

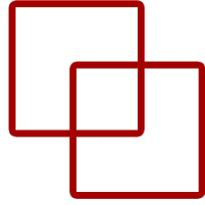
Presentación



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www.manuelcastillo.eu

Departamento de Inteligencia Artificial
Escuela Técnica Superior de Ingeniería Informática
Universidad Nacional de Educación a Distancia (UNED)

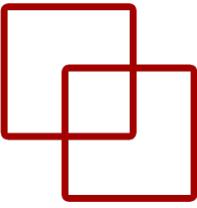
Preliminar



- Improving Deep Learning by Exploiting Synthetic Images © 2024 by Manuel Castillo-Cara is licensed under Attribution-NonCommercial 4.0 International



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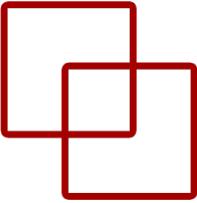
Curriculum Vitae

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Ingeniería
Informática

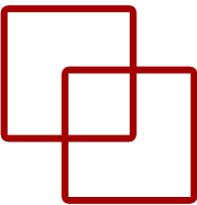


UNED

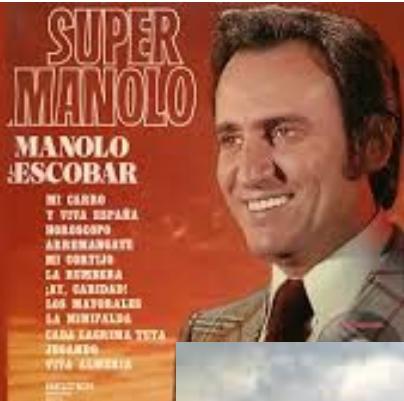
Almería



Almería



01. Pájaro Ciego
02. Madrecita M^a Del Carmen
03. Que Viva España
04. Tu Nombre Aníta
05. Mi Canción Es Para Ti
06. Mi Pequeña Flor
07. Que Bonita Es Mi Niña
08. Niña De Los Ojos Verdes
09. Mi Carruaje
10. Mientras Tú Me Vivirás
11. Ni Se Compra Ni Se Vende
12. Escribiente
13. Los Mayarales
14. Ay, Mi Sombra
15. Solo Te Pido
16. El Positivo No Se Equivoca
17. La Morena De Mi Copia
18. En Tierra Exótica
19. Valencia
20. Mi Canción Es Para Ti



Nicolás Salmerón fotografiado por Compañy,
publicado en la revista *Nuevo Mundo*
el 24 de septiembre de 1908.



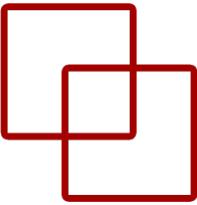
Presidente del Poder Ejecutivo de la
República Española

18 de julio de 1873-7 de septiembre de 1873

Predecesor Francisco Pi y Margall

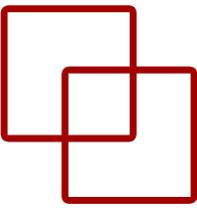
Sucesor Emilio Castelar

Doctorado - UCLM Albacete



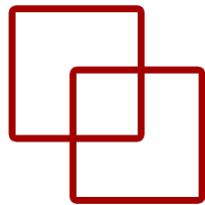
Imágenes tomadas de diferentes sitios de internet para una finalidad interna y no pública

UNI

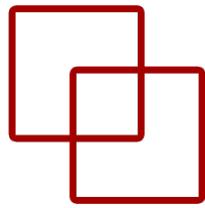


Imágenes tomadas de diferentes sitios de internet para una finalidad interna y no pública

