

Supplementary Figures Appendix

Figure S1. Quartile Setting

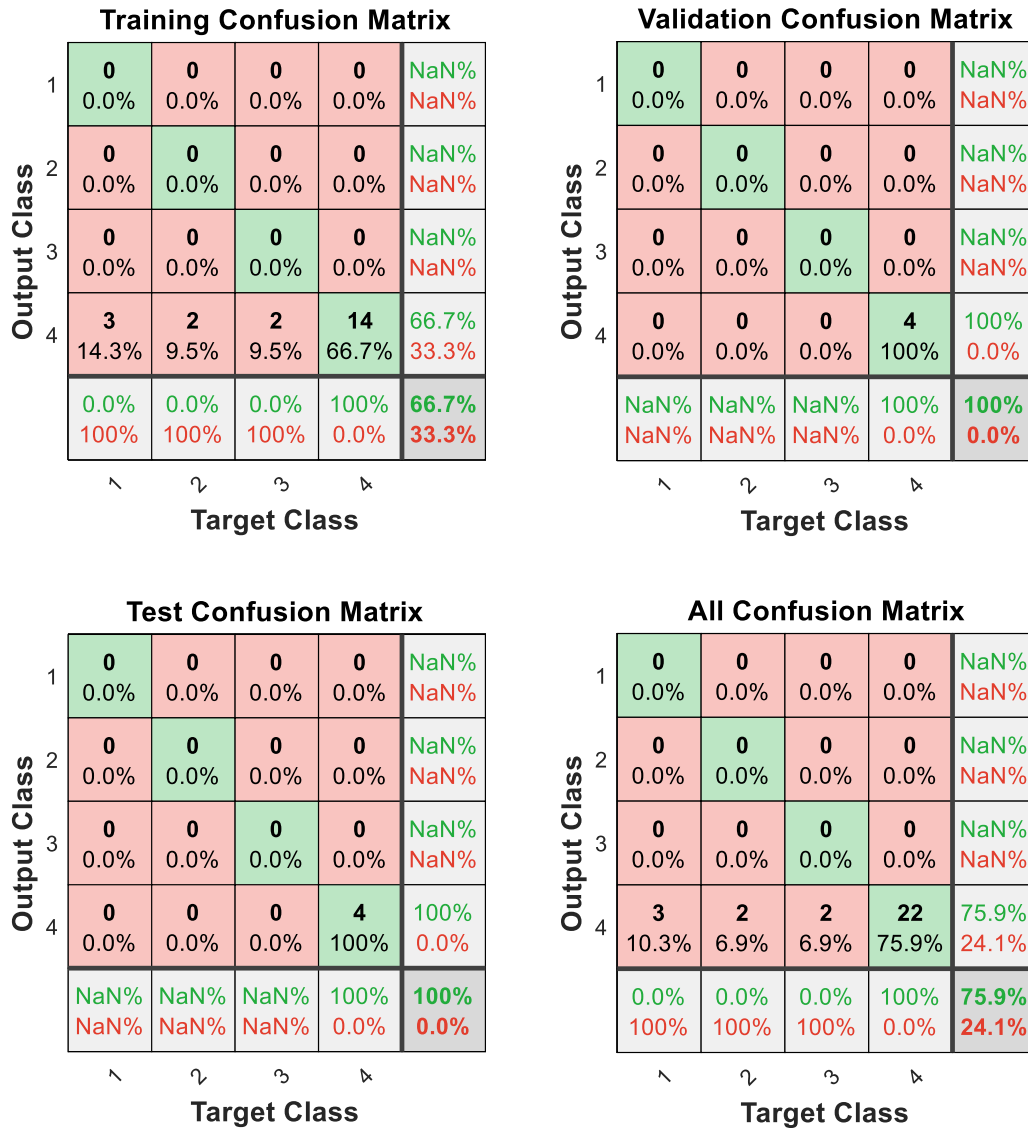


