UNIVERSIDADE DA CORUÑA

Aplicación de técnicas de Inteligencia Artificial e IoT a la vida real

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Facultad de Informática – Universidad Complutense Madrid

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- Propuesta de modelado híbrido
- Métodos utilizados
- Aplicaciones

Índice

- Propuesta de modelado híbrido

Modelado híbrido

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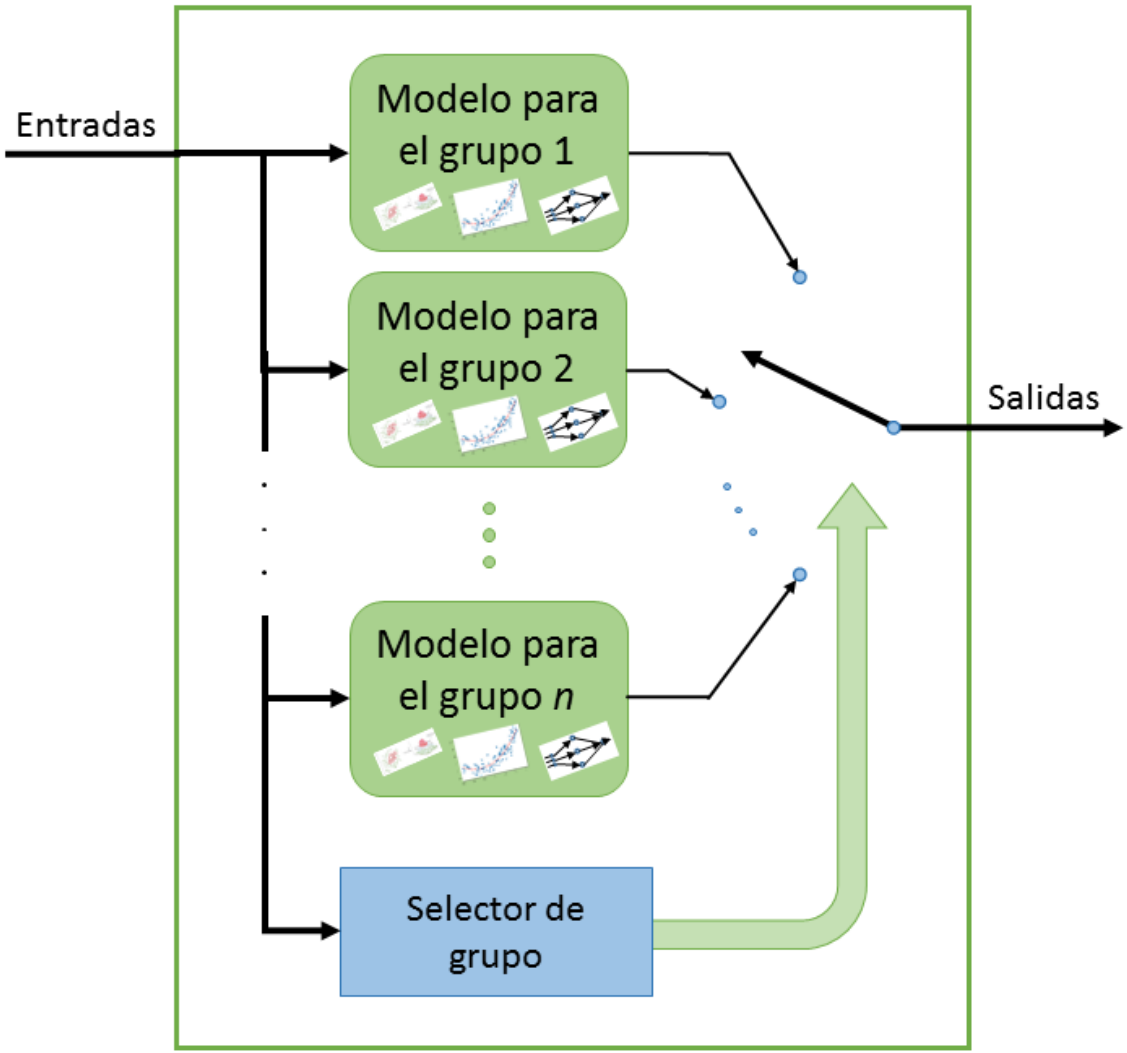

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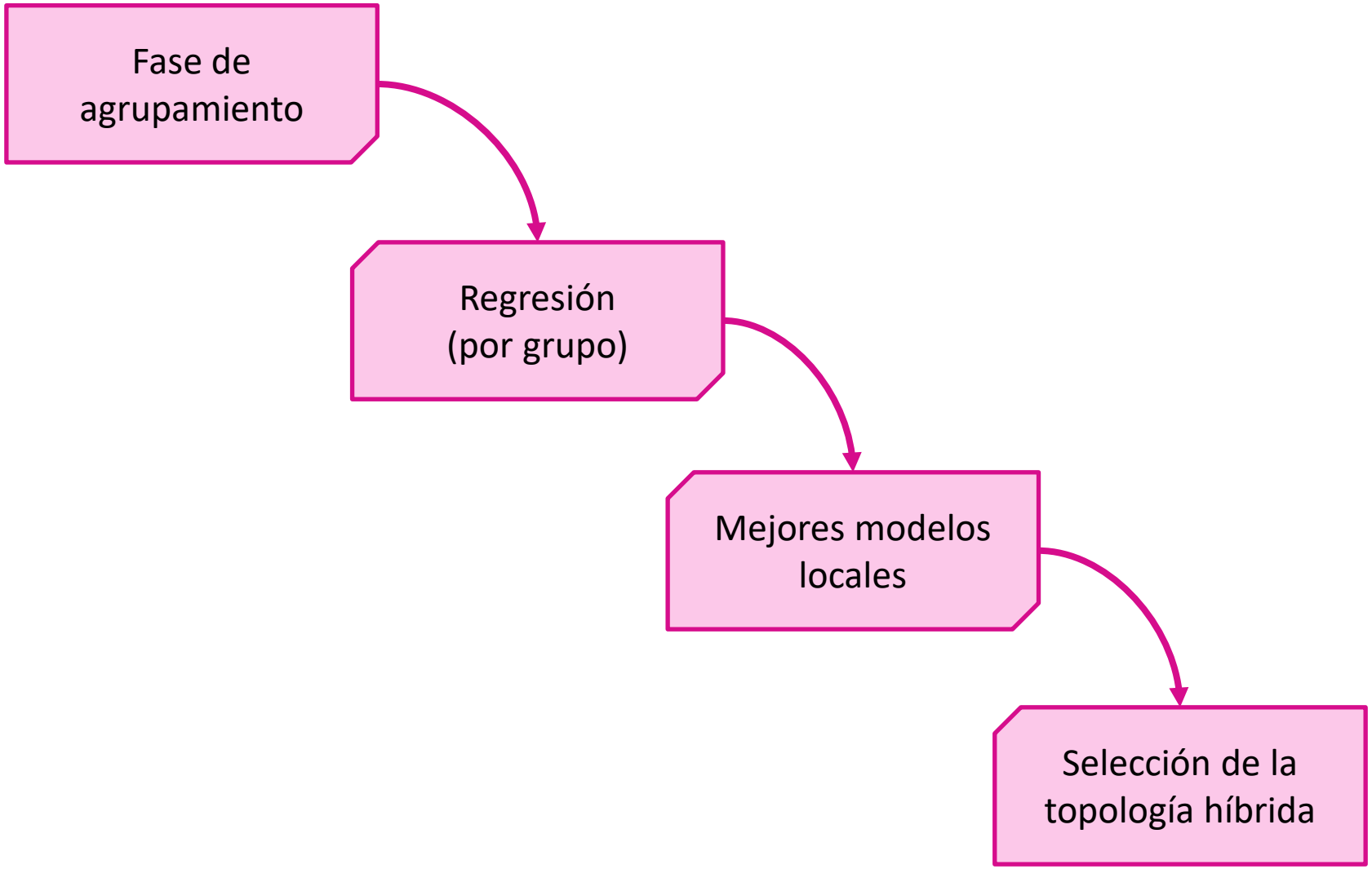
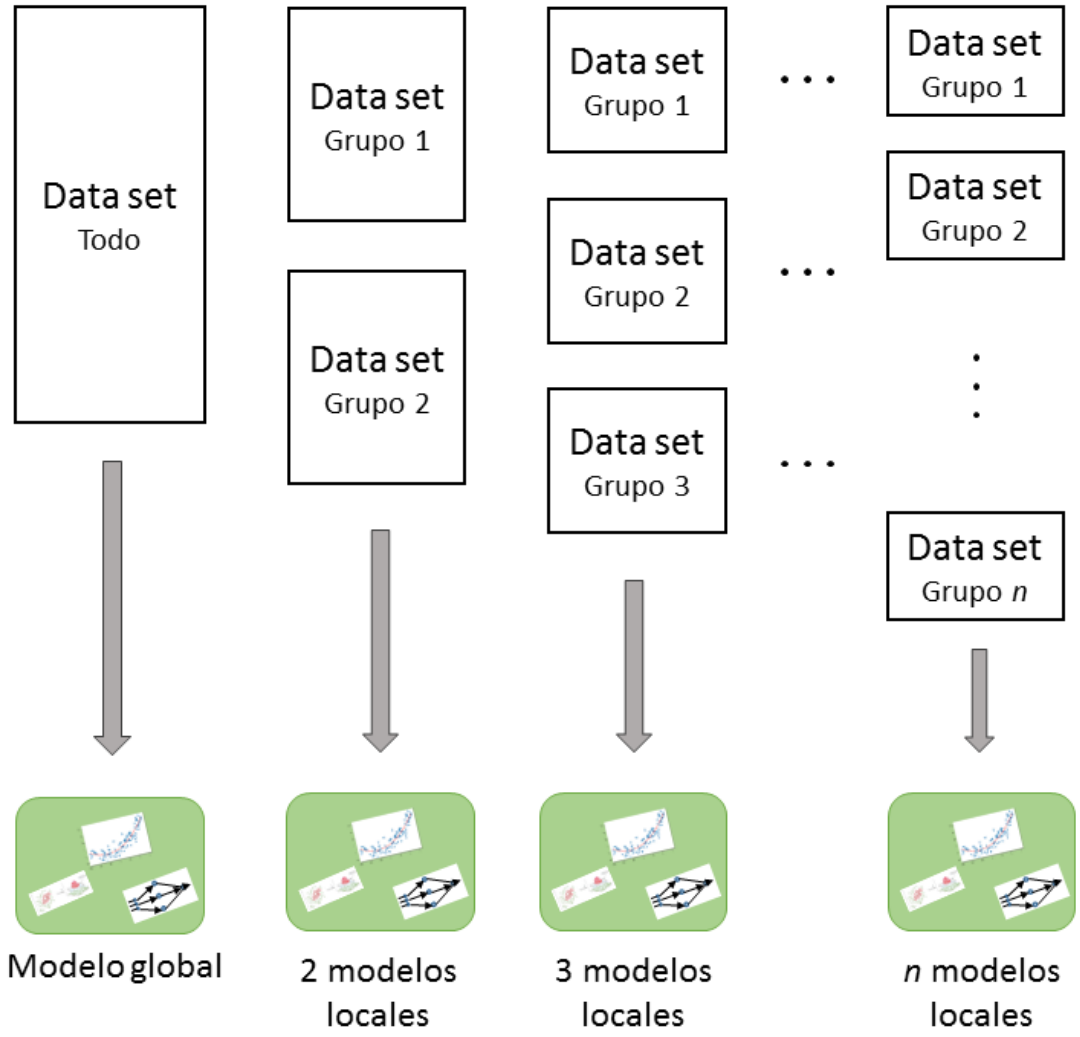


Modelo híbrido



Modelo híbrido

	Modelos locales				
	Grupo 1	Grupo 2	Grupo 3	Grupo 4	Grupo 5
Global					
Híbrido 2 grupos					
Híbrido 3 grupos					
Híbrido 4 grupos					
Híbrido 5 grupos					

Modelo híbrido – Errores

$$MSE = \frac{1}{n}\sum_{i=1}^{n}\left(y_{i_{modelo}} - y_{i_{real}}\right)^2$$

$$NMSE = \frac{1}{n}\sum_{i=1}^{n}\frac{\left(y_{i_{modelo}} - y_{i_{real}}\right)^2}{\overline{y_{i_{modelo}}} \cdot \overline{y_{i_{real}}}}$$

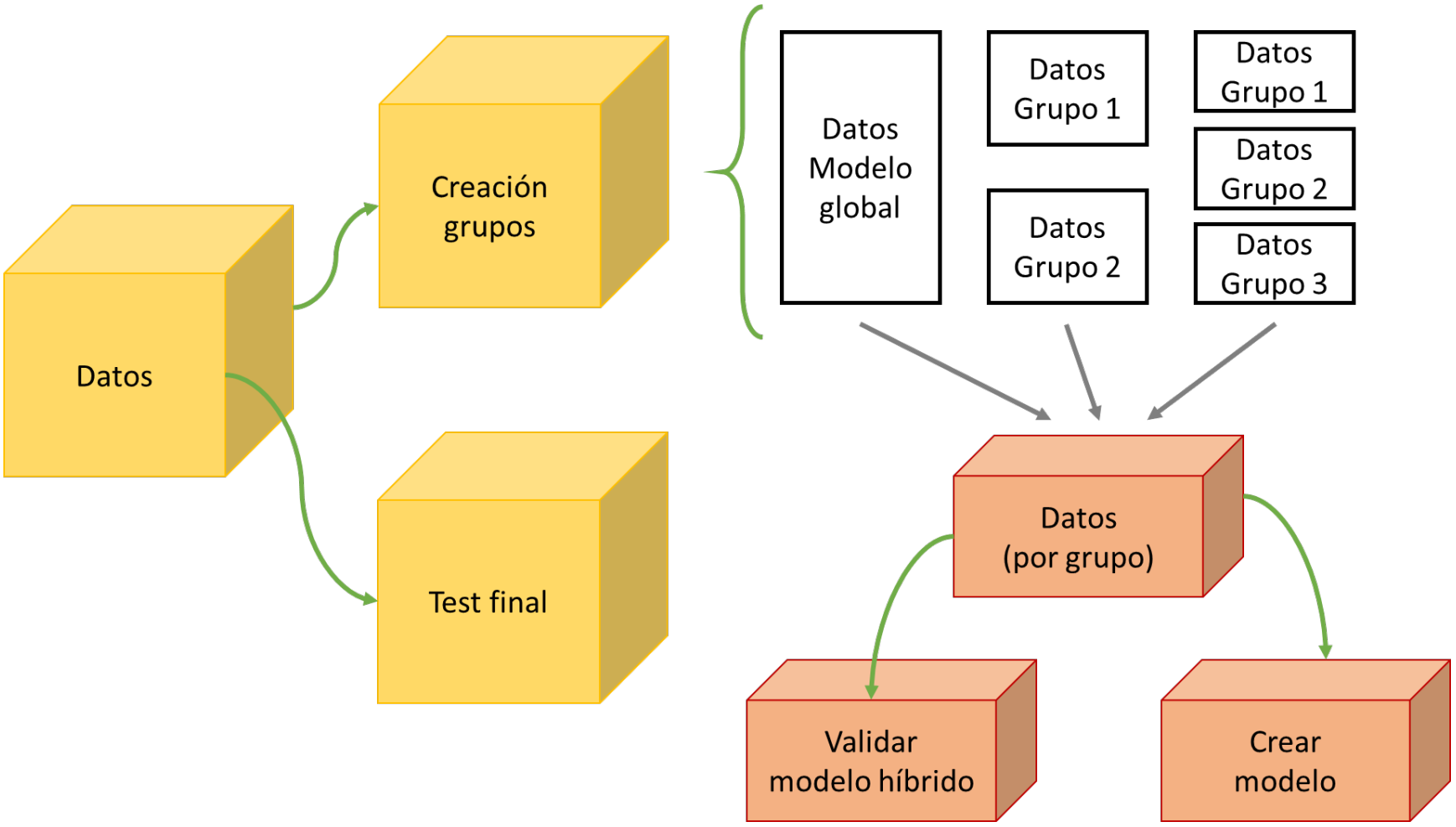
$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left|y_{i_{modelo}} - y_{i_{real}}\right|$$

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{y_{i_{modelo}} - y_{i_{real}}}{y_{i_{real}}}\right|$$

Modelo híbrido

	Modelos locales				
	Grupo 1	Grupo 2	Grupo 3	Grupo 4	Grupo 5
Global	ANN-12				
Híbrido 2 grupos	LS-SVR	ANN-2			
Híbrido 3 grupos	Poly-2	ANN-5	LS-SVR		
Híbrido 4 grupos	ANN-5	ANN-3	ANN-4	LS-SVR	
Híbrido 5 grupos	LS-SVR	LS-SVR	ANN-6	ANN-7	ANN-6