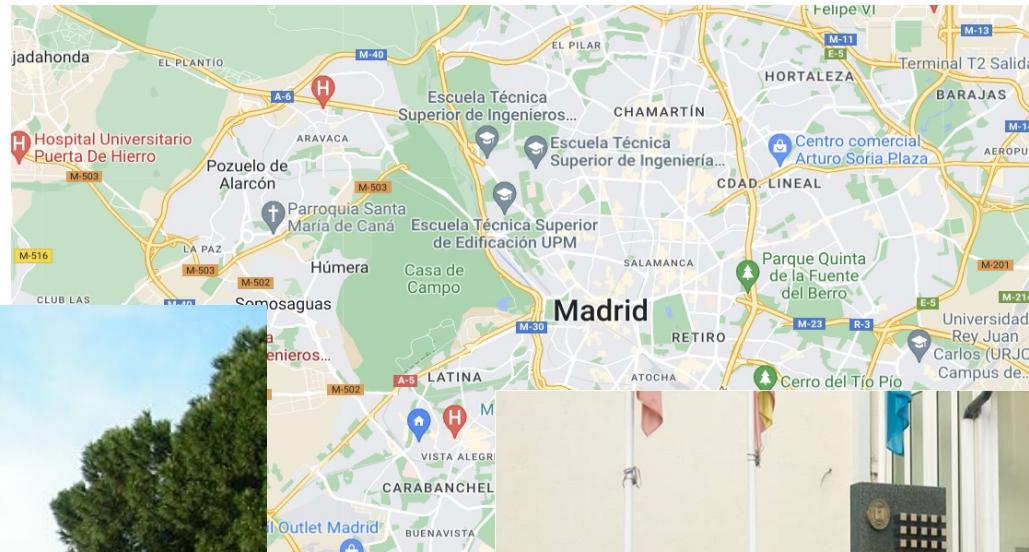
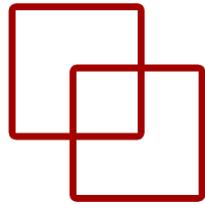
IUT-SCi



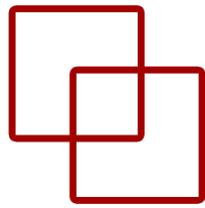
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OEG - UPM



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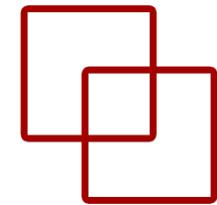


Estudiar en
la UNED

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UNED

UNED - México



- Universidad pública con representación internacional.
 - Tasas muy bajas con una exigencia alta.
 - Títulos europeos oficiales
- En México, hay centro [UNED](#). [Ubicación](#).
- Posibilidad de estudiar pregrado y posgrado:
 - [Máster de Inteligencia Artificial](#)
 - [Otros másteres de informática](#)



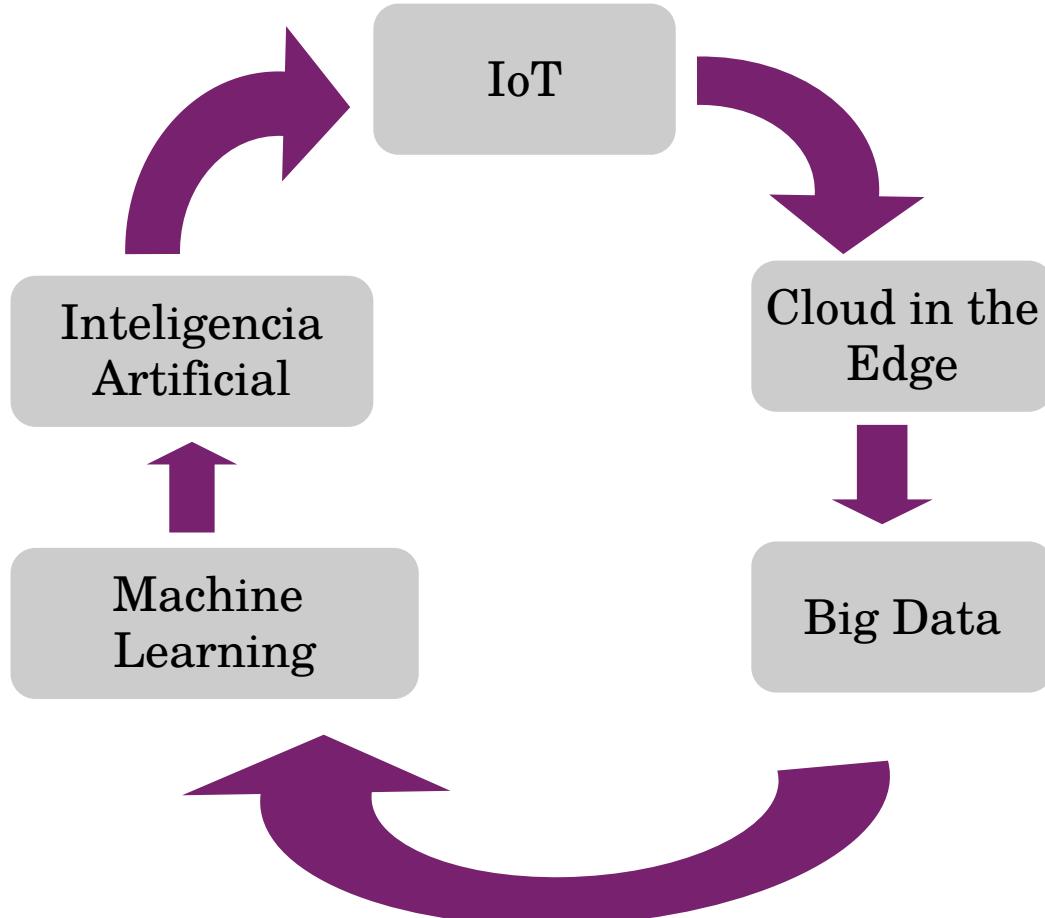
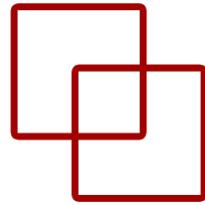
Líneas de investigación