Figure S1(a). ANN configuration

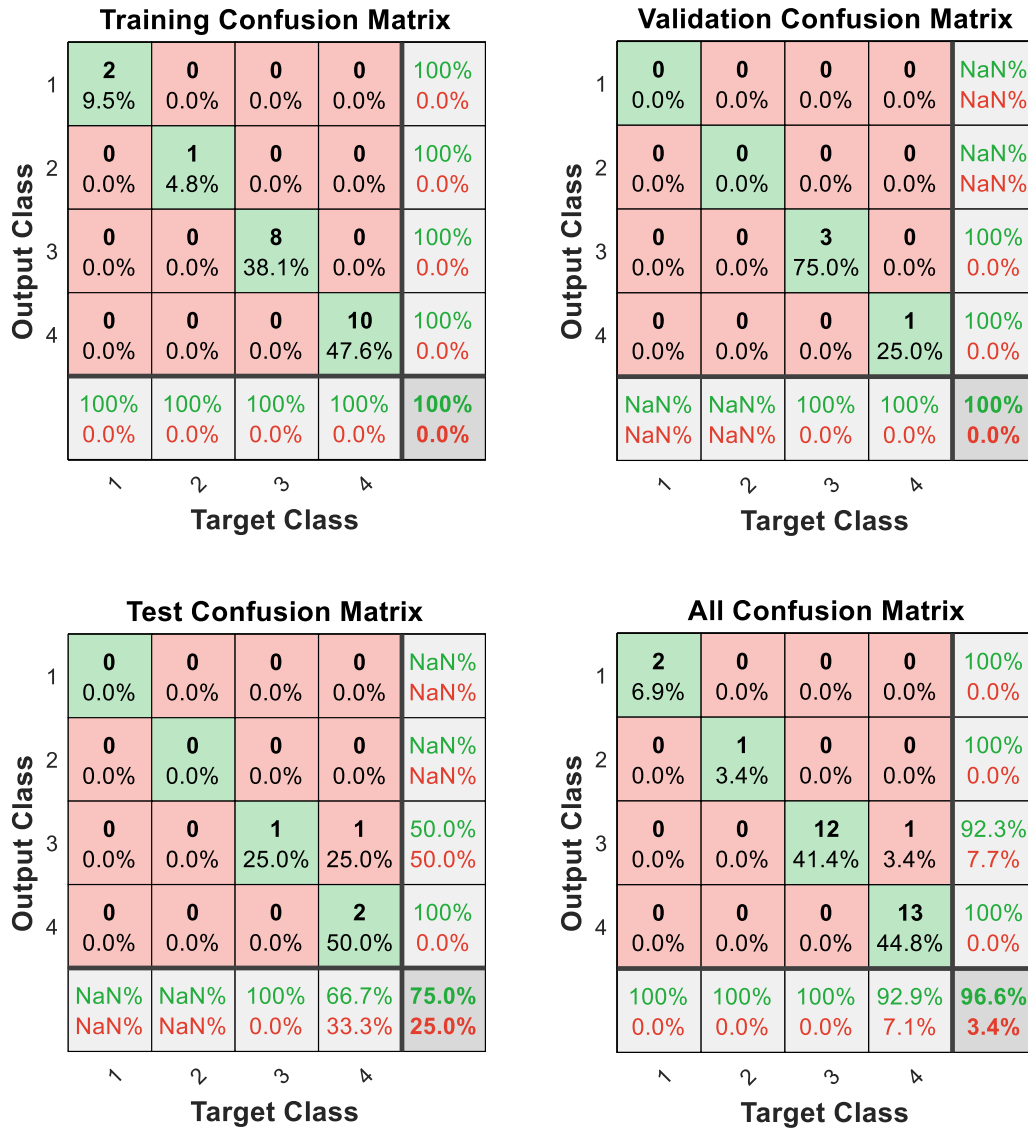


Figure S1(b). DEA-ANN configuration