Modelo híbrido



Índice

- Propuesta de modelado híbrido
- Métodos utilizados

Métodos utilizados

- Agrupamiento
- Regresión
- Validación
- Elección del modelo

Agrupamiento – K-Means

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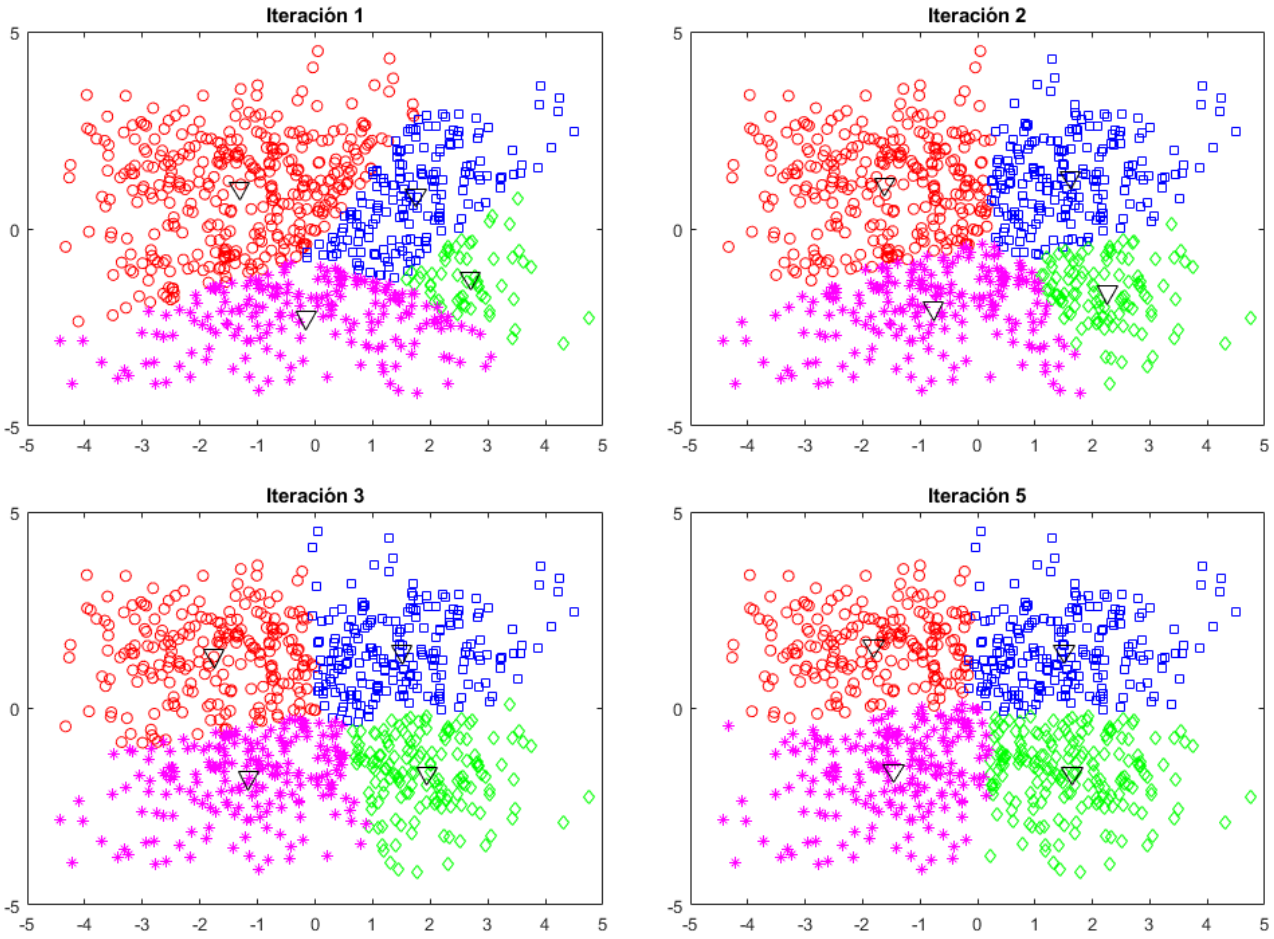
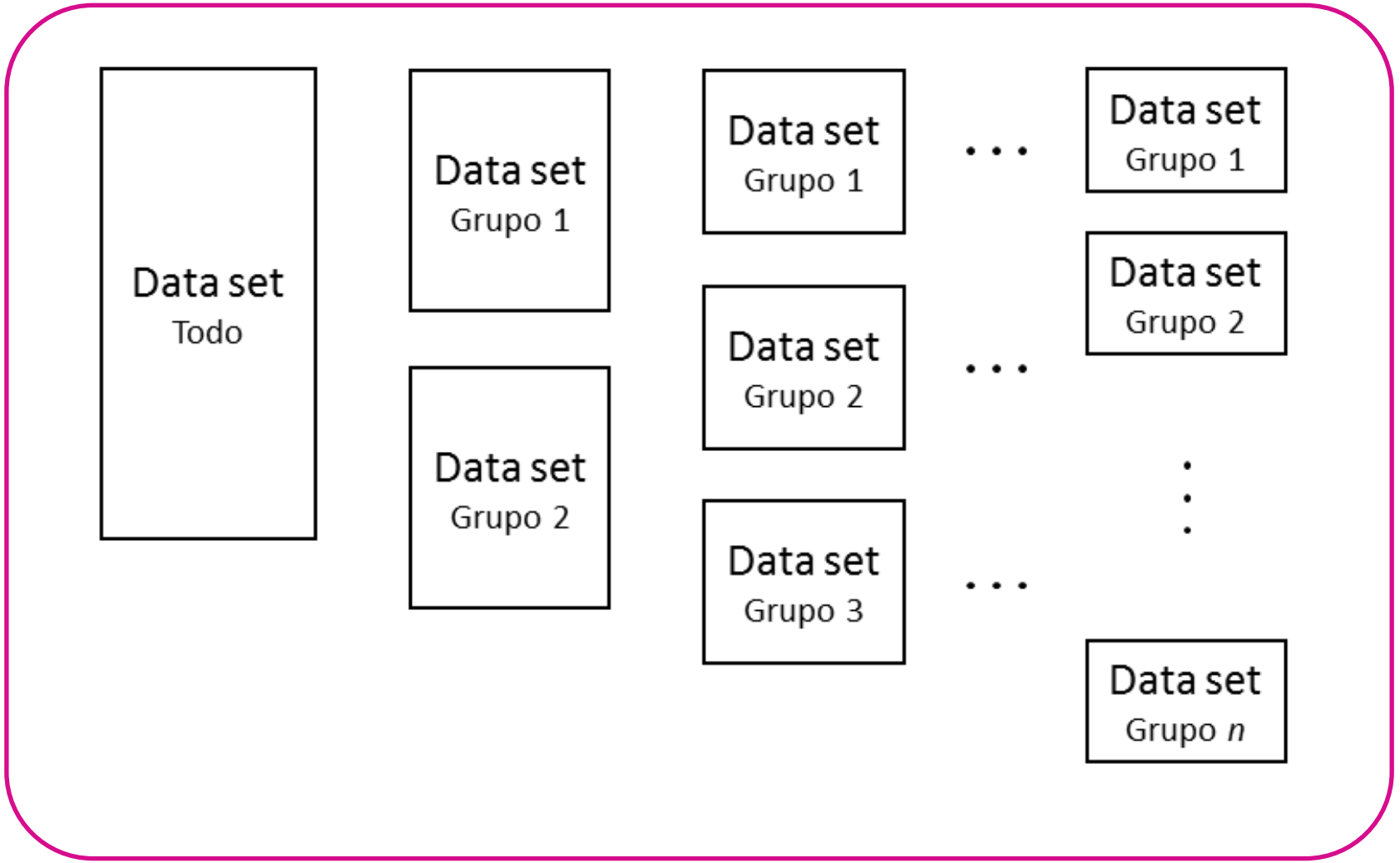
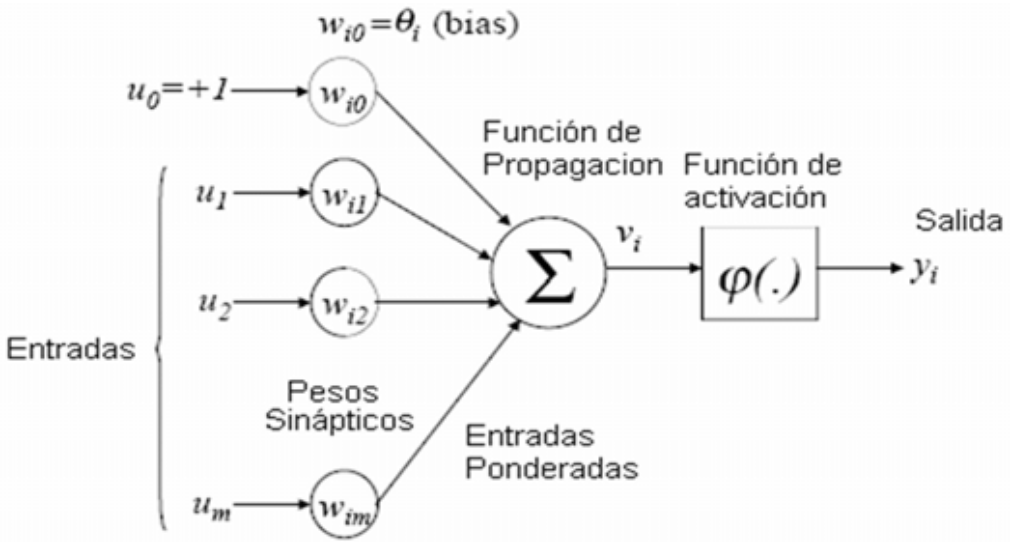