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ICBM-AI



Investigación, desarrollo
e innovación
(I+D+i)

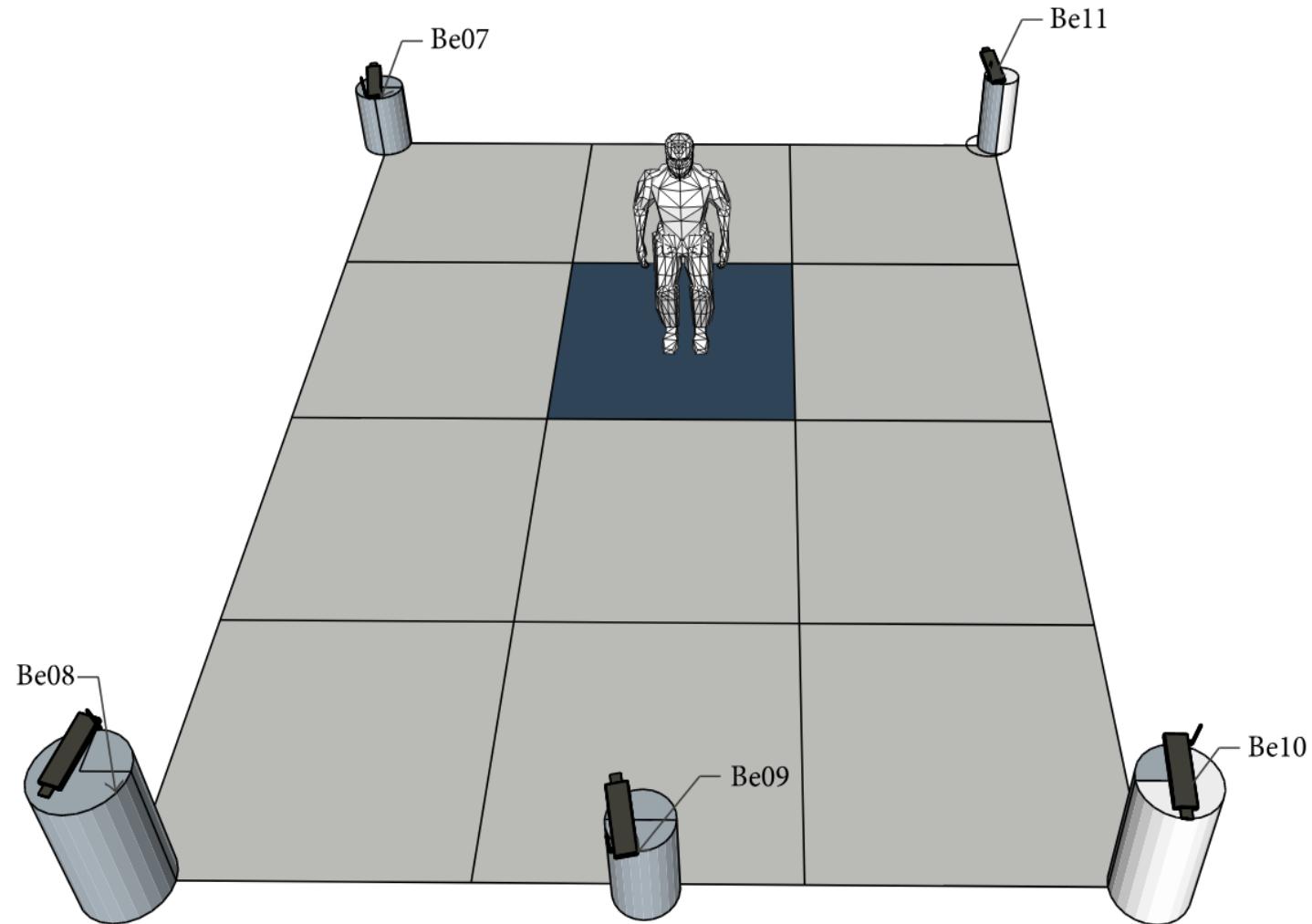
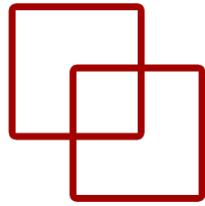
Indoor Localization

