupOÂexO\pºŒê‘Ïc j

NDH AED ˜ n,|û}q v2.5.3

{, 12 ˜

6.2 •êRÕ•xdÇ{Vue

|û}qh9dÚ˜ n,zi[š`'ÿ ‹ŠupOÂex CVÿ •êRÕ•xdÇg Os^snÑe¹lÕÿ

	**CV < 5%**	**šØzi[š**	**|!U®^sWG**
	**5% "d CV "d 15%**	**N-{lzi[š**	**–Æb QCe¹lÕ**
	**CV > 15%**	**ONzi[š**	**e¹]î•NoþlÕ**

NDH AED ˜ n,|û}q v2.5.3

{, 13 ˜

7 Y)l#_q—ÿVà[P

Y)l#\ `%Š:[¤\1Š:Nºexg ˜o„W_q—ÿ0 |û}qO•u(vø\ n«^¦ÿ , kwSò^sWGkÔ• ÿ € —^}U\ n«^¦ÿ Wúe¼x zvv|sþvø\ n«^¦v„˜

7.1 n«^¦_q—ÿ

kÔkwSò^sWGšØ 5°C NåN	**×1.06**	XžR 6%
kÔkwSò^sWGON 5°C NåN	**×1.10**	XžR 10%
}U\ n«^¦ > 33°C	**×1.08**	‘wq±
}U\ n«^¦ 30-33°C	**×1.04**	pŽq±
}U\ n«^¦ 10-15°C	**×1.06**	[ÒQ·
}U\ n«^¦ < 10°C	**×1.12**	V´[Ò

7.2 QvNÖY)l#Và}

oÕ^¦

- "e95%: ×1.03
- 85-95%: ×1.01
- <60%: ×0.99

–M–è

- "e30mm: ×0.92
- 10-30mm: ×0.96
- <10mm: ×0.98

‹fTJ

- Qk†_˜¨t : ×0.40
- } –è: ×0.75
- [ÒQ·‹fTJ: ×1.08

Y)l#Và[P: weatherFactor = n«^¦Và[P × oÕ^¦Và[P × –M–èVà[P × ‹fTJVà[P

{ÄW ÿ 0.40 - 1.15

NDH AED ˜ n,|û}q v2.5.3

{, 14 ~

8 AI [æfBR g•

|û}qetT AI Y'ŠžŠ j!W‹•2ˆL[æfBe°€^TŒN‹NöR g•ÿ •êRÕ‹XR%Sï€ý_q—ÿ`%Š:[¤\1Š:Nºexv„Và} 0

8.1 AI j!W‹•xdÇ

šØ} j!W‹	GPT-5.1, GPT-5, GPT-4o, GPT-4.1	5k!/Y)
N-} j!W‹	DeepSeek-R1, DeepSeek-V3	30k!/Y)
Wúy j!W‹	GPT-4o-mini, GPT-3.5-turbo	200k!/Y)

8.2 R g•{ÄW

Ø<ß!þ Y)l#N‹Nö	iuzïY)l#0 ˜±˜¨0 f´–è
Ø<ßå QlQqˆ[u	mAa r v|0 ˜ßriN-kÒ0 P³gÓuÅ
Ø=Þ— y>g N‹Nö	Y'W‹m;RÕ0 N¤• N‹eE0 y:Z •JˆL
Ø=ÜÅ {ÀeåeHaÉ	Qlw>PGg 0 [xh!PGg 0 rykŠ{Àeå
Ø=ÜË e?{V‹Šfô	e6Œ»Š¿et0 R mAe?{V0 g RÙ‹Šfô

8.3 AI Và[P–PR6

```
AI Và[P{ÄW :          aiFactor = max(0.85, min(1.15, rawAIFactor))
–PR6{ÄW  ±15%ÿ –2kbU®N Và} •N^¦_q—ÿ˜ n,
```

NDH AED ˜ n,|û}q v2.5.3

{, 15 ˜

9 `'€ýc j , ŠUO0

9.1 vîj `'€ýc j

c j	vîj	N uLg Os	rÀaK
MAE	< 2.5 uÅNº	2.63-2.64	Ø<ß¯ •2ˆLN-
MAPE	< 2.5%	~2-3%	Ø<ß¯ •2ˆLN-
e¹T n–xº^¦	> 93%	~91%	Ø<ß¯ •2ˆLN-
80% CI ‰†„Ës‡	> 80%	~85%	Ø<ß¯ •2ˆLN-
95% CI ‰†„Ës‡	> 95%	~95%	Ø<ß¯ •2ˆLN-
R²	> 0.97	~0.95	Ø=ÜË _…[æsþ