Figure S2. Tercile Setting

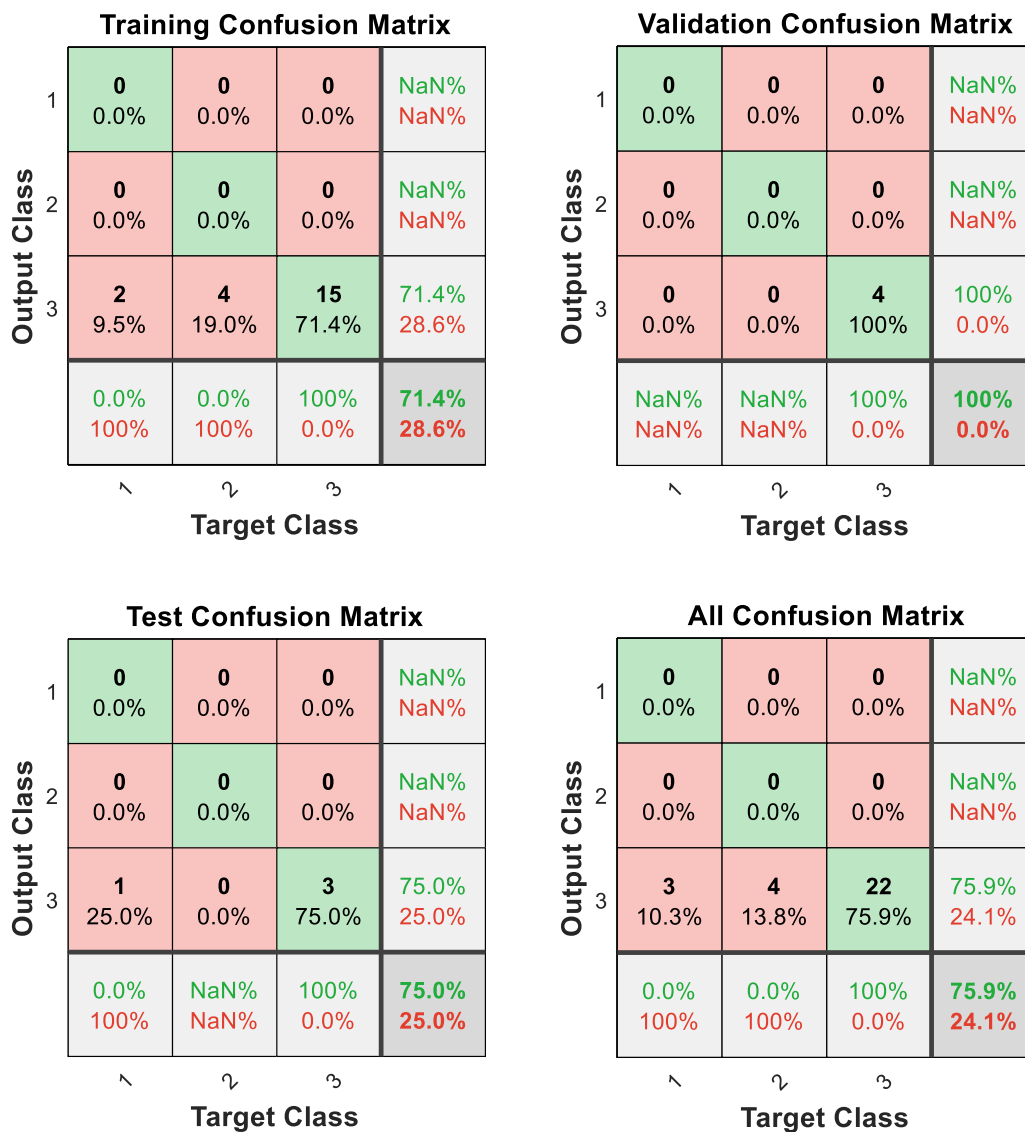


Figure S2(a). First ANN configuration: CNF1