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Indoor Localization





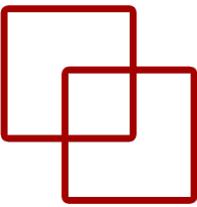
BeeGons!

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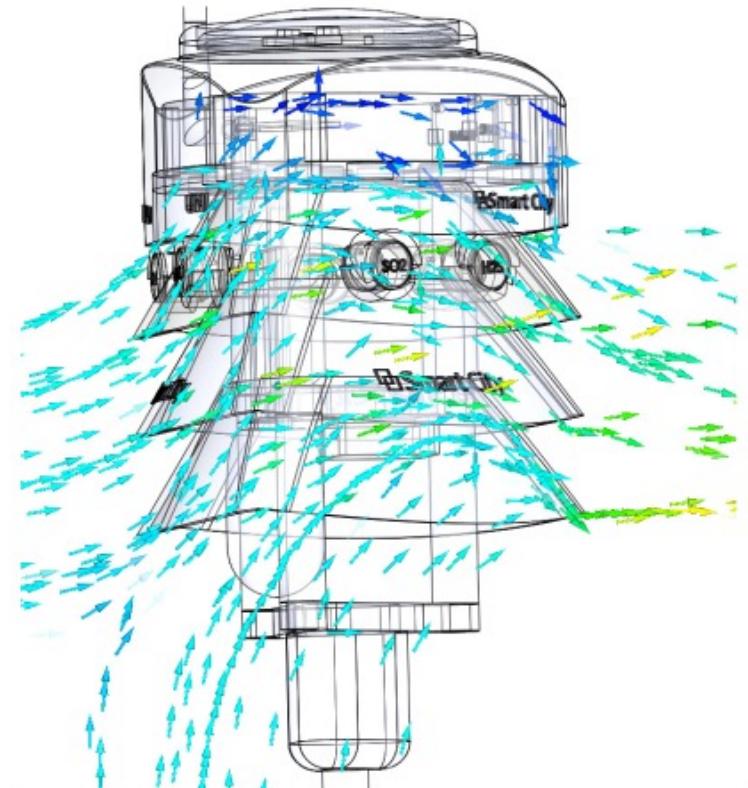
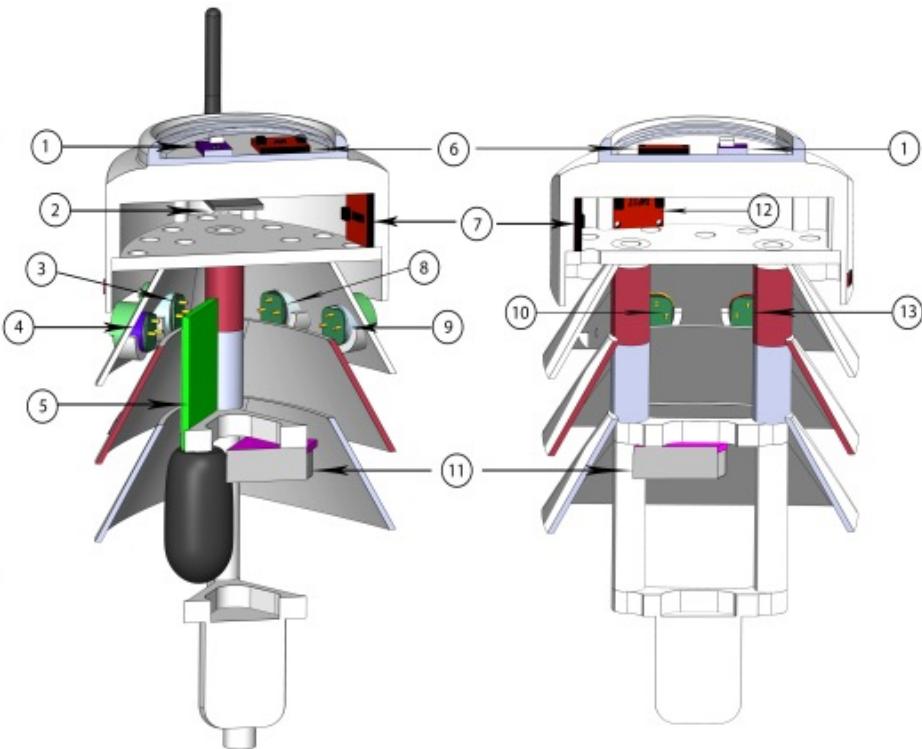