9.2 ŠUO0c j Ql_

MAE MAE = (1/n) × :7Ç‘Ö" Ò w b|

MAPE MAPE = (100/n) × :7Ç‘Ö" Ò w b|/y b

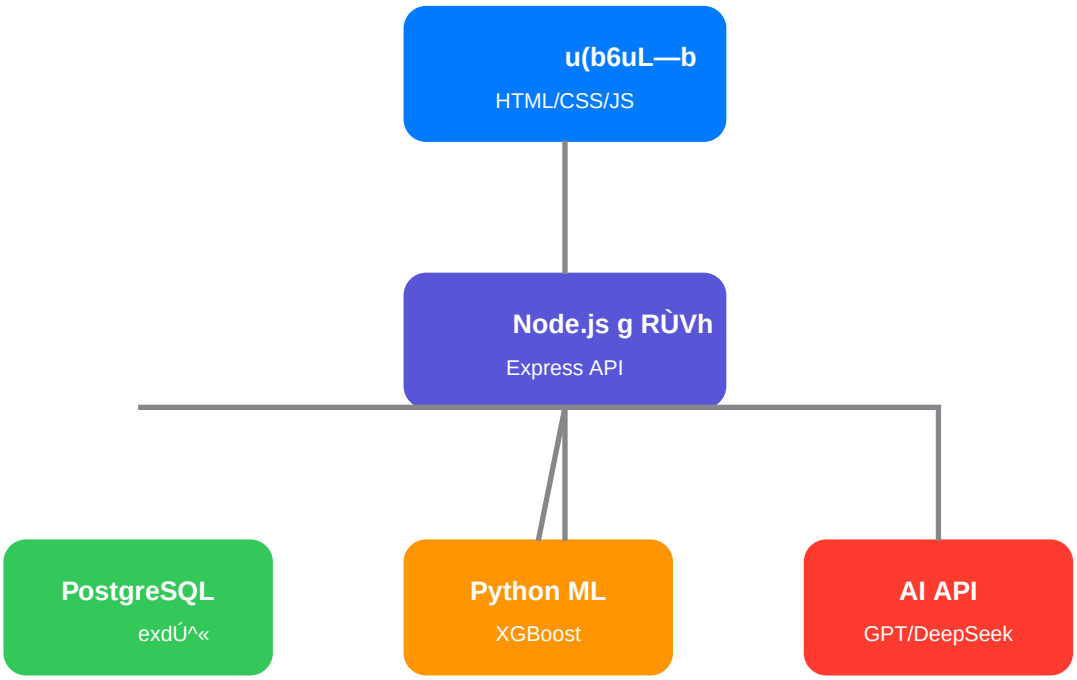
RMSE RMSE = " [(1/n) × :2‡‘Ö" Ò w b)²]

R² R² = 1 - SS_res/SS_tot

NDH AED ˜ n,|û}q v2.5.3

{, 16 ˜

10 |û}qg¶iËW



exdÚmAz

1. u(b6Š*UO}²˜ ÿ ‰øv|˜ n,ŠËlB
2. Node.js g RÙVhc¥e6ŠËlB
3. _ž PostgreSQL srSÖkwSòexdÚ
4. Š¿u(Python XGBoost j!W‹ÿ Y,Sïu(ÿ
5. Š¿u(AI API •2ˆL[æfBN‹NöR g•
6. }œT b@g Và[PŠ {—g }B˜ n,
7. •ÔVÞ˜ n,}PgœTŒ•nOáS@•“

b€ˆShç

RMzï:	HTML5, CSS3, JavaScript (ES6+), Chart.js
_Œzï:	Node.js 18+, Express
exdÚ^«:	PostgreSQL 15+
ML:	Python 3, XGBoost, NumPy, Pandas
AI:	OpenAI GPT, DeepSeek

•è•r:

Railway, Docker

NDH AED ˜ n,|û}q v2.5.3

{, 17 ~

}PŠž

NDH AED ˜ n,|û}qf/N P ‡•T N†}qŠ [x0 j_Vh[x•ÒTŒNº]åfz€ýv„N uL} ˜ n,^sSð0 • •N}PT Y z.QH•2b€ˆSTŒe¹lÕÿ |û}

|û}qv„h8_ÃQ*RâS bìÿ

• Y Và[PNXlÕj!W‹ - }œT € anfB•“0 Y)l#0 PGg 0 AIVà} {IY ‘Í_q—ÿ
• RÕaKVà[PŠ {— - O•u(nþRÕz—SãTŒc exˆpn k ‘Í•iaÉexdÚ‹ŠS
• j_Vh[x•ÒXž_7 - XGBoost j!W‹cUcI‰ –Üv„—^}Ú`'j!_
• [æfB AI R g• - •êRÕ‹XR%TŒ‘ÏS e°€^N‹Növ„_q—ÿ
• Y ‘Í^snÑe¹lÕ - 9z.^snÑb€ˆS}œT _—QúziPev„g }B˜ n,
• N xº[š`'‘ÏS - cÐO›•nOáS@•“^kR©lz{V

g*O†v|\Ue¹T S bìÿ

1. etT fôY Y •èexdÚn•ÿ mAa vãn,0 zzl#Œê‘Ï{lÿ
2. [æsþY fB•“{ÄW ˜ n,ÿ 1-6\ fB0 1-7Y)0 1-4•1ÿ
3. •‹v|v{j_`£€ ˜ n,RŸ€ý
4. c ~ŒQ*S {—lÕNå•TR0N uLg Osn–xº^¦
5. v|ˆh[xˆSŠÖe‡sr_—W –›Š•Sï

b P •ôR›e¼\ NDH AED ˜ n,|û}qbS• b N uLN g n–xº0 g Sï—`v„`%Š:[¤\1Š:˜ n,]åQw0

North District Hospital

Hospital Authority, Hong Kong
Version 2.5.3 | December 2025