Agrupamiento – K-Means

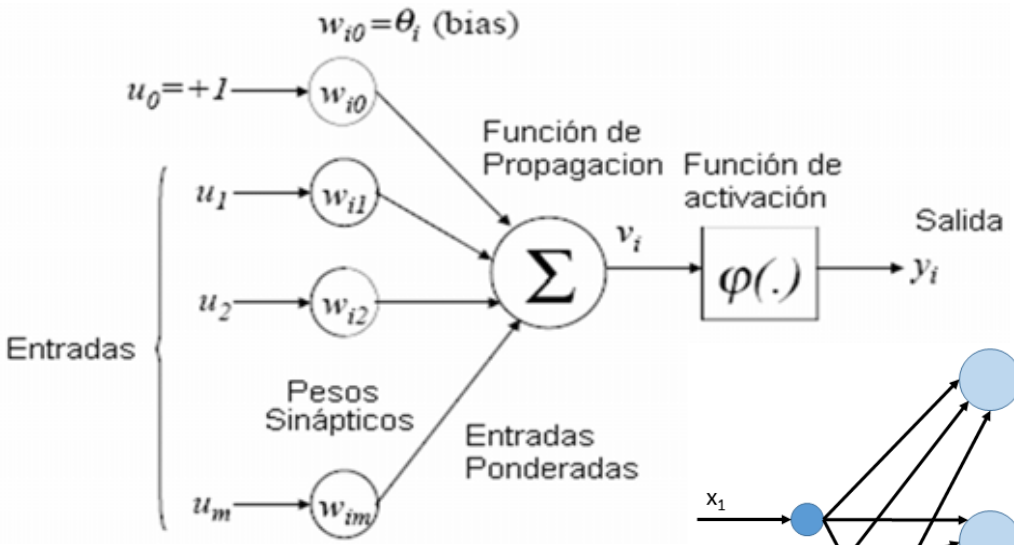


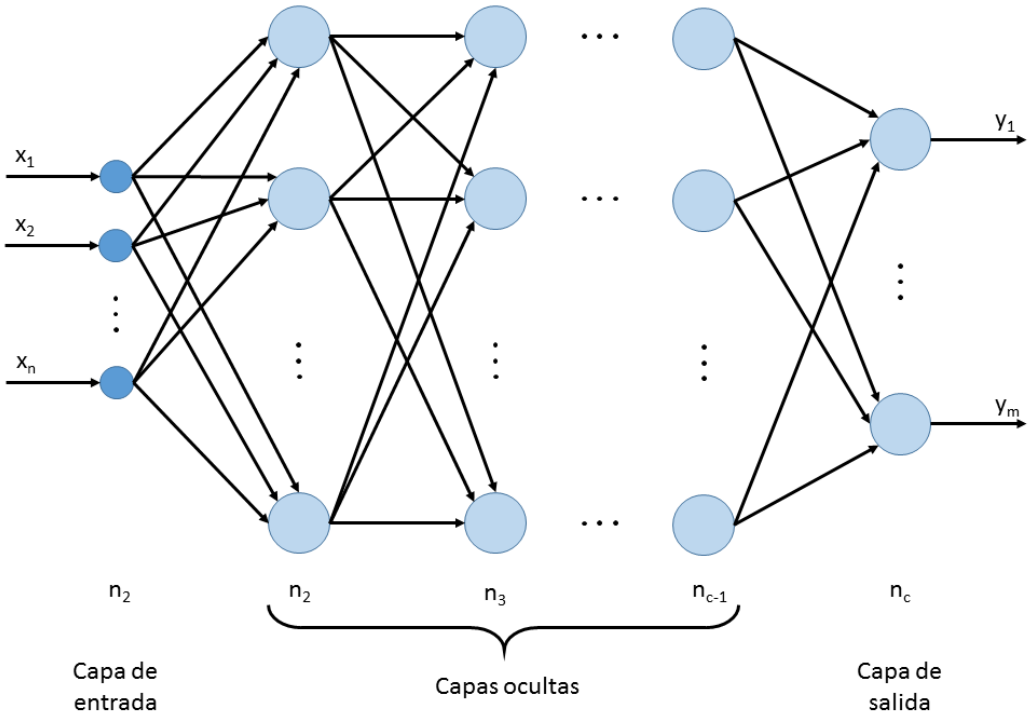
Regresión

Regresión – Redes neuronales artificiales



Regresión – Redes neuronales artificiales

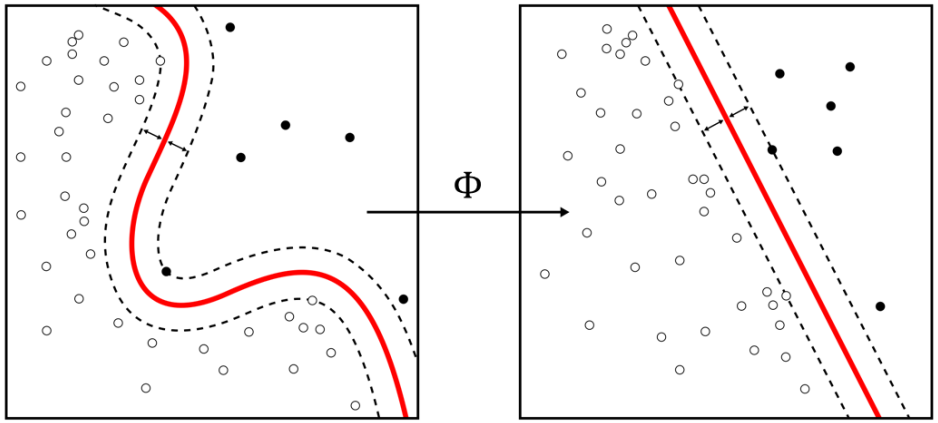


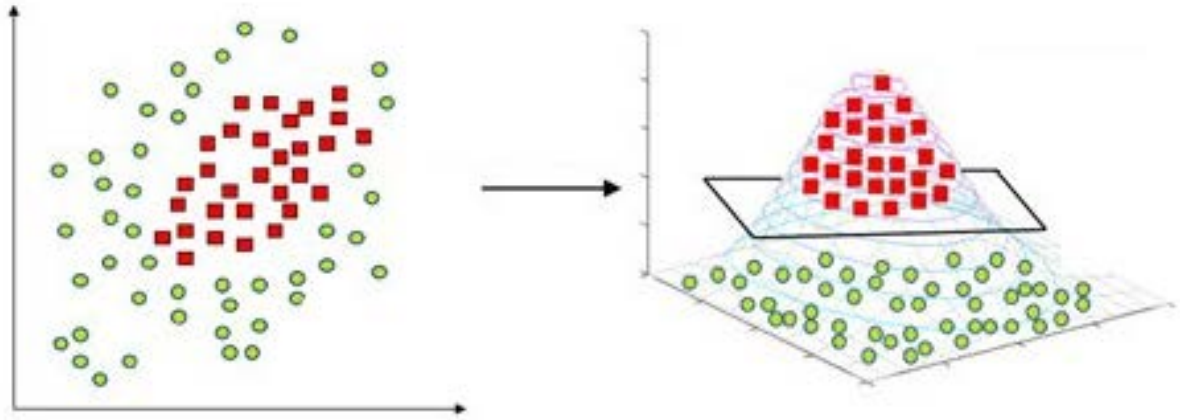


Regresión – Máquinas de vectores soporte

Regresión – Máquinas de vectores soporte

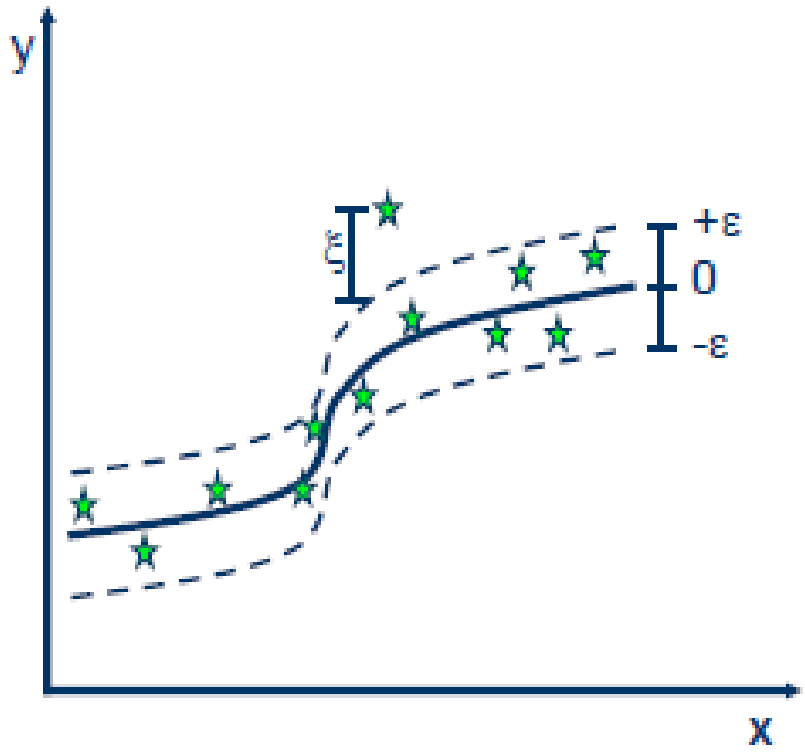
$$\Phi : X \rightarrow F$$

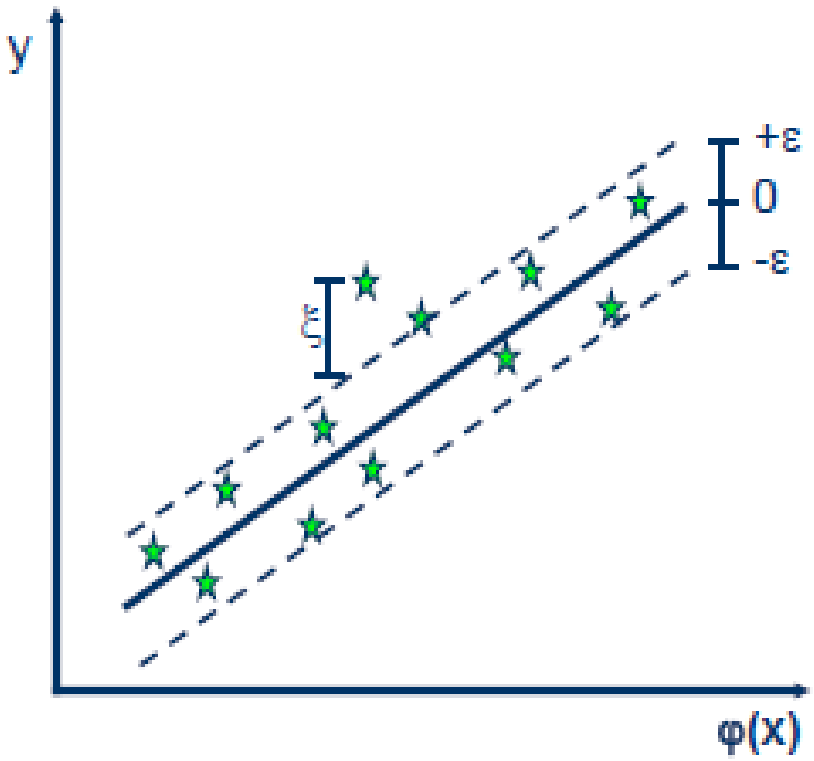




Regresión – Máquinas de vectores soporte

$$\Phi : X \rightarrow F$$





Regresión – Regresión polinomial

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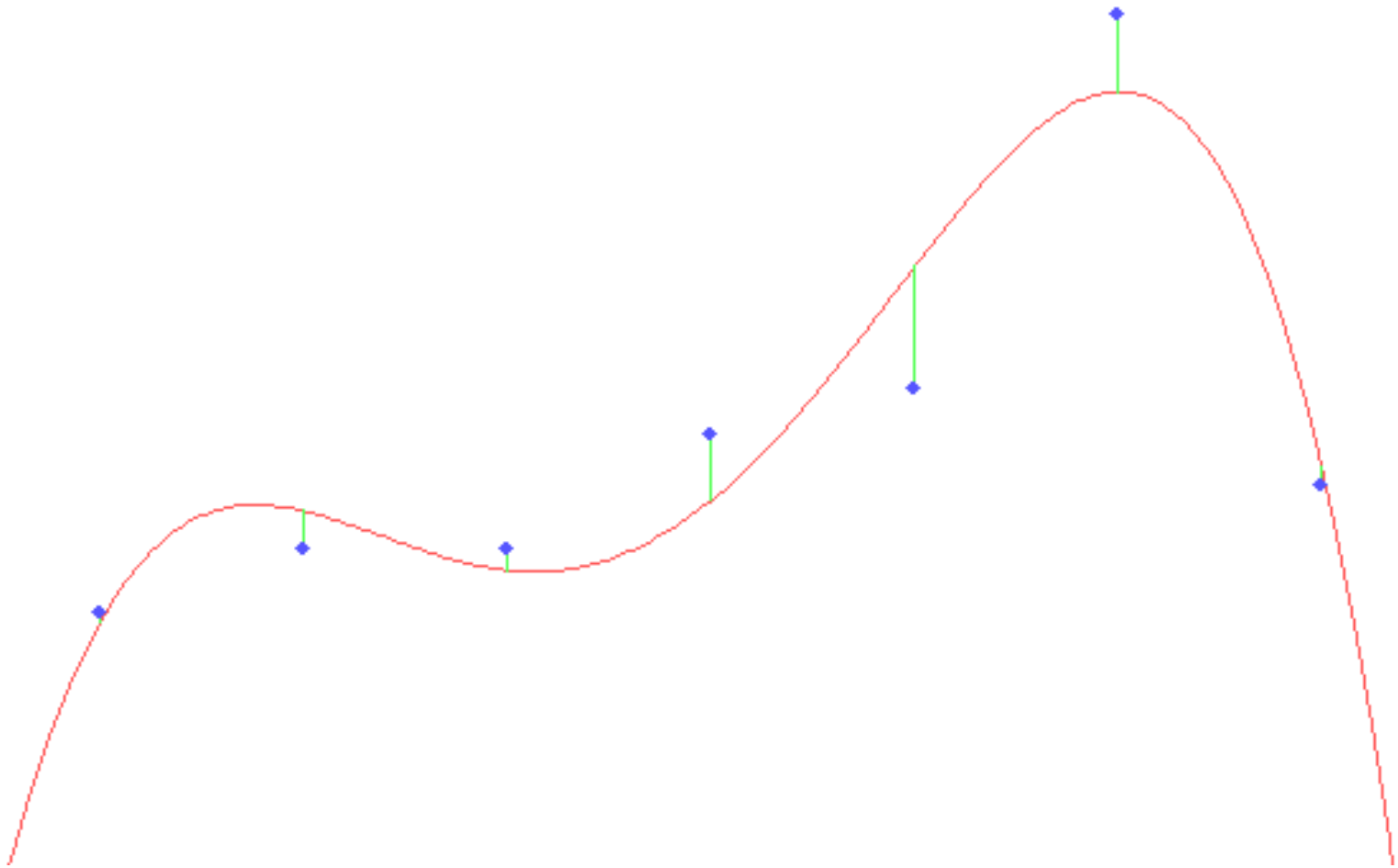
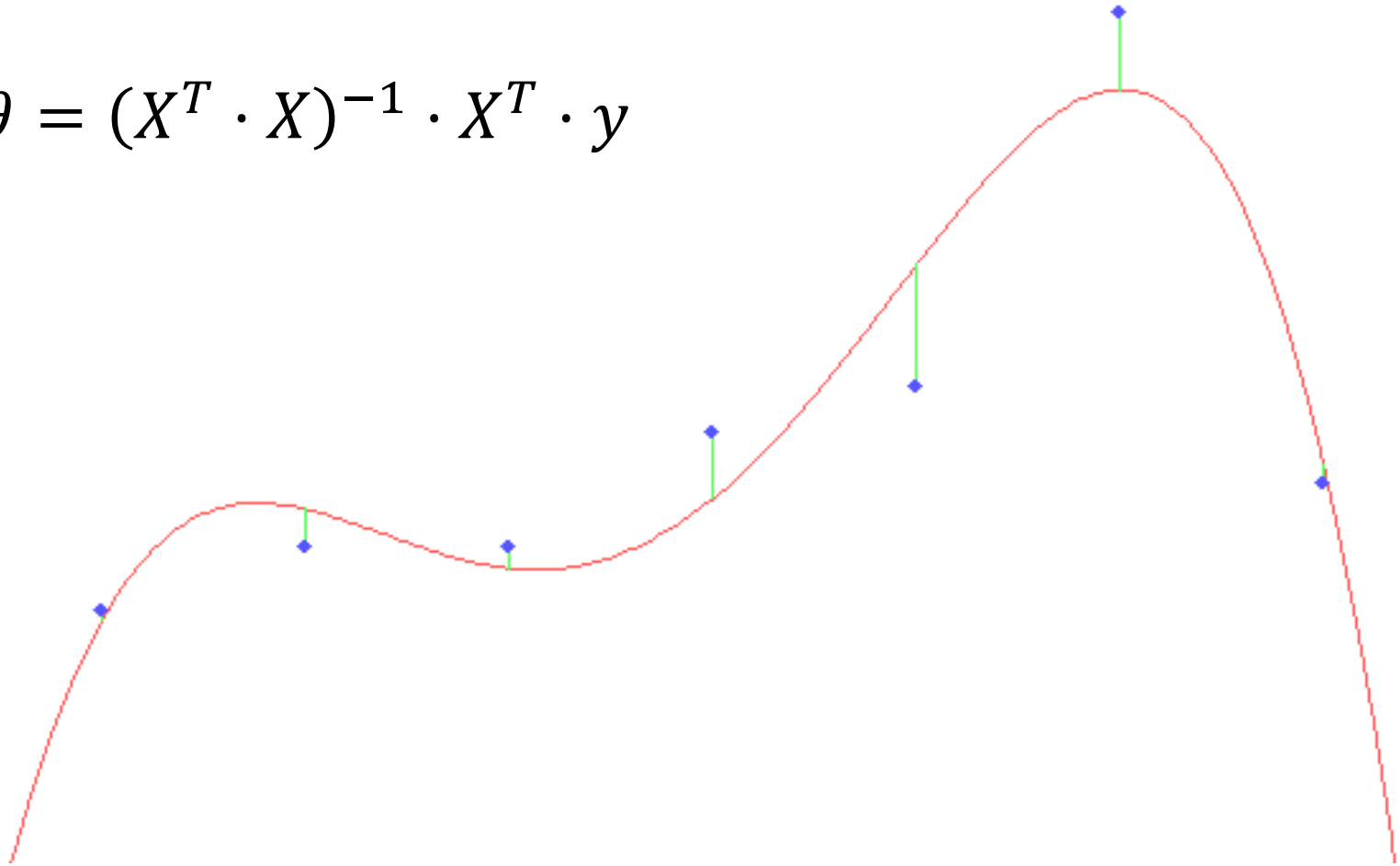


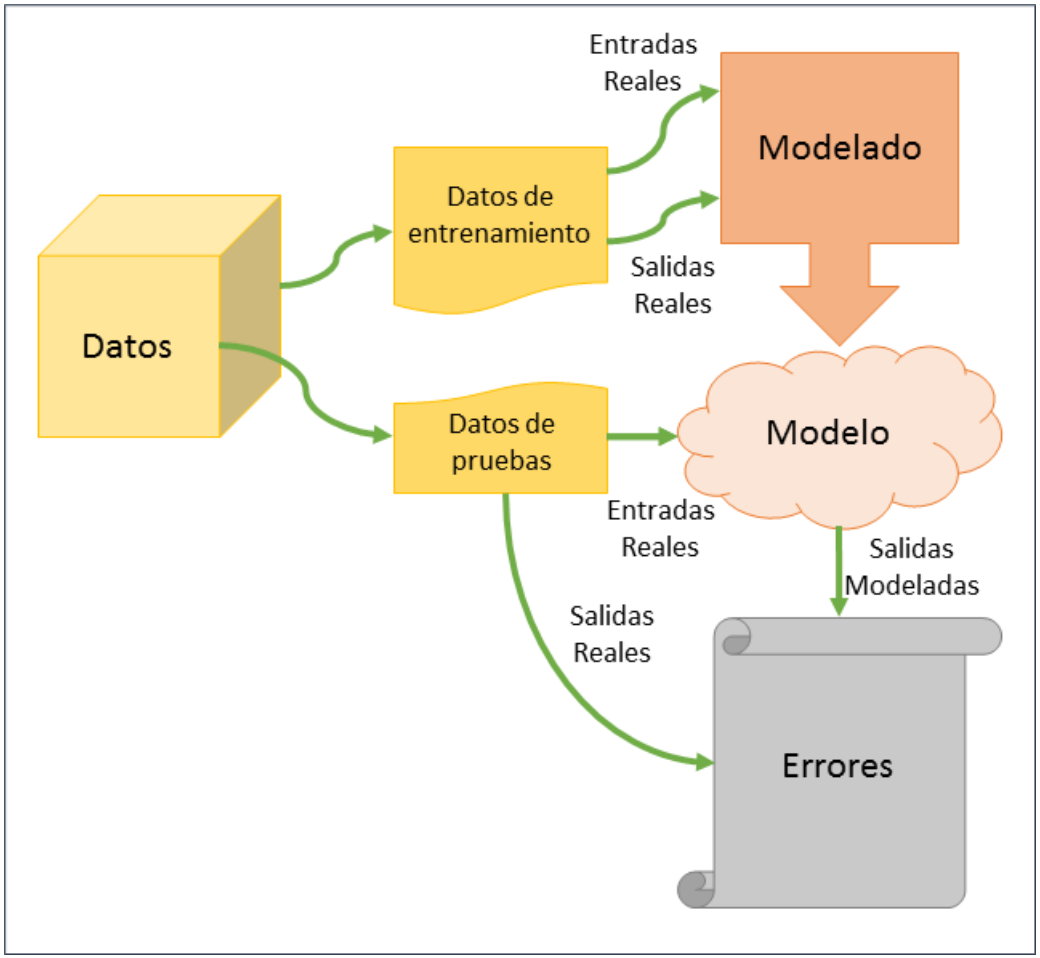
Regresión – Regresión polinomial

$$\theta = (X^T \cdot X)^{-1} \cdot X^T \cdot y$$

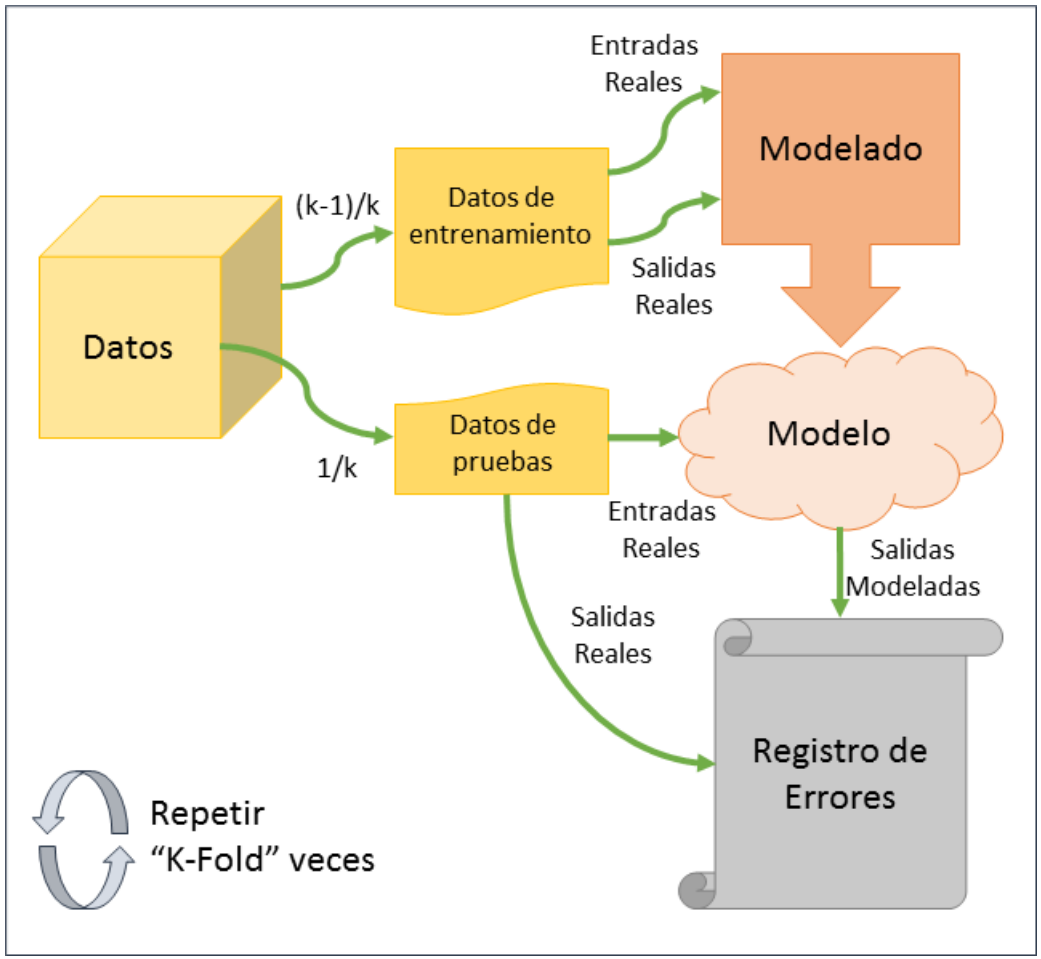


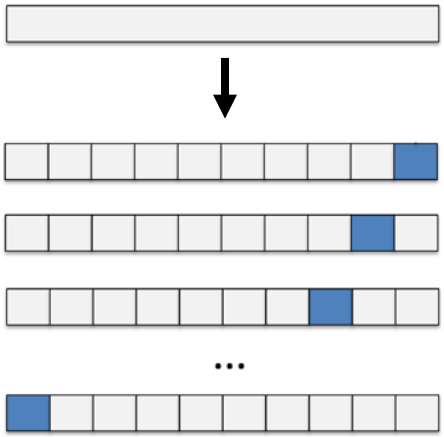
Validación

Validación – Hold Out



Validación – Cross Validation





Elección del modelo de regresión

Elección del modelo de regresión

- Validación con Hold Out
  - Redes neuronales artificiales
    - Diferente número de neuronas en la capa oculta
  - Máquinas de vectores soporte
  - Regresión polinomial
    - Diferentes grados del polinomio
- Error de cada modelo