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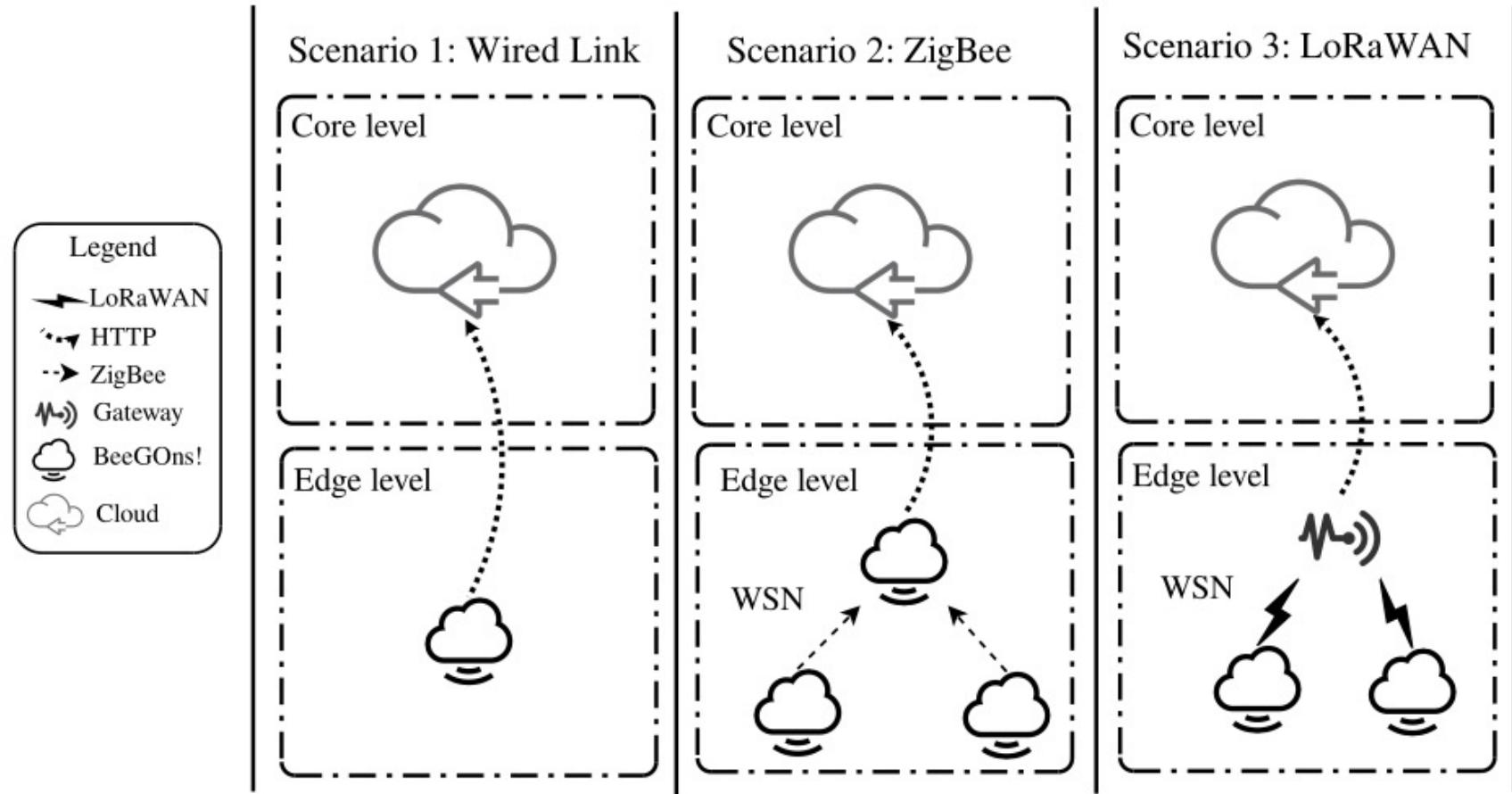
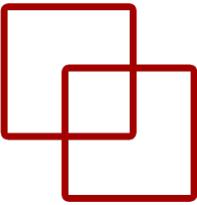
BeeGOns!