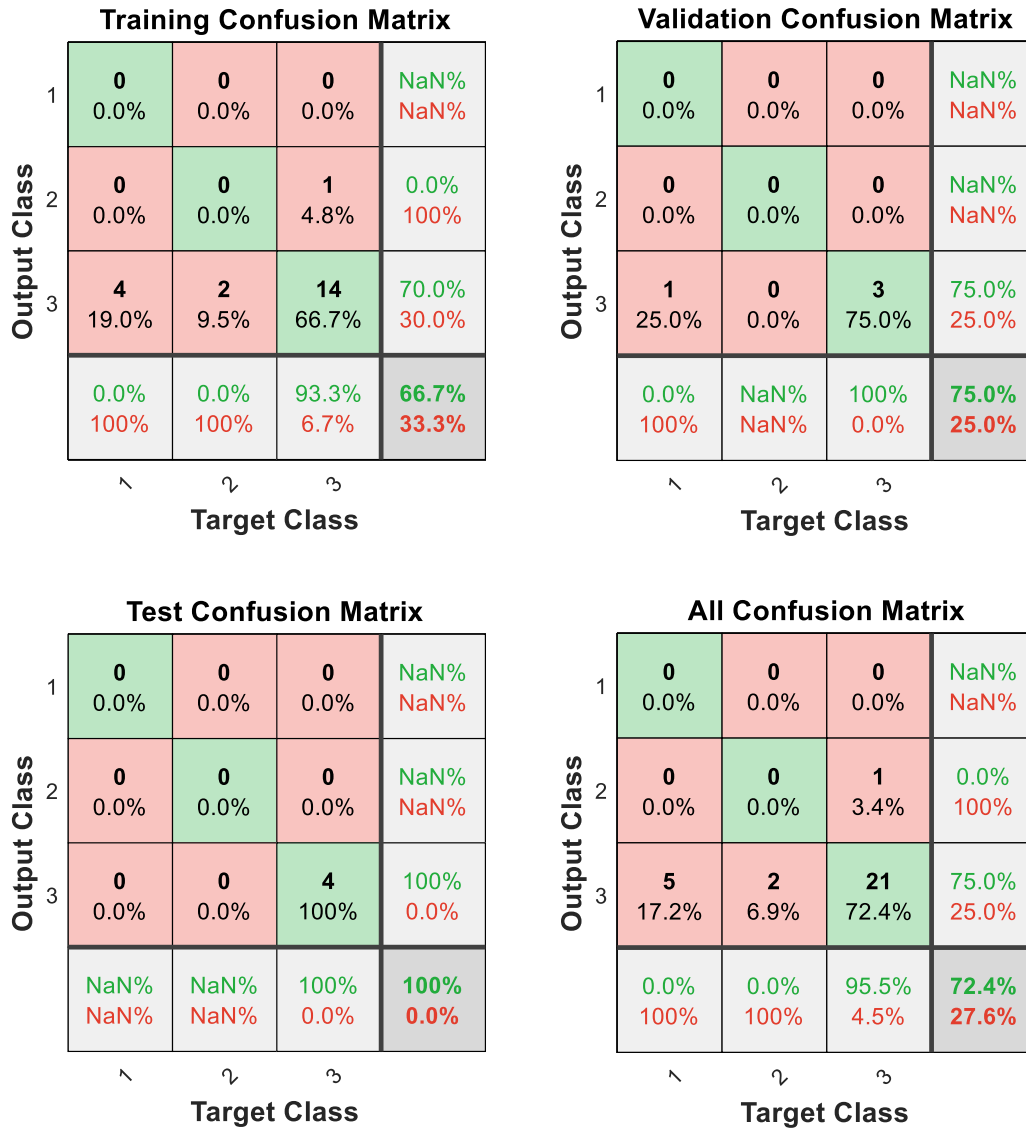


Figure S2(b). Second ANN configuration: CNF2

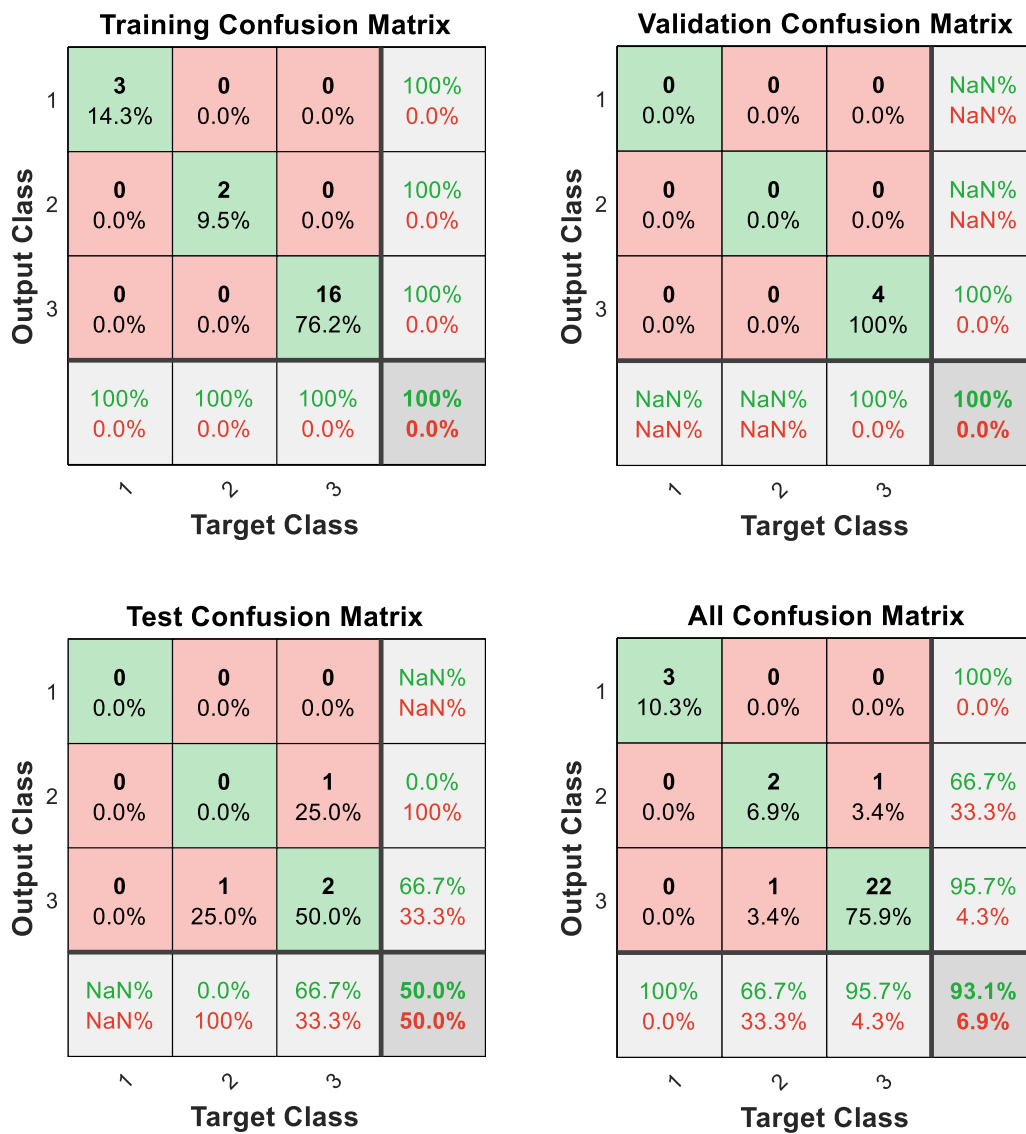