Elección del modelo de regresión

- Validación con Cross Validation
  - Redes Neuronales Artificiales
    - K - Diferente número de neuronas en la capa oculta
  - K - Máquinas de soporte vectorial
  - Regresión polinomial
    - K - Diferentes grados del polinomio
- Error de cada modelo

Elección del modelo de regresión

- Validación
- Error de cada modelo
- Mejor modelo
- Entrenamiento del modelo con todos los datos

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- Propuesta de modelado híbrido
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Aplicaciones

- Hybrid intelligent system to perform fault detection on BIS sensor during surgeries
- Power cell SOC modelling for intelligent virtual sensor implementation
- Prediction of the energy demand of a hotel using an artificial intelligence-based model: Luxury hotel in Tenerife
- Fuel cell hybrid model for predicting hydrogen inflow through energy demand
- Hybrid intelligent system to predict the individual academic performance o engineering students

Hybrid intelligent system to perform fault detection on BIS sensor during surgeries

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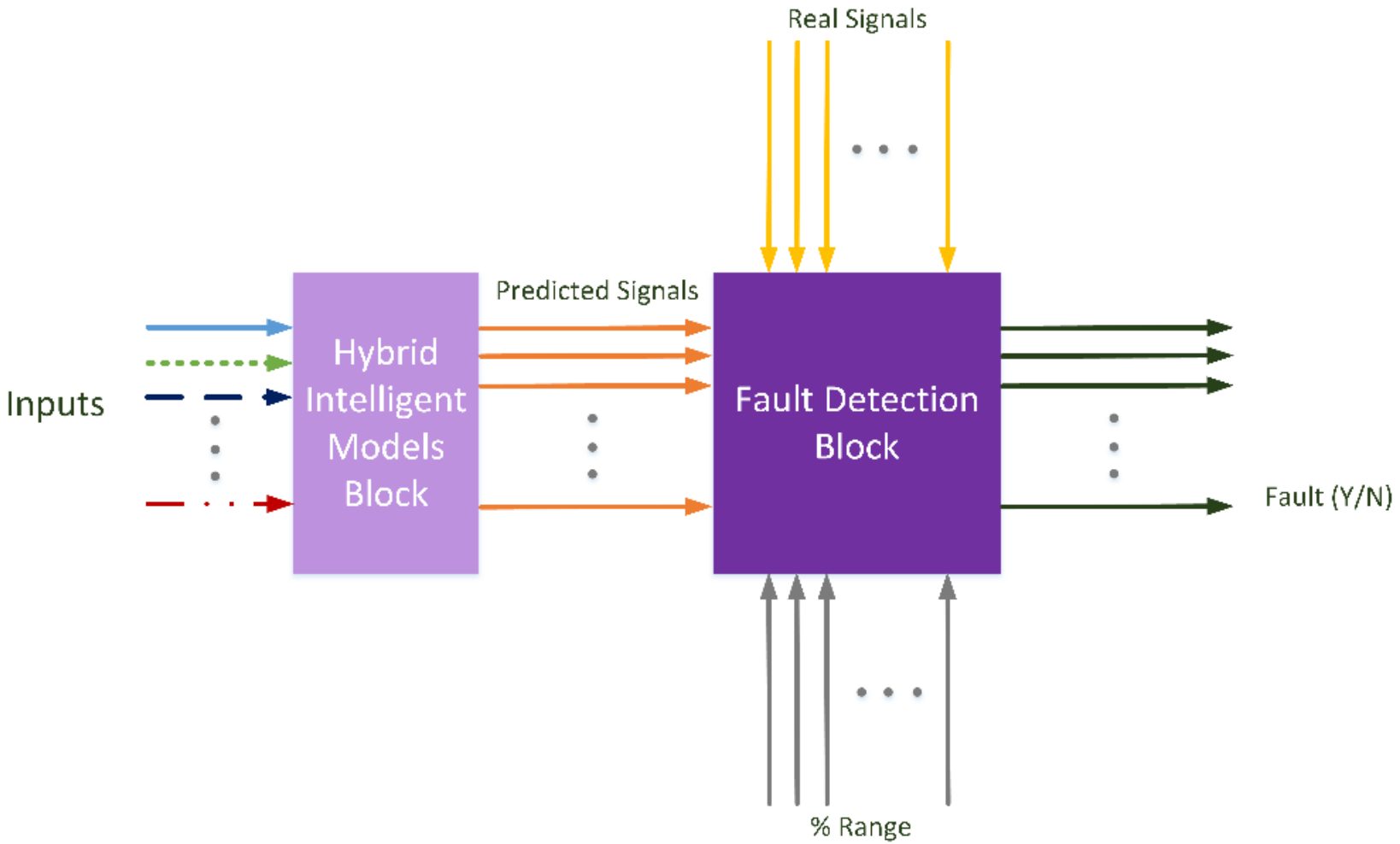
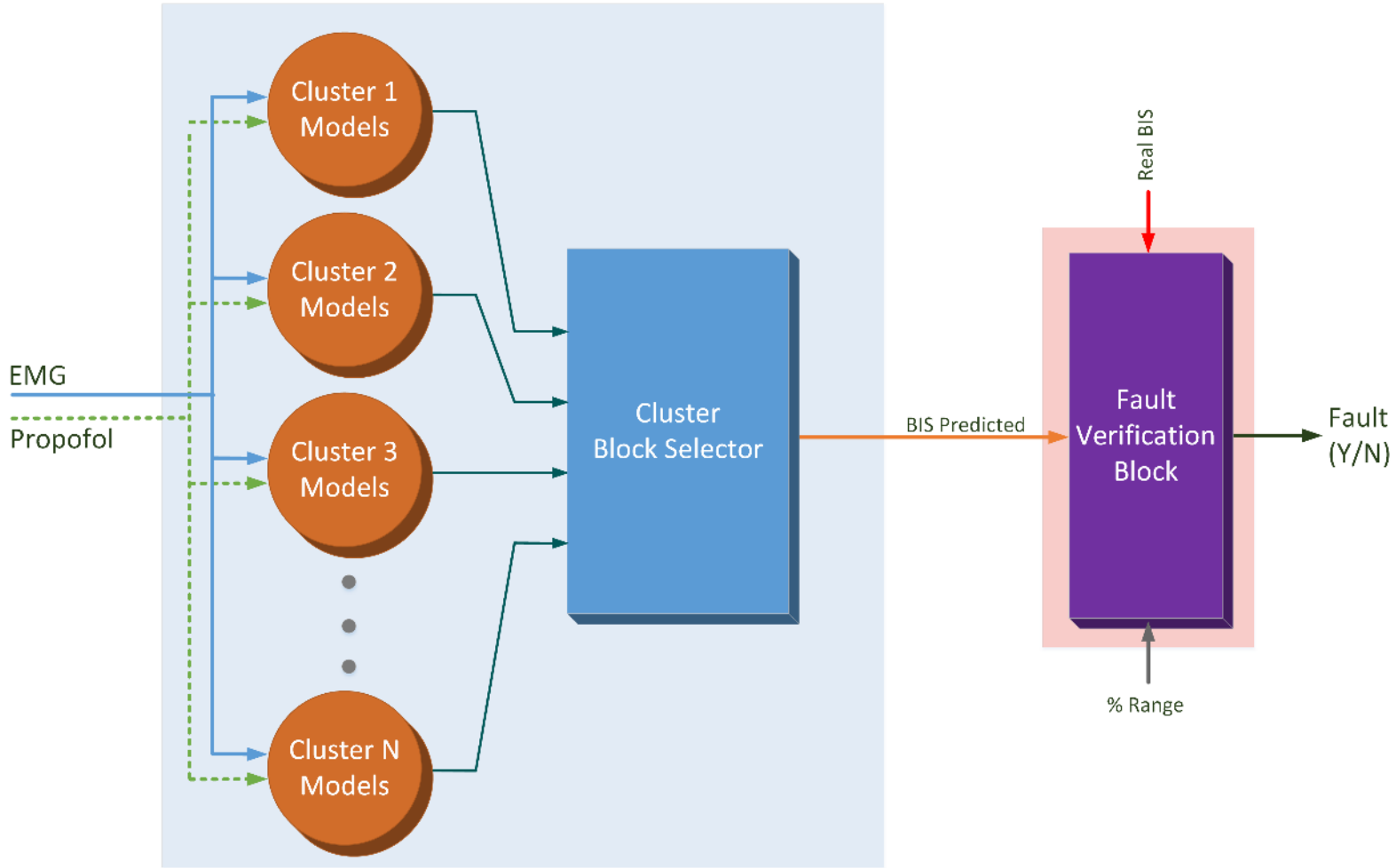


Hybrid intelligent system to perform fault detection on BIS sensor during surgeries



Hybrid intelligent system to perform fault detection on BIS sensor during surgeries

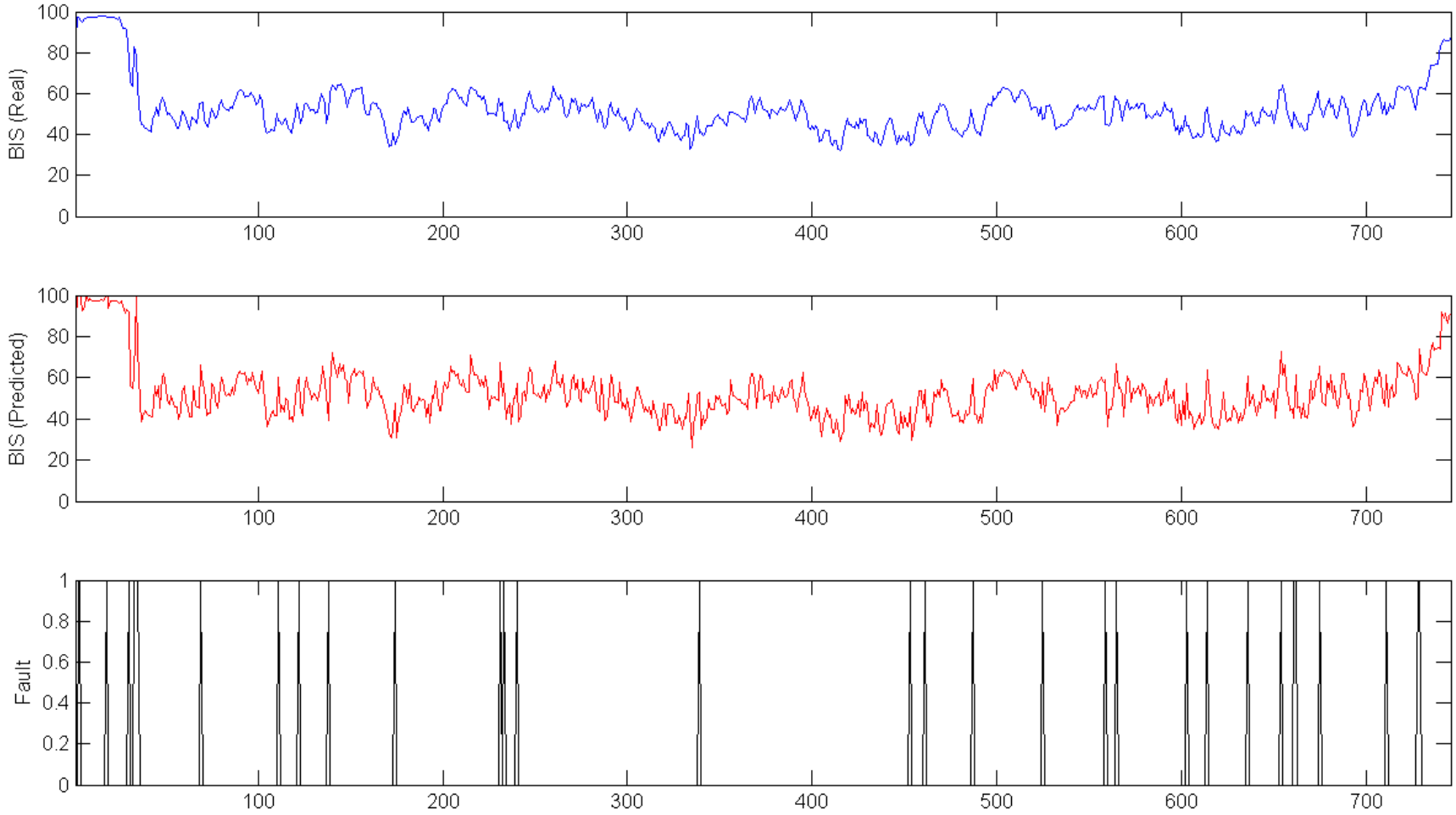
- 50 pacientes
- 42.788 muestras

	Grupo 1	Grupo 2
Global	100%	
Híbrido 2 grupos	0,8%	99,2%

	Grupo 1	Grupo 2
Global	0,8531	
Híbrido 2 grupos	$8{,}1 \cdot 10^{-4}$	0,4129

	Grupo 1	Grupo 2
Global	ANN-6	
Híbrido 2 grupos	ANN-2	ANN-9

Hybrid intelligent system to perform fault detection on BIS sensor during surgeries