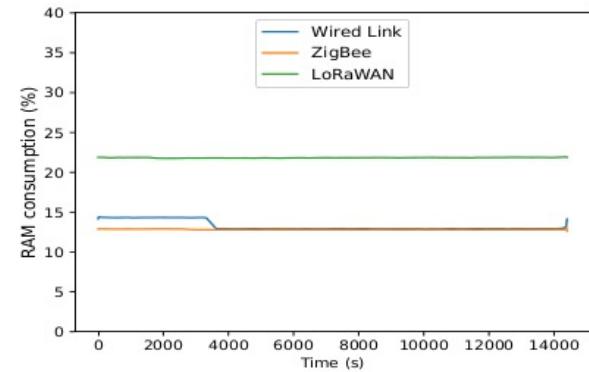
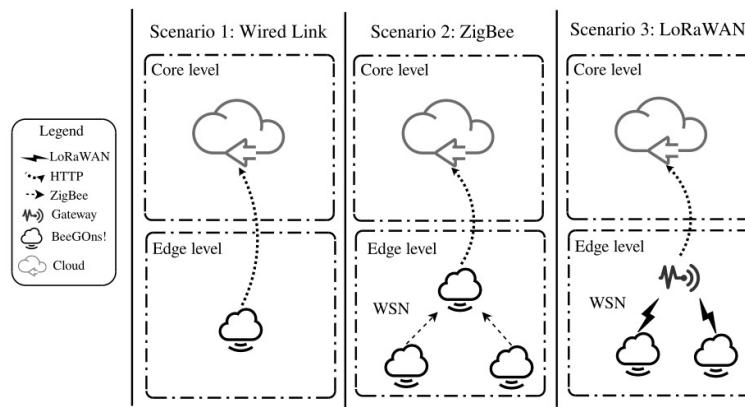
Legend	
1.	TSL2561
2.	LoRaWAN / ZigBee
3.	O ₃
4.	NO ₂
5.	ZC-DONGGE
6.	VEML6075
7.	BME680
8.	CO
9.	NO
10.	H ₂ S
11.	PMSA003I
12.	TMP117
13.	SO ₂