Figure S2(c). DEA-ANN configuration

Figure S3. Median Setting

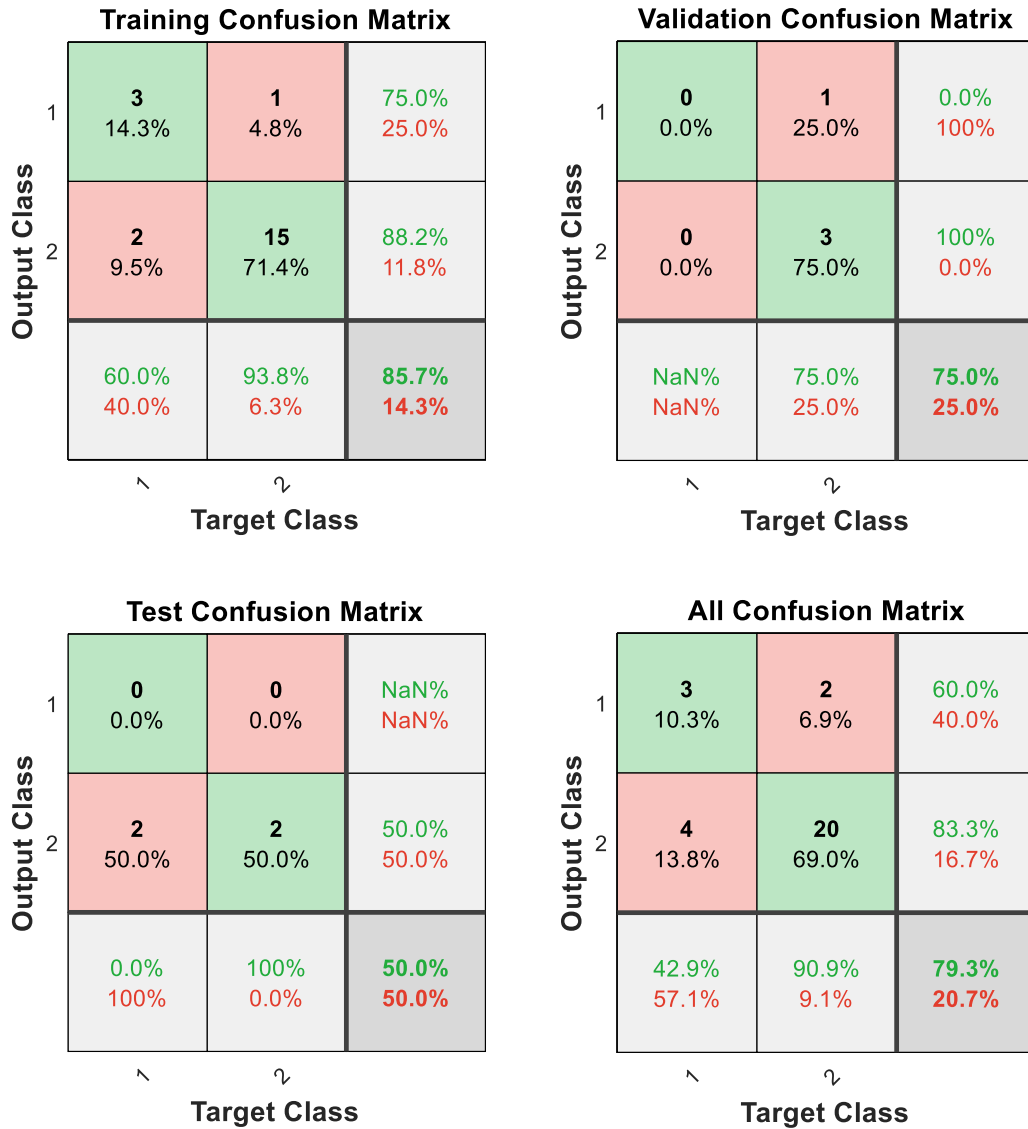