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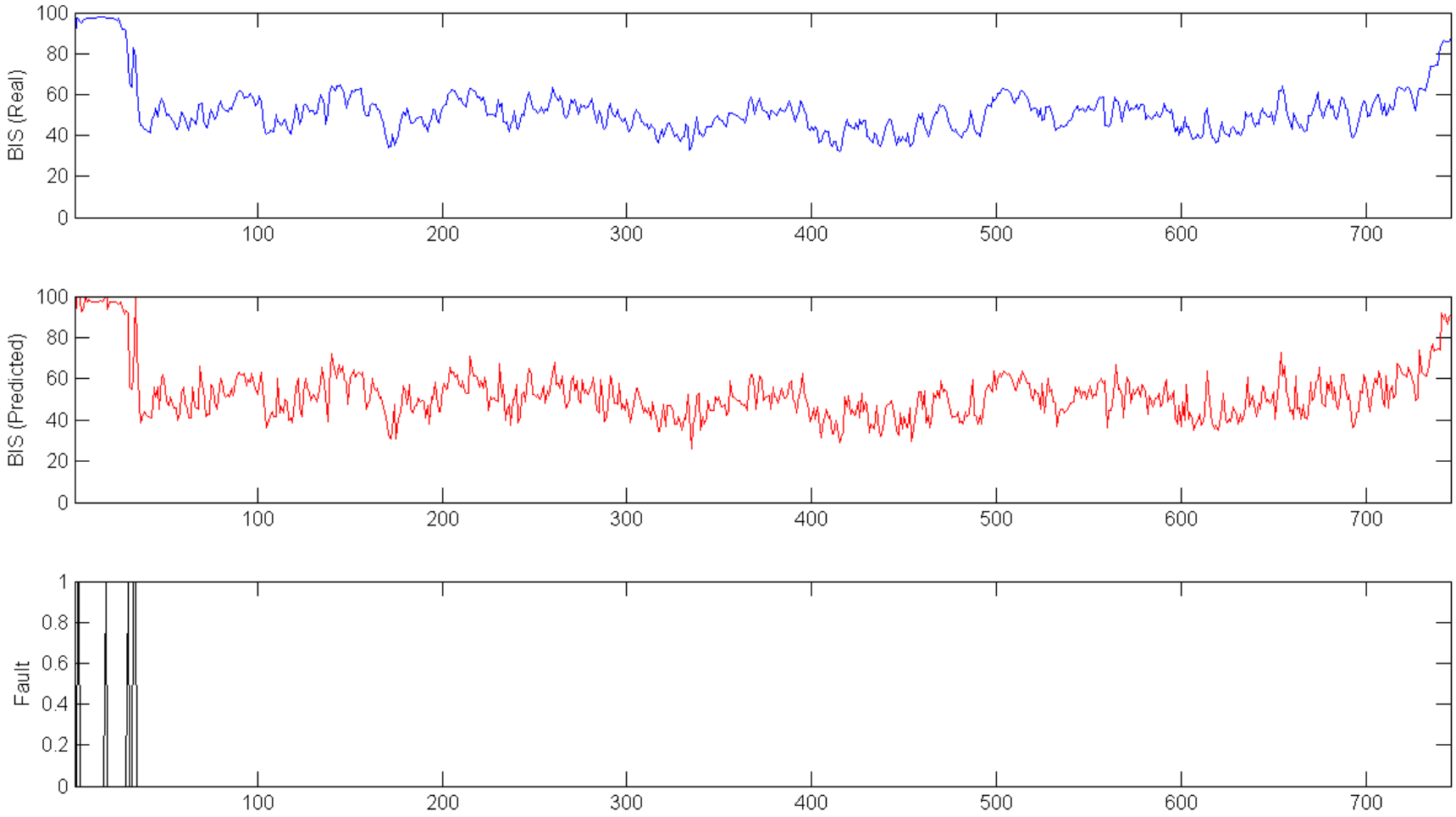

Power cell SOC modelling for intelligent virtual sensor implementation

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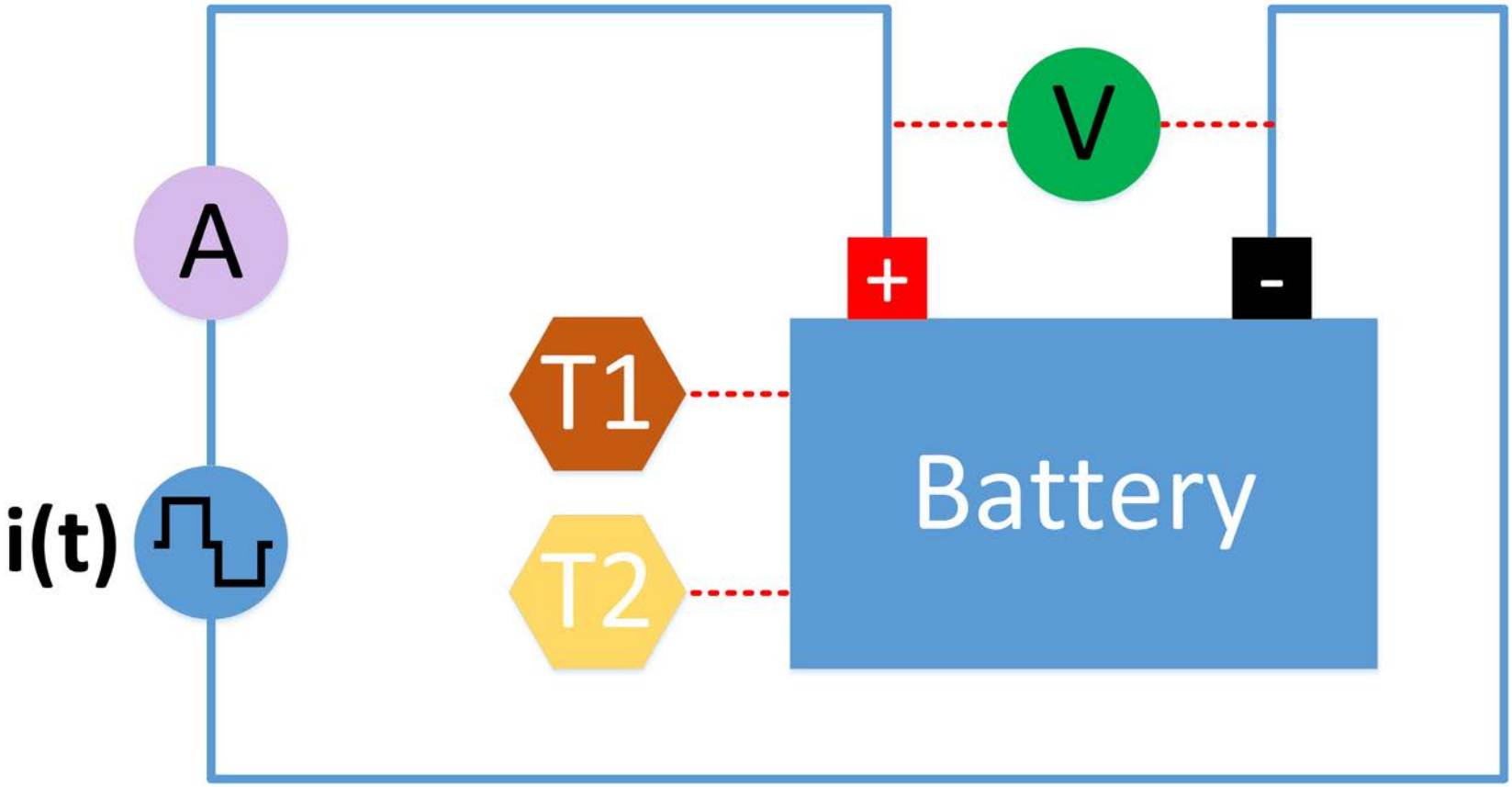

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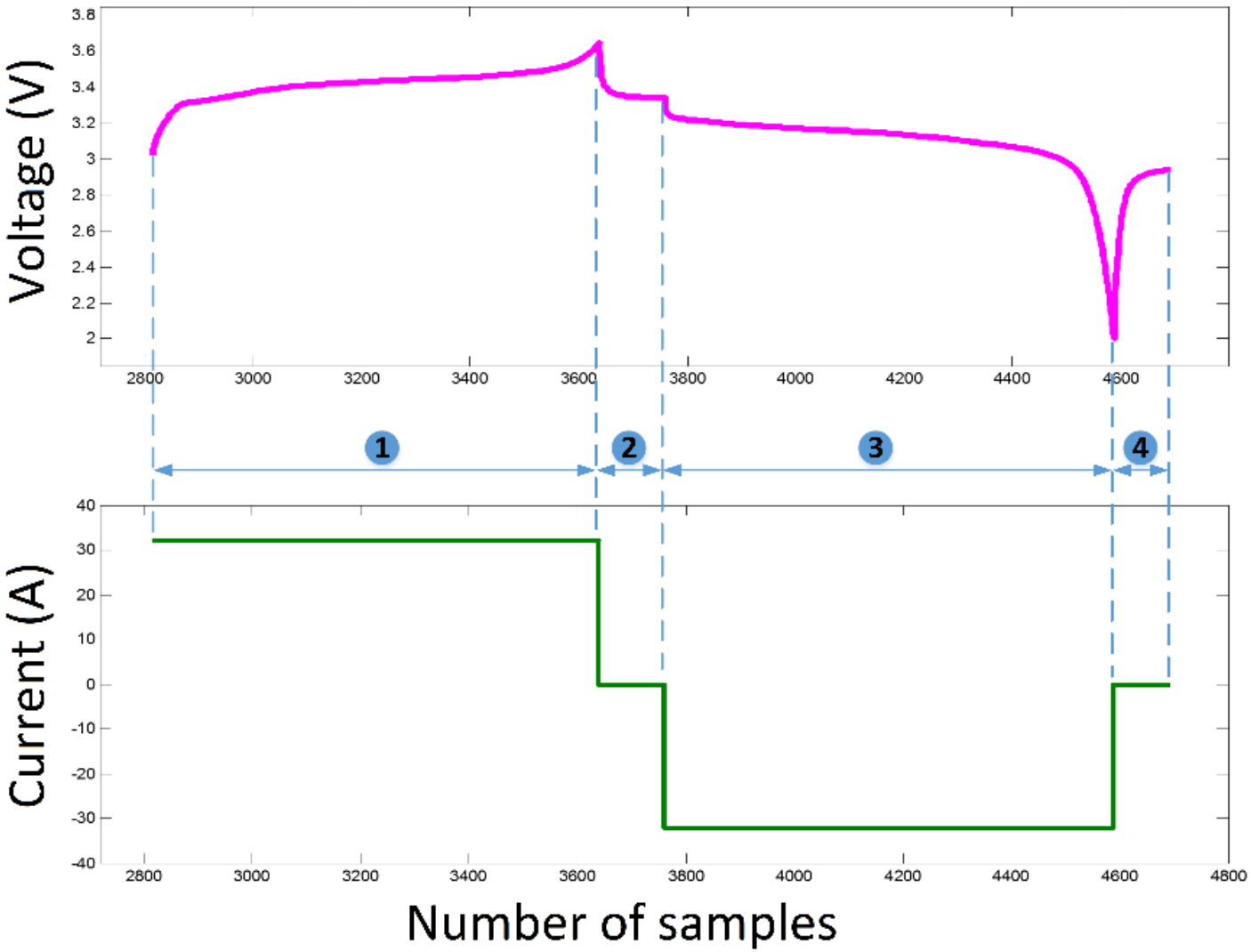

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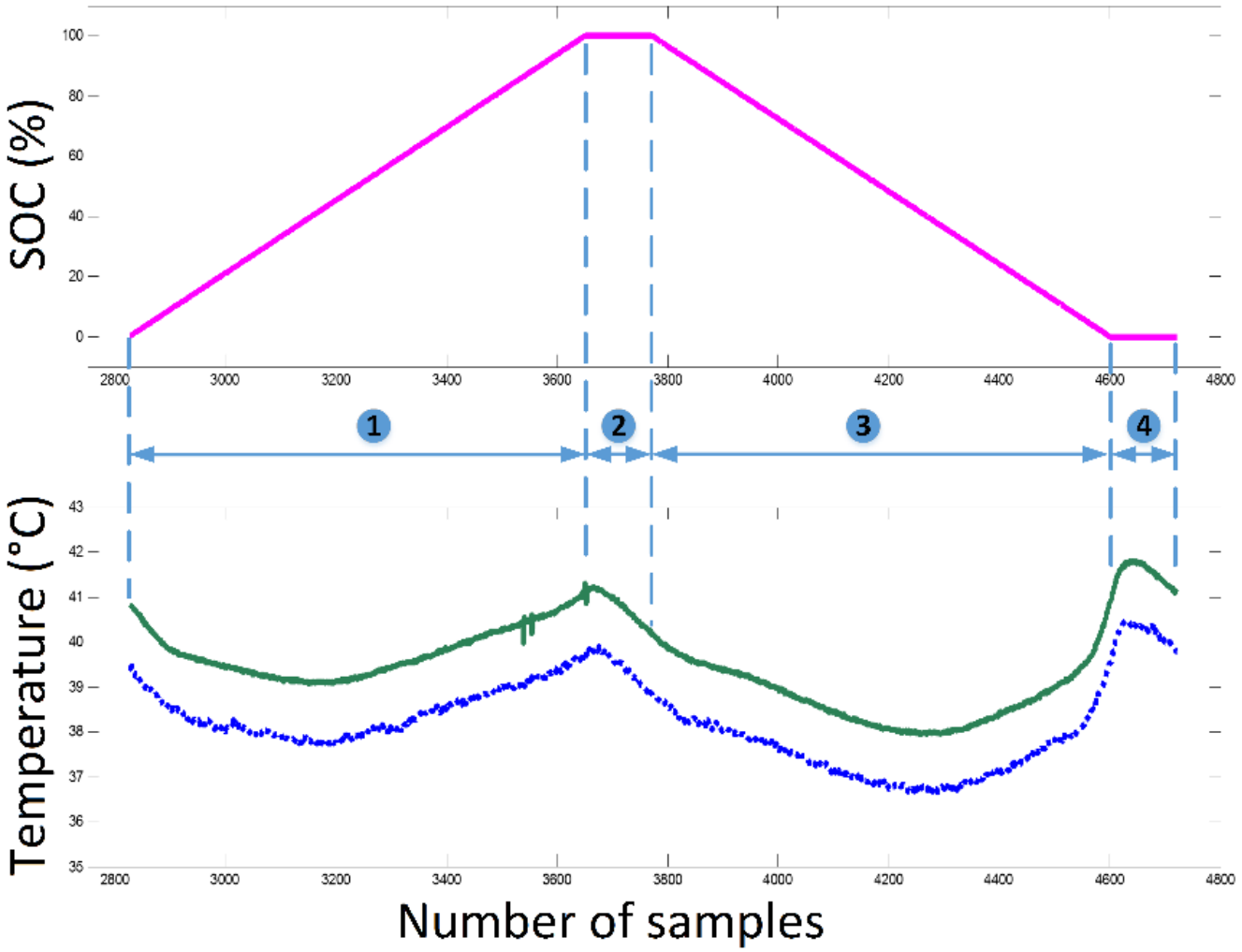

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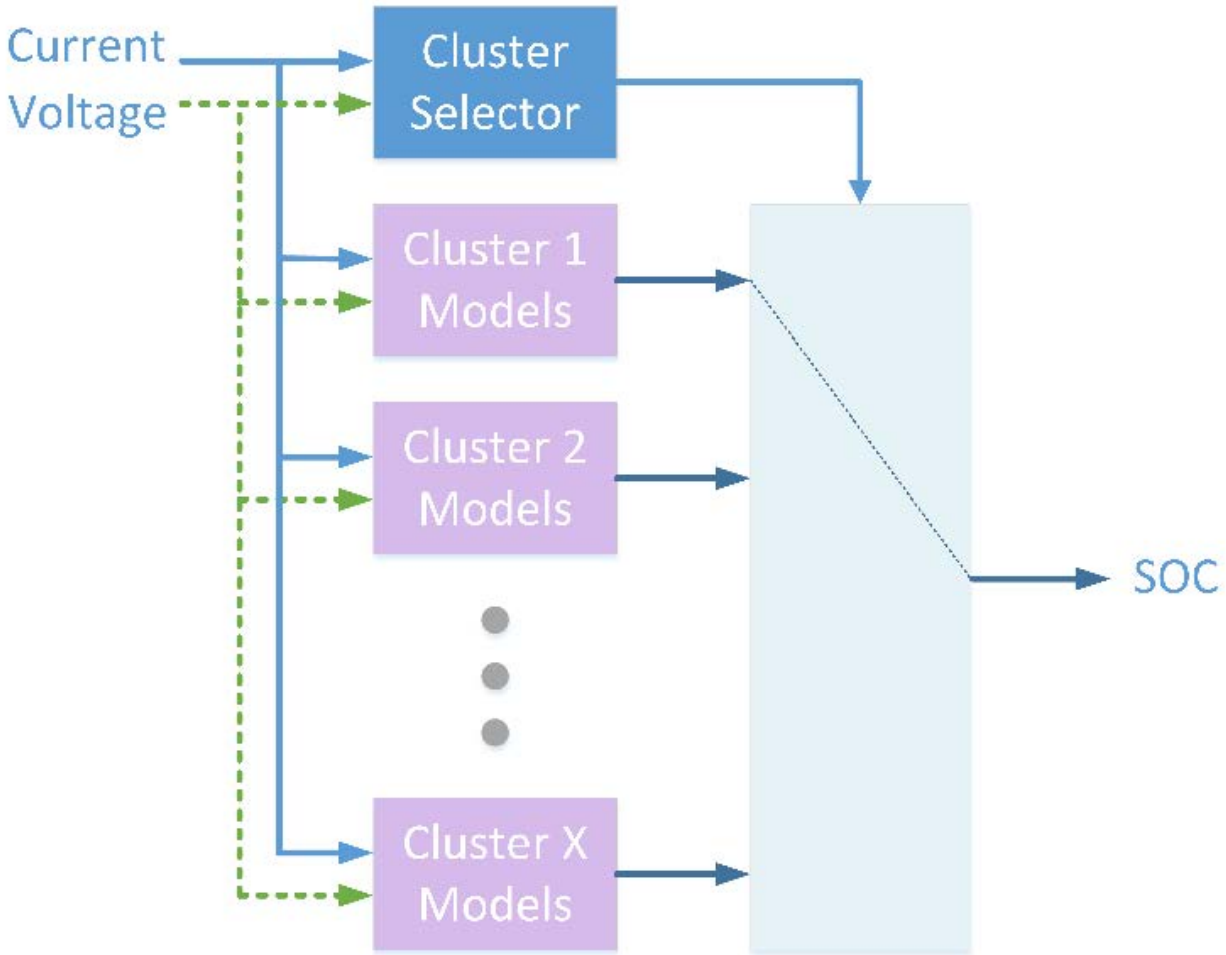