Figure S3(a). ANN configuration

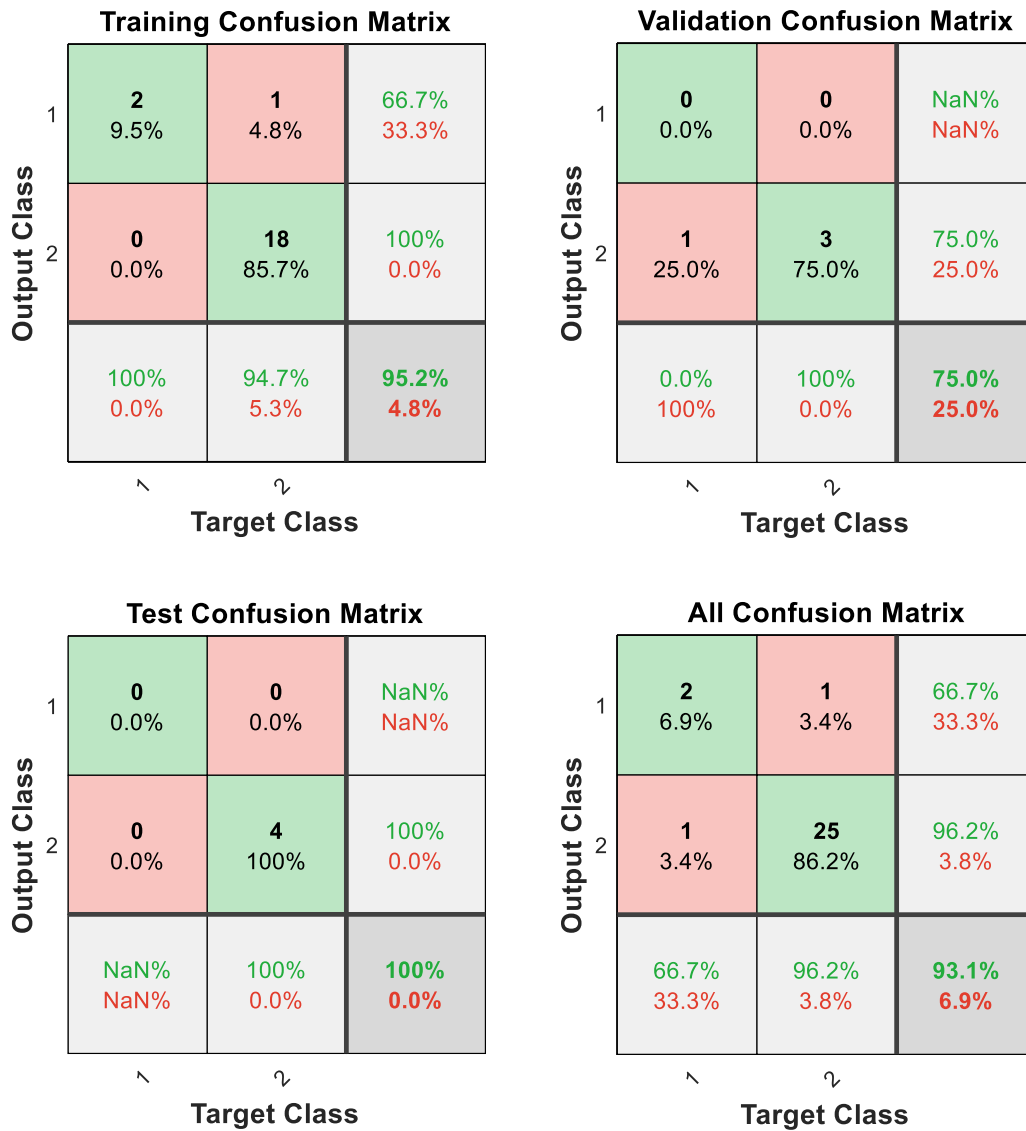
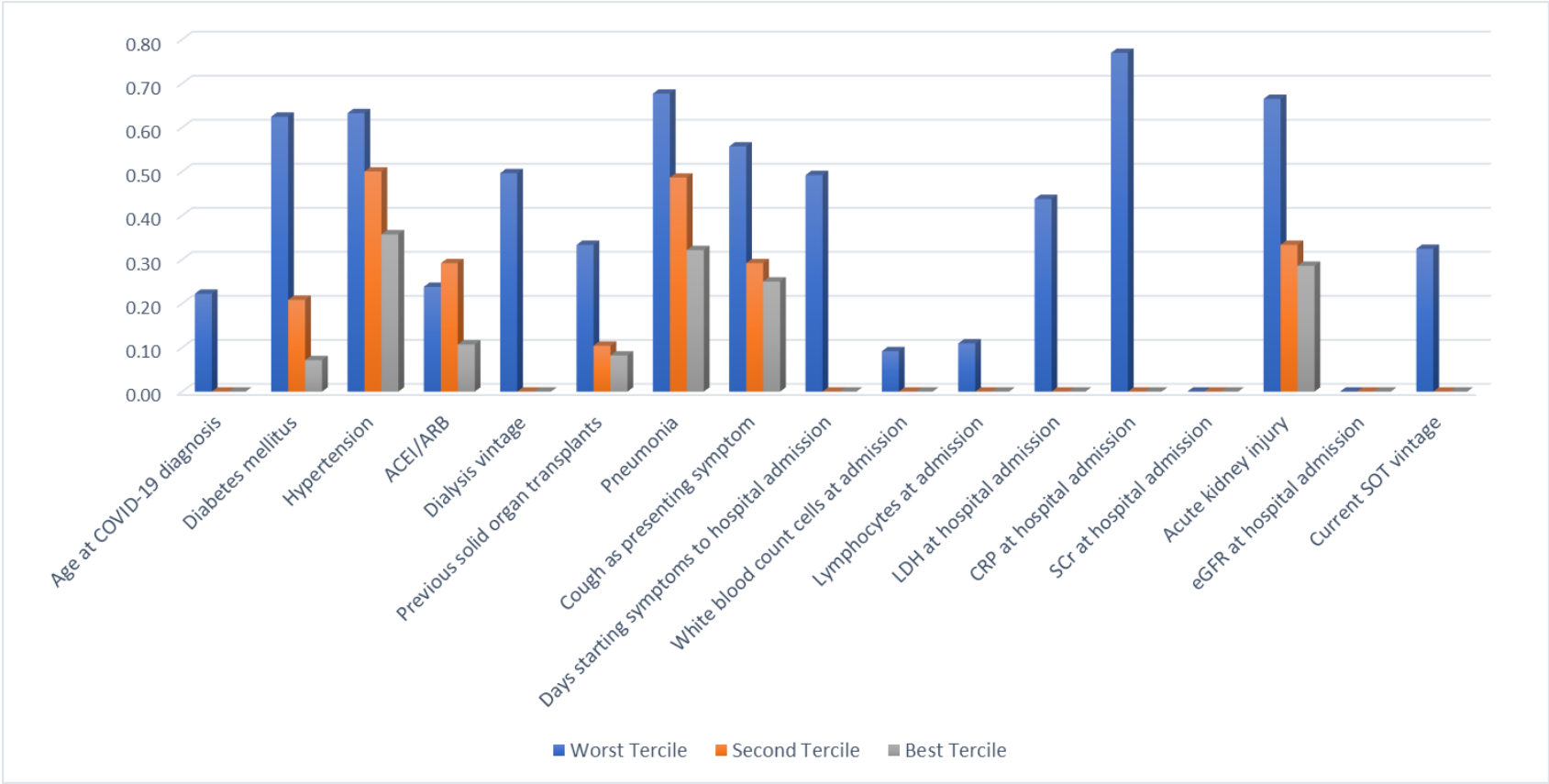


Figure S3(b). DEA-ANN configuration

Figure S4. Patient performance across input variables for the different index categories generated using DEA when death and days spent in intensive care are taken as outputs



Legend: The index has been normalized within the interval [0, 1]. Higher values represent relatively worse performances.

Supplementary Tables Appendix

Extended Data Table S1. Kidney and transplant characteristics

Etiology of Chronic Kidney Disease, n (%)	
Glomerulonephritis	9 (23.7)
Polycystic disease	8 (21.1)
Diabetic nephropathy	6 (15.8)
Hypertensive nephroangiosclerosis	5 (13.2)
Unknown	5 (13.2)
Others	5 (13.2)
Type of transplant, n (%)	
Kidney transplant	35 (92.1)
Multiple organ transplant	3 (7.9)
Source of donor, n (%)	
Decease donor	30 (78.9)
Living donor	8 (21.1)
Other comorbidities, n (%)	
Dyslipidemia	14 (36.8)
Coronary Artery Disease	4 (10.5)

Immunosuppressive drug at COVID-19 diagnosis, n (%)	
Calcineurin inhibitor	33 (86.8)
Antimetabolite drug	24 (57.9)
mTOR inhibitor	16 (42.1)
Prednisone	32 (84.2)

Extended Data Table S2. Hospital admission laboratory results

Mean serum creatinine at hospital admission (mg/dl) (s.d.) (range)	1.59 (0.65) (0.7-3.4)
Mean eGFR at hospital admission (ml/min/1.73 m ²) (s.d.) (range)	49.47 (19.17) (18-95)
Mean white cell count at hospital admission (s.d.) (range)	6734 (3154) (2800-13400)
Mean lymphocytes at hospital admission (s.d.) (range)	877 (1419) (0-8700)
Mean haemoglobin at hospital admission (g/dL) (s.d.) (range)	12.49 (2.07) (8.8-17.5)
Mean platelets at hospital admission (s.d.) (range)	192969 (77687) (71000-404000)
Mean AST at hospital admission (IU/L) (s.d.) (range)	42.37 (32.01) (14-142)
Mean ALT at hospital admission (IU/L) (s.d.) (range)	34.63 (26.74) (8-127)
Mean GGT at hospital admission (IU/L) (s.d.) (range)	77.77 (67.24) (13-378)
Mean LDH at hospital admission (IU/L) (s.d.) (range)	310.26 (107.92) (142-529)
Mean CRP at hospital admission (mg/dL) (s.d.) (range)	13.58 (7.78) (0.4-32)
Mean procalcitonin at hospital admission (ng/mL) (s.d.) (range)	0.42 (0.57) (0-1.9)
Mean ferritin at hospital admission (ng/mL) (s.d.) (range)	513.50 (422.78) (70-1566)

Mean D-dimer at hospital admission (ng/mL) (s.d.) (range)	1316.13 (1339.03) (200-5600)
Mean high sensitivity Troponin I at hospital admission (ng/mL) (s.d.) (range)	58.85 (168.91) (3.8-803)

Acronyms: eGFR: estimated Glomerular Filtrate Rate; AST: Aspartate transaminase; ALT: Alanine transaminase; GGT: gamma glutamyl transferase; LDH: Lactate dehydrogenase; CRP: C-reactive protein.