Power cell SOC modelling for intelligent virtual sensor implementation

	Carga	Reposo	Descarga	Reposo
Muestras	6.619	1.089	7.451	1.211
ANN	**0,1094**	0,0921	**0,4767**	0,0917
Poly	23,997	0,0904	17,814	0,0930
LS-SVR	0,1392	**0,0902**	0,5052	**0,0865**
	ANN-10	LS-SVR	ANN-8	LS-SVR

Prediction of the energy demand of a hotel using an artificial intelligence-based model: Luxury hotel in Tenerife

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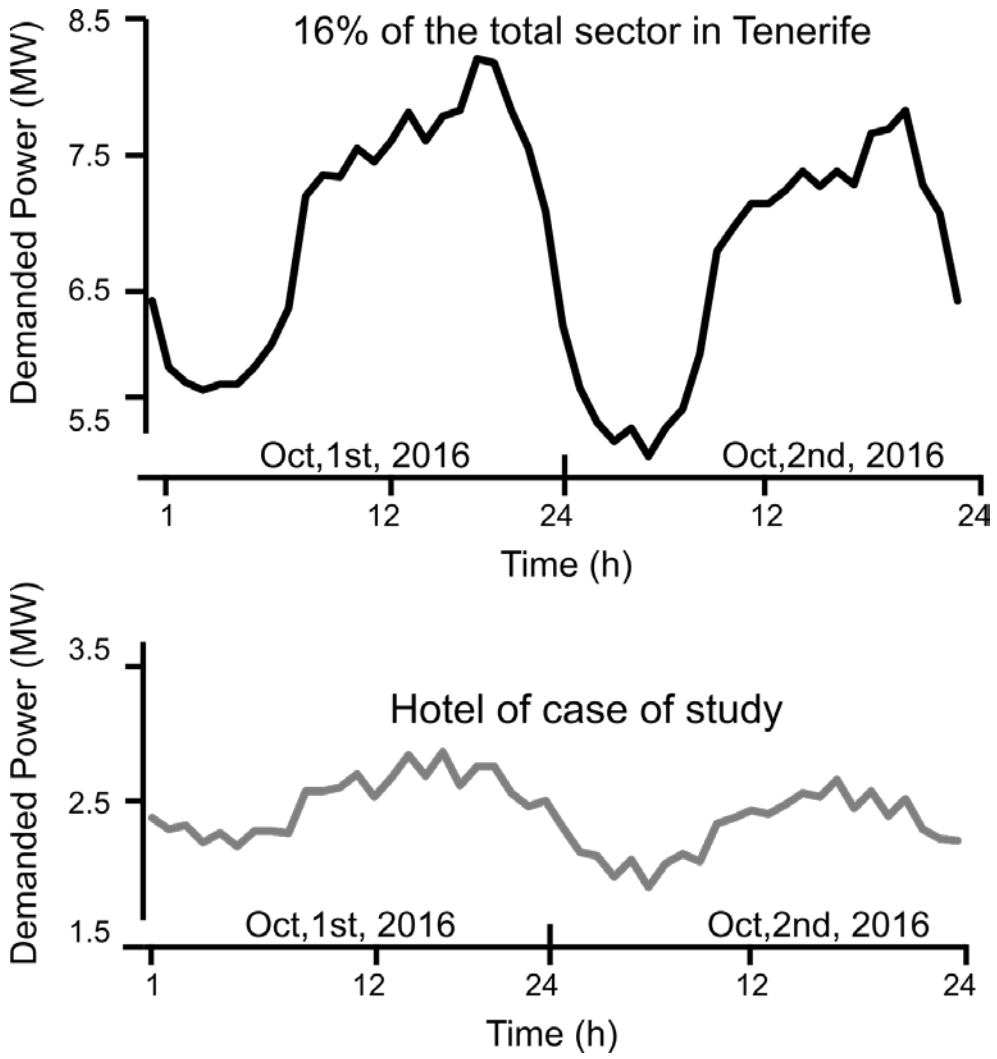

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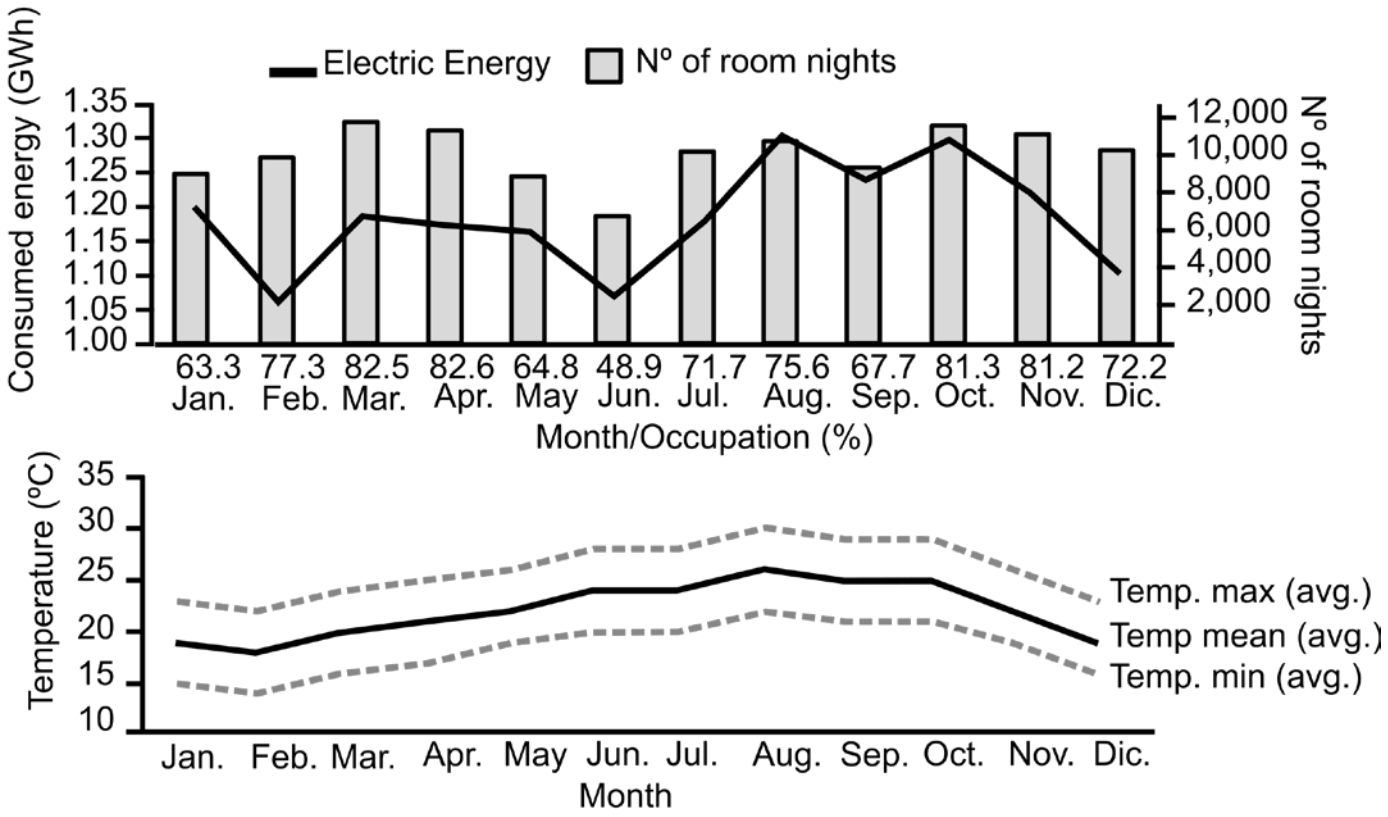

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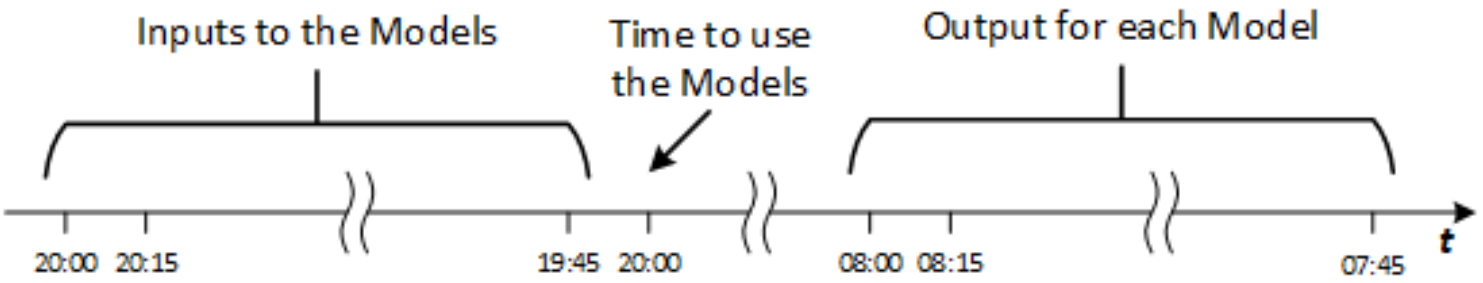

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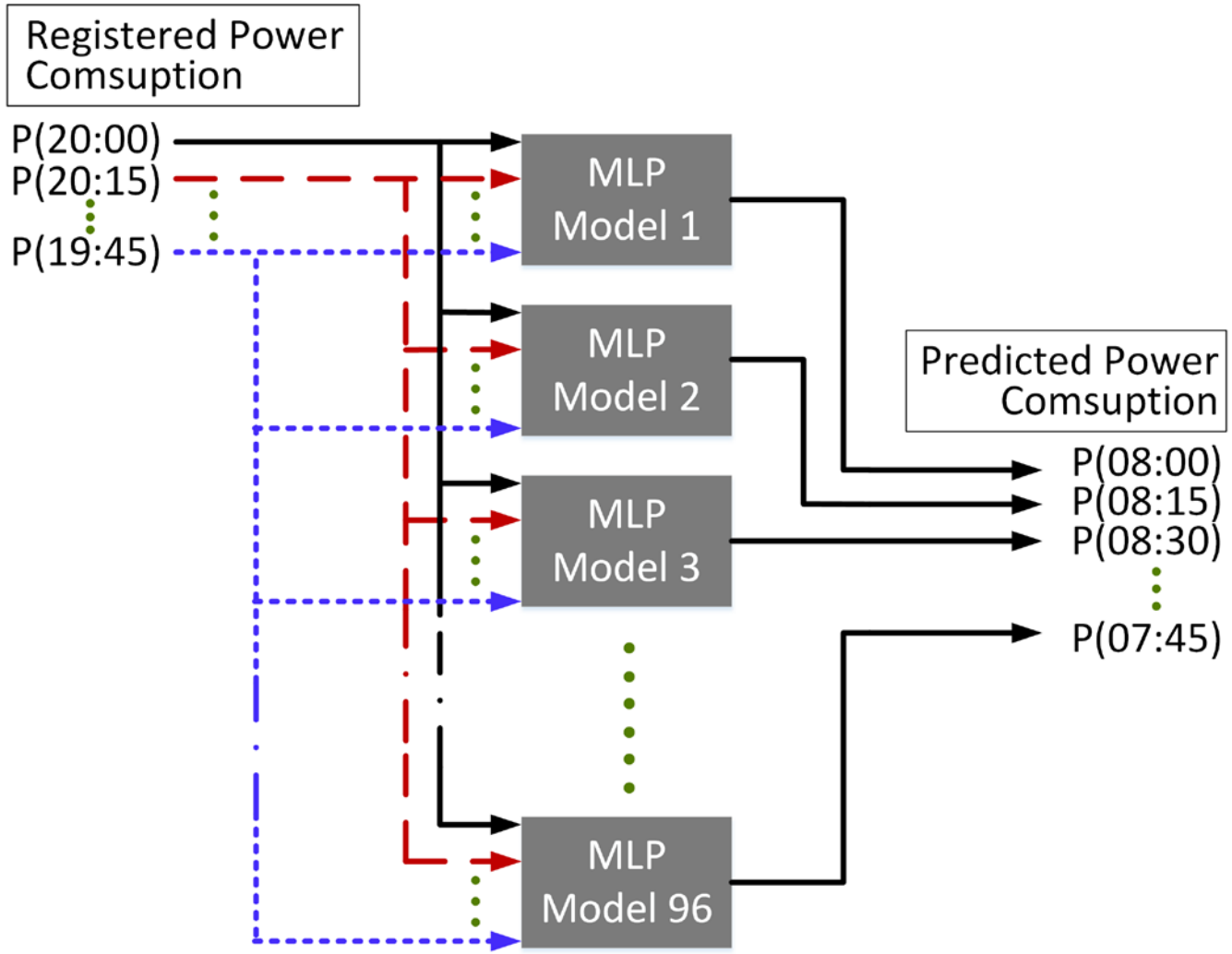
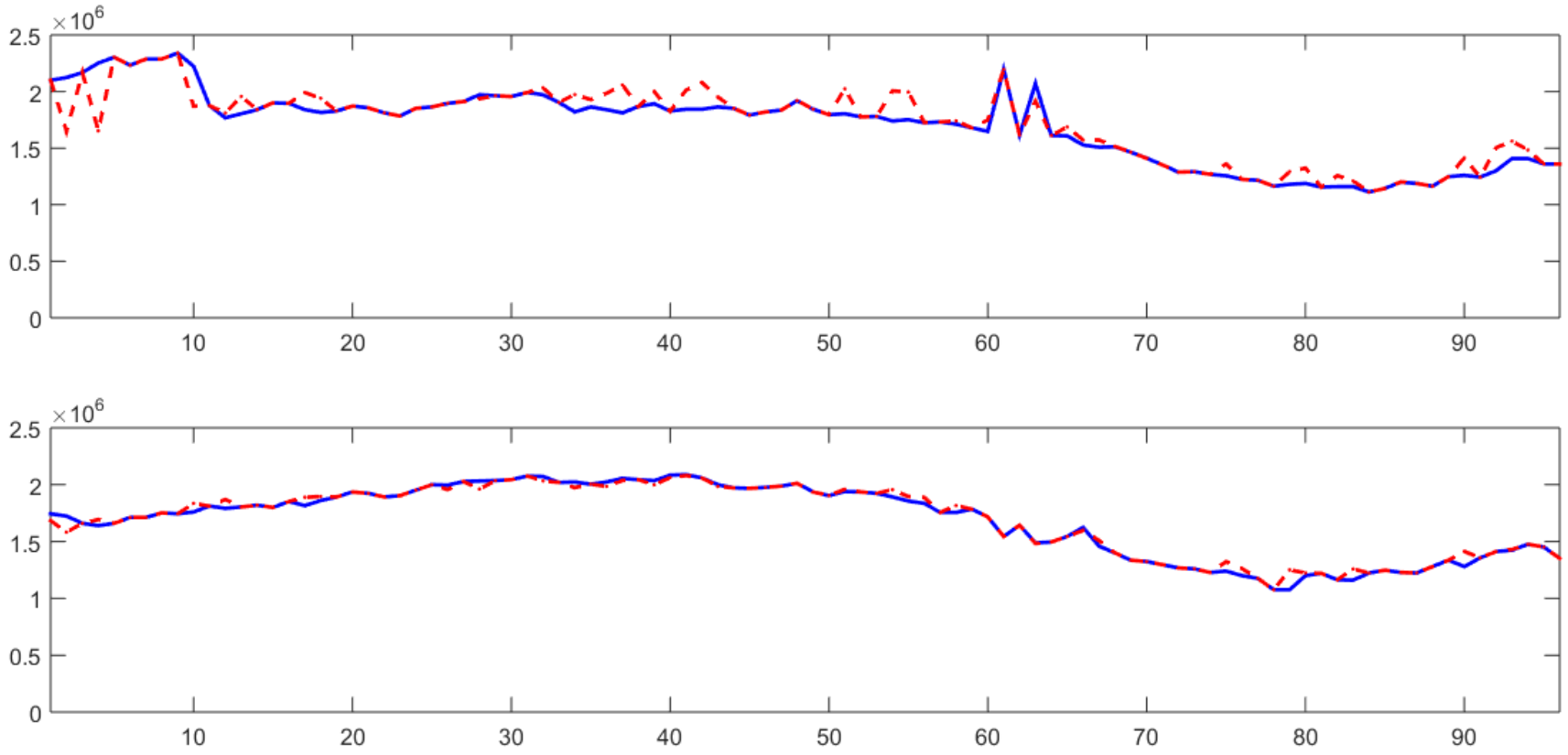


Prediction of the energy demand of a hotel using an artificial intelligence-based model: Luxury hotel in Tenerife