Extended Data Table S3. ICU comparative analysis

Variable	Intensive Care Unit (N=9)	Non-intensive Care Unit (N=29)	P value
Cough as presenting symptom, n (%)	8 (88.9)	15 (51.7)	0.030
Pneumonia, n (%)			
No	0 (0.0)	7 (24.1)	0.032
Unilateral	0 (0.0)	7 (24.1)	
Bilateral	9 (100.0)	15 (51.8)	
Mean lactate dehydrogenase (IU/L) (s.d.)	397.86 (130.41)	281.47 (84.54)	0.009
Mean CRP (mg/dl) (s.d.)	11.99 (4.73)	8.76 (7.94)	0.011
Mean D-dimer (ng/mL) (s.d.)	5000 (4687.93)	2113.45 (1776.83)	0.021
Steroid pulse, n (%)	7 (77,8)	10 (34.5)	0.034
Mean days at hospital(s.d.)	16.33 (7.19)	10.48 (6.11)	0.026
Graft loss, n (%)	2 (22.2)	4 (13.8)	0.457
Death, n (%)	2 (22.2)	3 (10.3)	0.352

Results include all recipients who were hospitalized with COVID-19 from March 3 to

April 24, and followed-up till April 27,2020.

χ^2 test (or Fisher's exact test whenever appropriate), Student's t test, and analysis of variance (Mann-Whitney test).

Table S4. Input profiles of patients and output treatment variables

Input Variables	Output Variables
Age at COVID-19 diagnosis	ICU admission
Diabetes mellitus	Treatments with tocilizumab
Hypertension	Pulses of methylprednisolone
Angiotensin-converting-enzyme inhibitors (ACEI) / angiotensin-receptor blockers (ARB) treatment	
Dialysis vintage (months)	
Previous SOT	
Pneumonia	
Cough as presenting symptom	
Time from starting symptoms to hospital admission (days)	
White blood count cells at admission	
Lymphocytes at admission	
LDH at hospital admission	
CRP at hospital admission	

SCr at hospital admission	
Acute kidney injury	
eGFR at hospital admission	
Current SOT vintage	

Table S5. Categorization of the index values and each alternative configuration

	Index Values and Categories			
	[1, 0.75]	[0.75, 0.5]	[0.5, 0.25]	[0.25, 0]
DEA	Worst Quartile	-	Third Quartile	Best Quartile
	Number of Output Treatments per Quartile			
CNF1	3	-	2 and 1	0
CNF2	3 and 2	-	1	0
CNF3	3	2	1	0

Table S6. Binary variables assigned to the hybrid model and each alternative configuration

	Index Values and Logistic Categories			
	[1, 0.75]	[0.75, 0.5]	[0.5, 0.25]	[0.25, 0]
DEA	1	-	0	0
DEA2	1	-	1	0
	Number of Output Treatments per Logistic Category			
CNF1	3		2 and 1	0
Logistic	1	-	0	0
CNF2	3 and 2		1	0
Logistic	1	-	0	0
CNF3	3	2	1	0
Logistic	1	1	1	0

Table S7. Categorization of the index values and the alternative configurations when death and days spent in intensive care are taken as outputs

Table S7(a). Quartile setting

	Index Values and Categories			
	[1, 0.75]	[0.75, 0.5]	[0.5, 0.25]	[0.25, 0]
DEA	Worst Quartile	Second Quartile	Third Quartile	Best Quartile
	Outputs per Category			
CNF	Death	ICU > 2 weeks	ICU < 2 weeks	None
Class	1	2	3	4

Table S7(b). Tercile setting

	Index Values and Categories		
	[1, 0.67]	[0.67, 0.33]	[0.33, 0]
DEA	Worst Tercile	Second Tercile	Best Tercile
	Outputs per Category		
CNF1	Death	ICU	None
CNF2	Death and ICU > 2 weeks	ICU < 2 weeks	None
Class	1	2	3

Table S7(c). Median setting

	Index Values and Categories	
	[1, 0.5]	[0.5, 0]
DEA	Worst Median	Best Median
	Outputs per Category	
CNF	Death and ICU	None
Class	1	2