	MAE	MSE	Max.
Day 1	5.7391e+4	1.4214e+10	5.9734e+5
Day 2	2.3342e+4	2.7553e+9	2.1512e+5
Day 3	2.3618e+4	2.9911e+9	2.2468e+5
Day 4	1.9649e+4	2.0681e+9	2.0361e+5
Day 5	1.0874e+4	7.9320e+9	1.6466e+5
Day 6	1.8274e+4	1.5006e+9	1.7438e+5
Day 7	3.9412e+4	5.6905e+9	2.2109e+5
Day 8	1.7507e+4	1.4570e+9	1.5210e+5
Mean	2.6258e+4	3.9337e+9	2.4412e+5

Prediction of the energy demand of a hotel using an artificial intelligence-based model: Luxury hotel in Tenerife



Fuel cell hybrid model for predicting hydrogen inflow through energy demand

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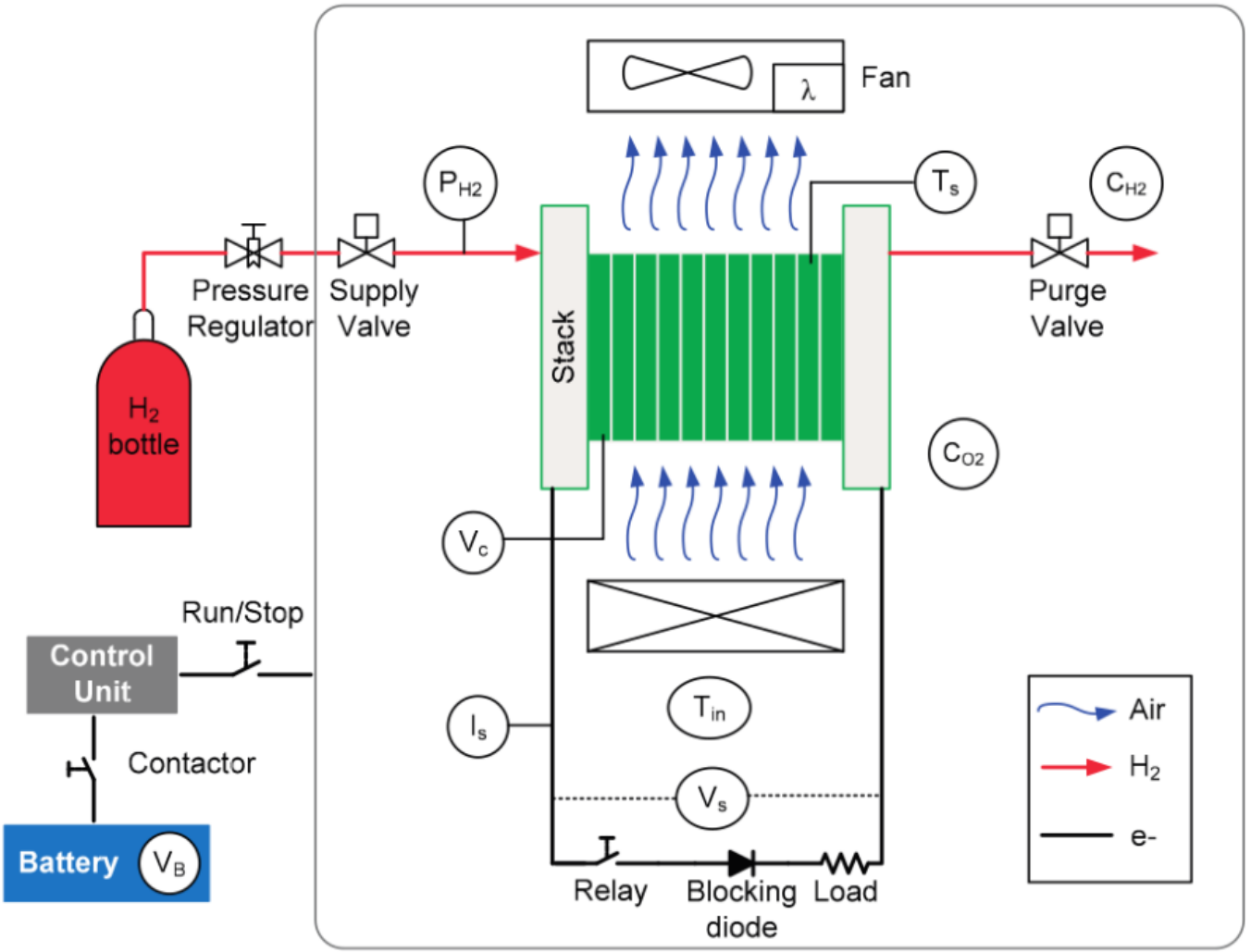

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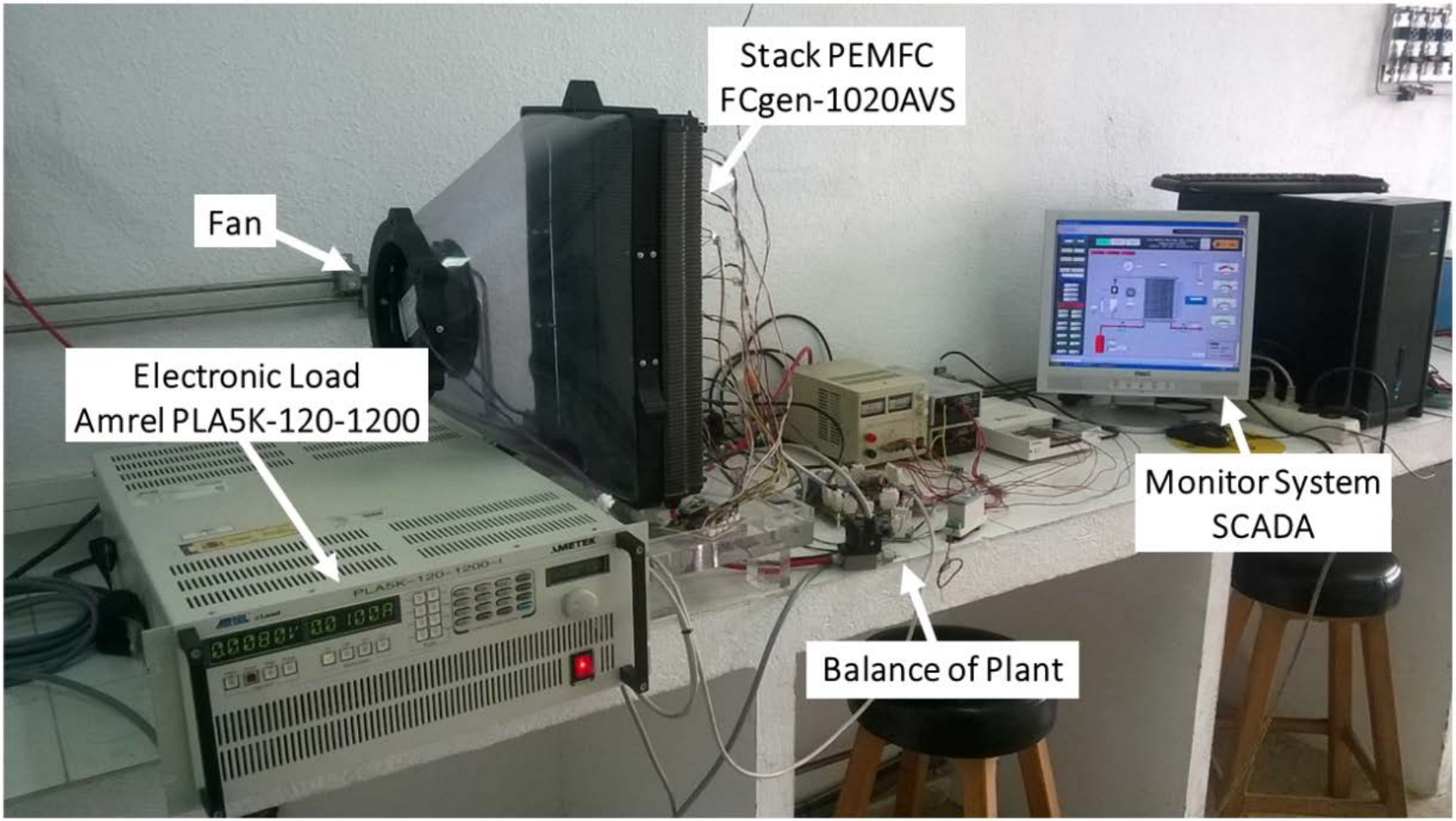

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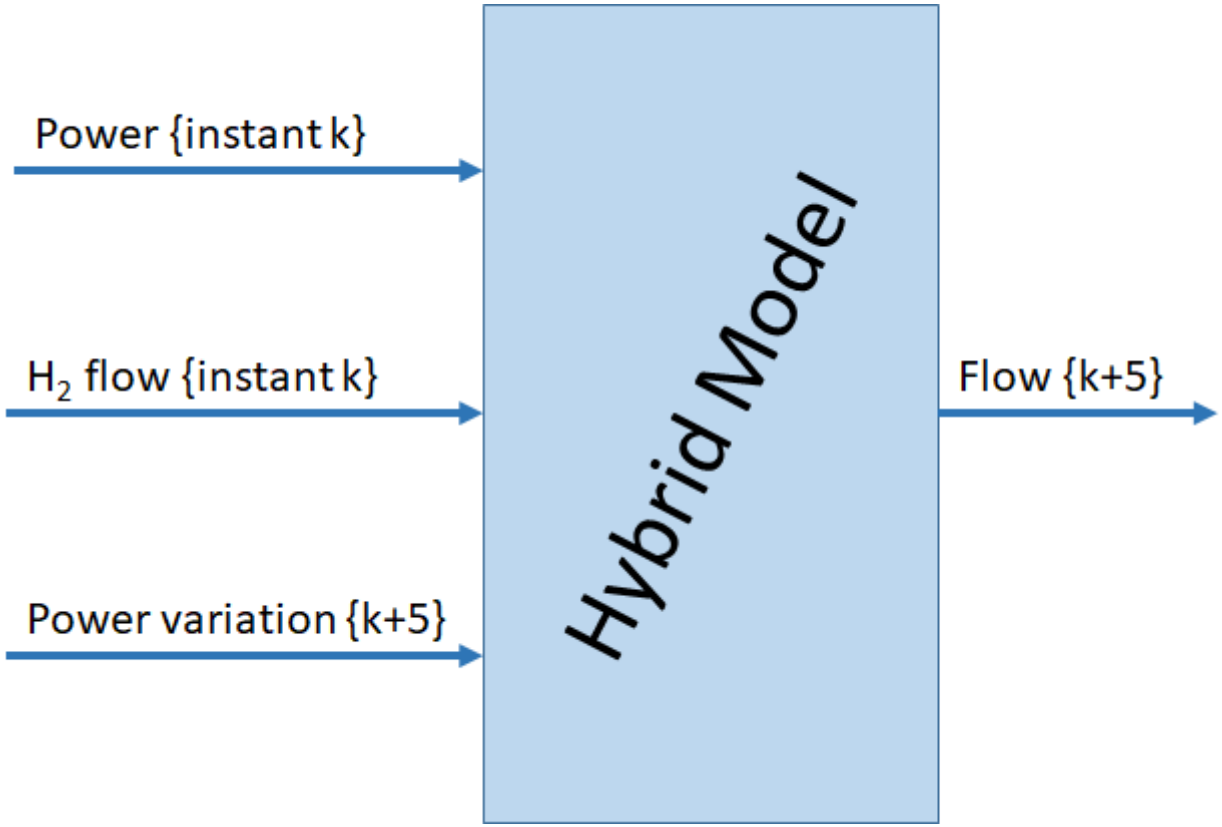


Fuel cell hybrid model for predicting hydrogen inflow through energy demand

	Cl-1	Cl-2	Cl-3	Cl-4	Cl-5	Cl-6	Cl-7	Cl-8	Cl-9	Cl-10
Global	0.0123									
Hybrid 2	0.0108	0.0149								
Hybrid 3	0.0111	0.0130	0.0091							
Hybrid 4	0.0089	0.0073	0.0114	0.0122						
Hybrid 5	0.0269	0.0120	0.0054	0.0068	0.0124					
Hybrid 6	0.0269	0.0149	0.0121	0.0053	0.0072	0.0095				
Hybrid 7	0.1104	0.0026	0.0138	0.0123	0.0053	0.0069	0.0095			
Hybrid 8	0.1104	0.0027	0.0069	0.0092	0.0140	0.0121	0.0053	0,0071		
Hybrid 9	0.1104	0.0029	0.0199	0.0049	0.0069	0.0092	0.0108	0.0054	0.0069	
Hybrid 10	0.1104	0.0069	0.0027	0.0162	0.0040	0.0068	0.0094	0.0068	0.0122	0.0054

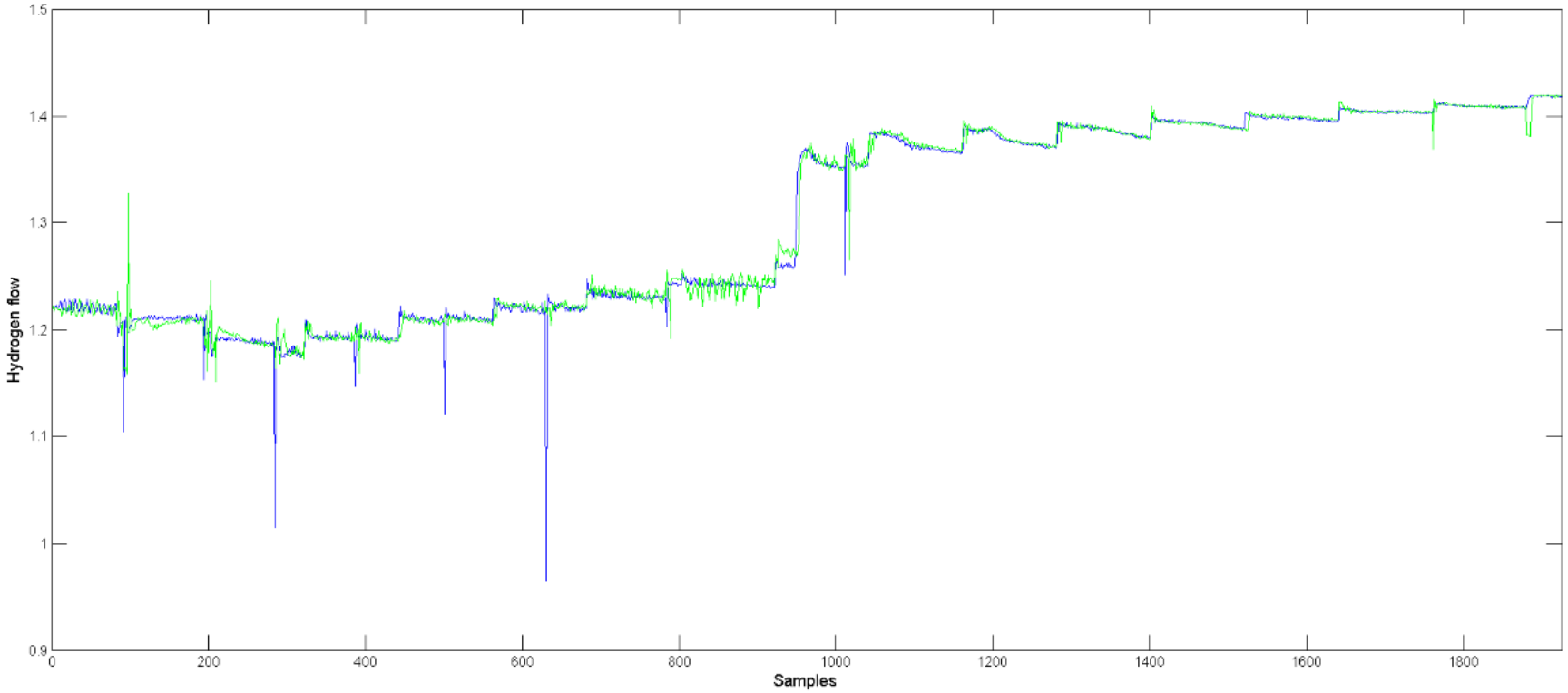
	Cl-1	Cl-2	Cl-3	Cl-4	Cl-5	Cl-6	Cl-7	Cl-8	Cl-9	Cl-10
Global	ANN12									
Hybrid 2	ANN14	Poly1								
Hybrid 3	ANN14	ANN12	ANN13							
Hybrid 4	ANN11	ANN11	Poly1	ANN11						
Hybrid 5	Poly1	Poly2	Poly1	ANN12	ANN11					
Hybrid 6	Poly2	ANN13	Poly2	Poly1	ANN14	ANN13				
Hybrid 7	Poly1	ANN11	ANN13	Poly1	Poly1	ANN15	ANN11			
Hybrid 8	Poly1	ANN15	ANN13	ANN14	ANN11	Poly2	Poly1	ANN14		
Hybrid 9	Poly1	ANN13	ANN11	ANN15	ANN15	ANN15	ANN13	Poly1	ANN15	
Hybrid 10	Poly1	ANN15	ANN14	ANN11	ANN15	ANN13	ANN12	ANN14	Poly1	Poly1

Fuel cell hybrid model for predicting hydrogen inflow through energy demand

Global	Hybrid Model (Local Models)								
	2	3	4	5	6	7	8	9	10
0.1403	0.1405	0.1466	0.2567	0.6253	0.9691	0.3424	0.1204	0.2638	0.2015

Fuel cell hybrid model for predicting hydrogen inflow through energy demand

Global	Hybrid Model (Local Models)								
	2	3	4	5	6	7	8	9	10
0.1403	0.1405	0.1466	0.2567	0.6253	0.9691	0.3424	0.1204	0.2638	0.2015



Hybrid intelligent system to predict the individual academic performance o engineering students

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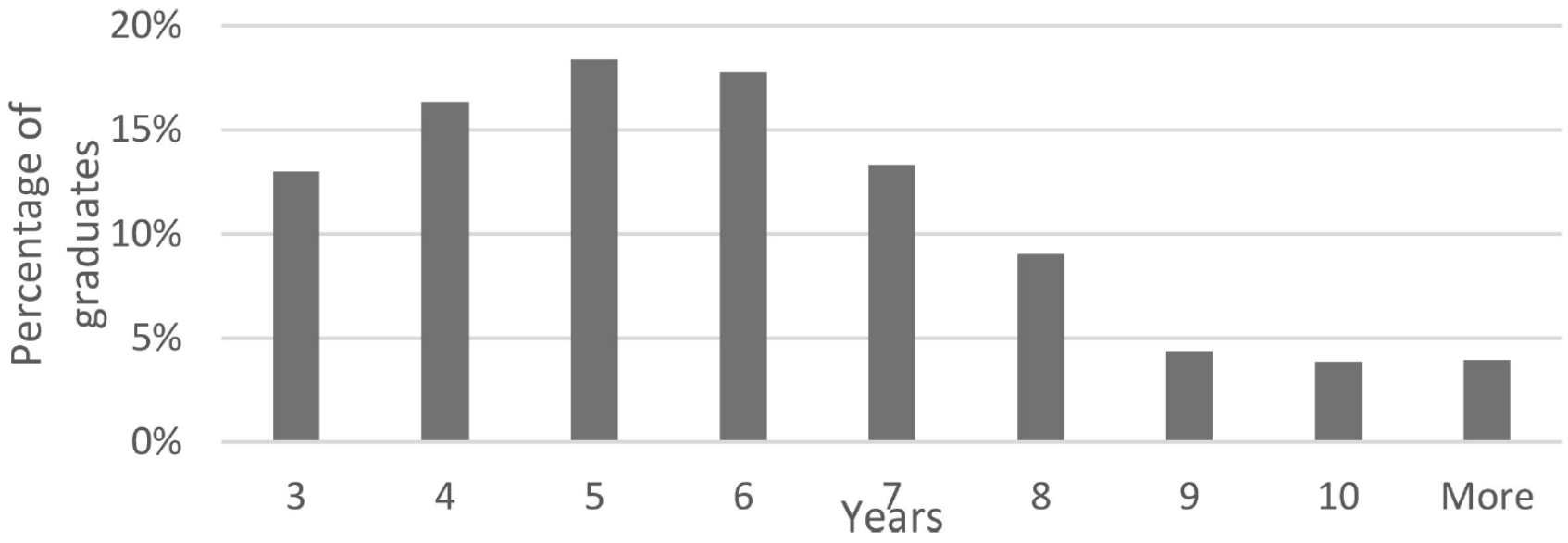

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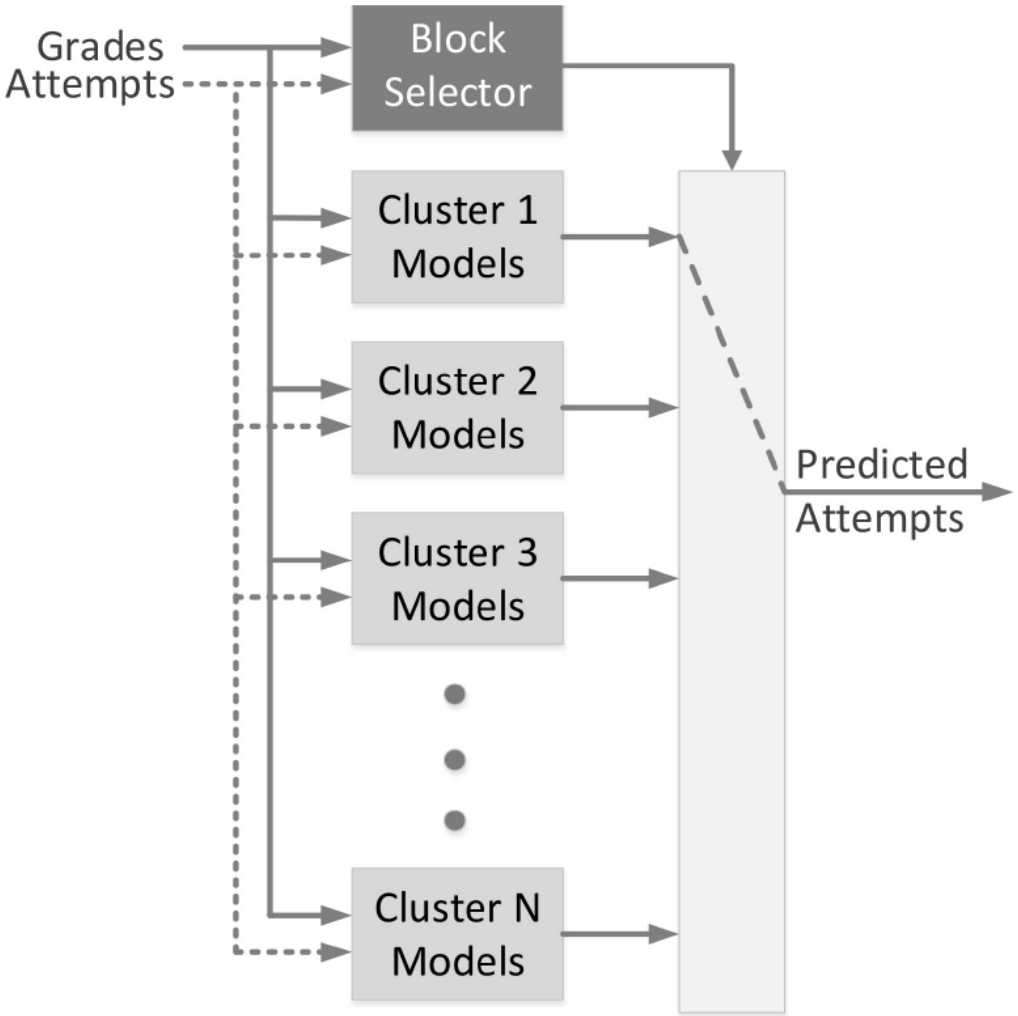
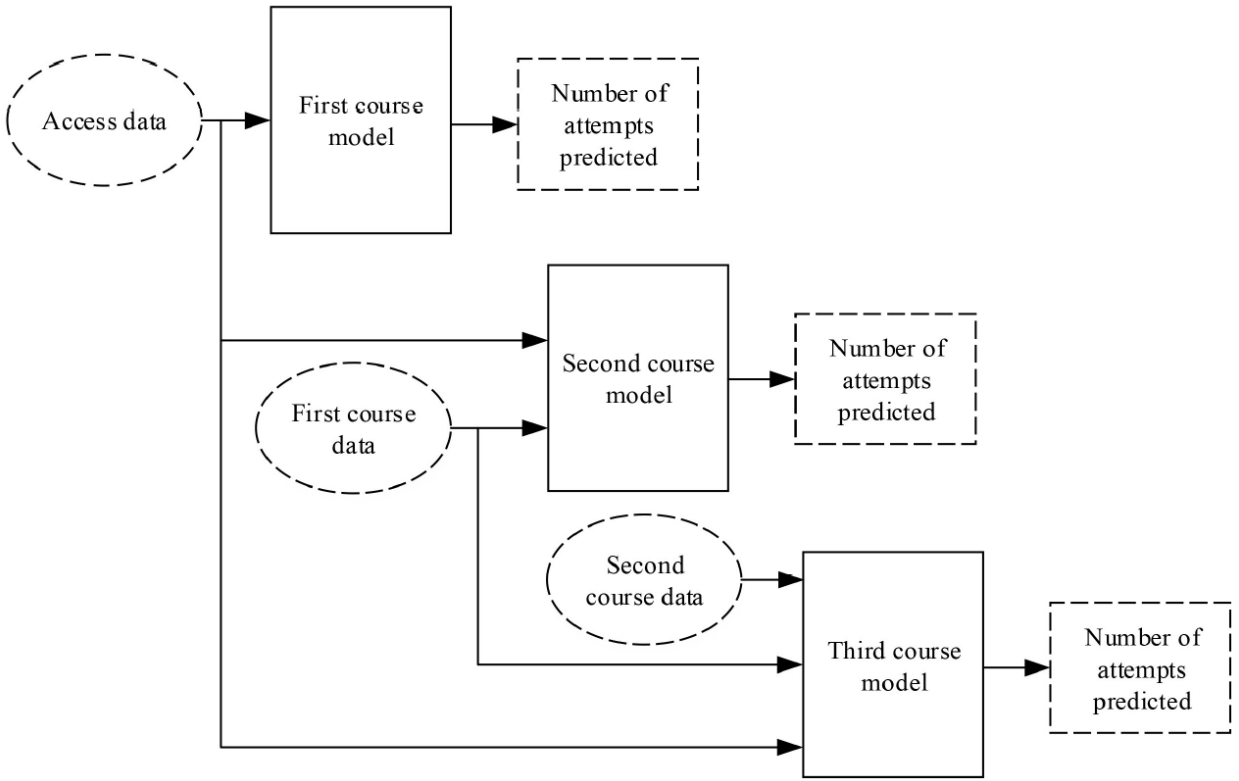


Hybrid intelligent system to predict the individual academic performance o engineering students

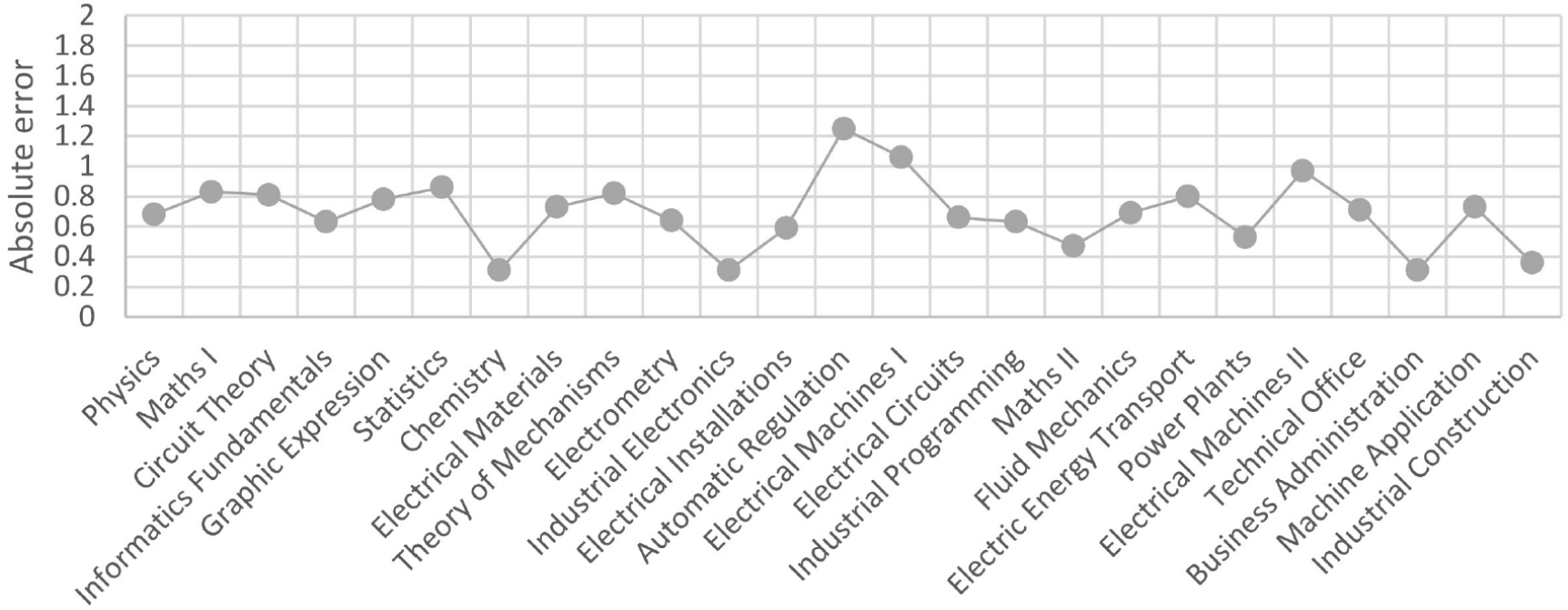
Academic Record							
			Subject 1			Subject *n*	
Student code	**Access method**	**Admission grade**	**Grade**	**Attempts**	. . .	**Grade**	**Attempts**
22002	H. school	7.5	8.5	1		6	2
32002	A. degree	7.0	5.0	3		8.0	1

Hybrid intelligent system to predict the individual academic performance o engineering students

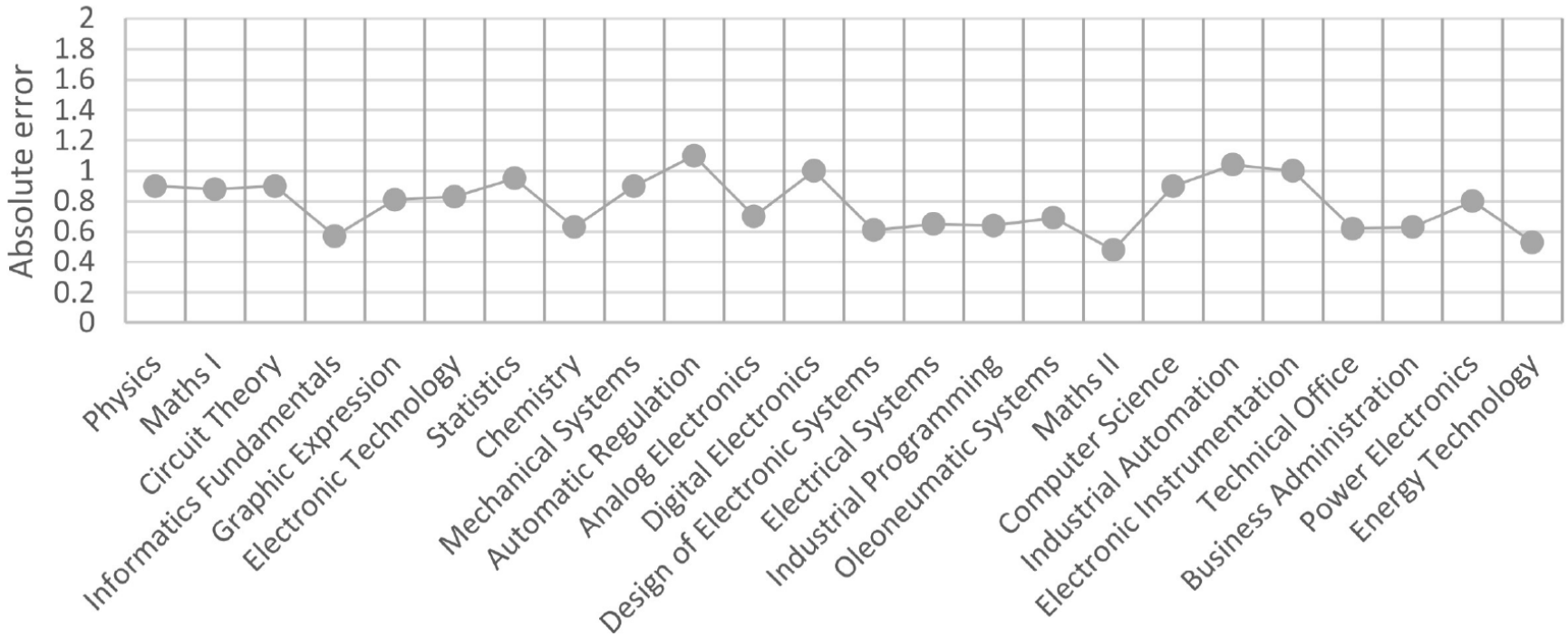
Academic Record							
			Subject 1			Subject *n*	
Student code	**Access method**	**Admission grade**	**Grade**	**Attempts**	. . .	**Grade**	**Attempts**
22002	H. school	7.5	8.5	1		6	2
32002	A. degree	7.0	5.0	3		8.0	1



Hybrid intelligent system to predict the individual academic performance o engineering students



Hybrid intelligent system to predict the individual academic performance o engineering students



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Turno de preguntas

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