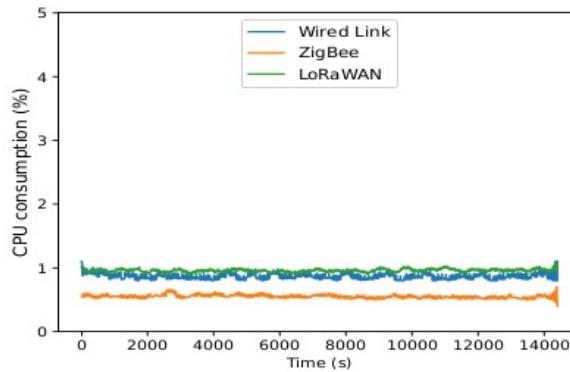
BeeGOns!



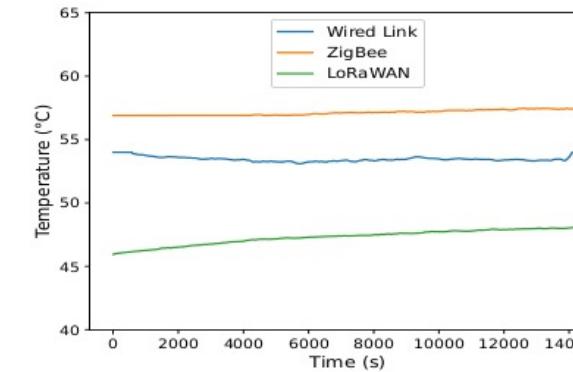
BeeGOns!



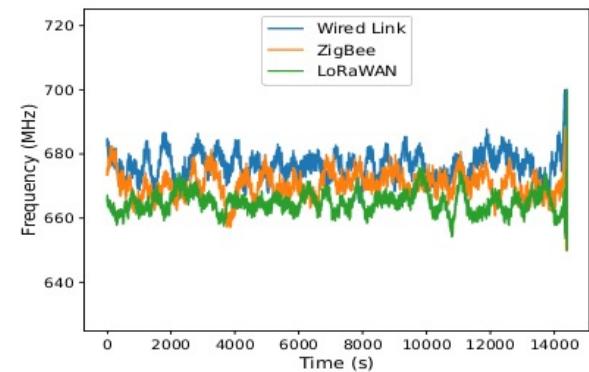
(a)



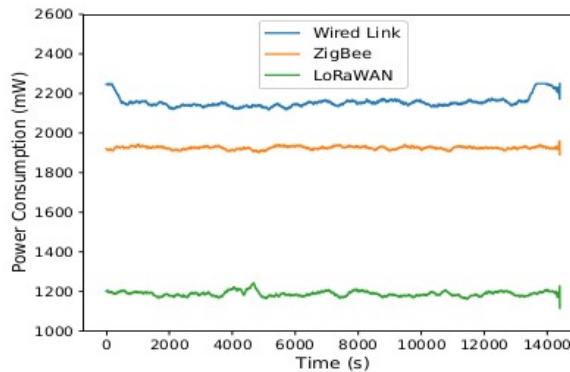
(b)



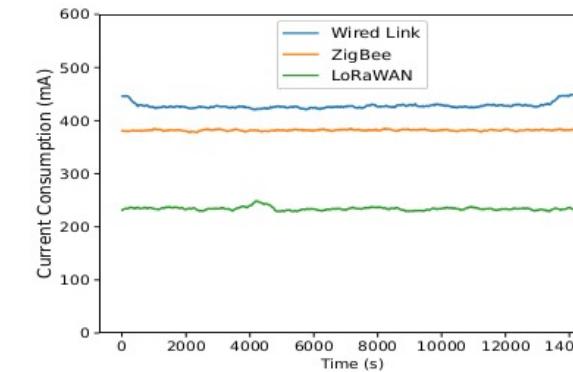
(c)



(d)



(e)



(f)

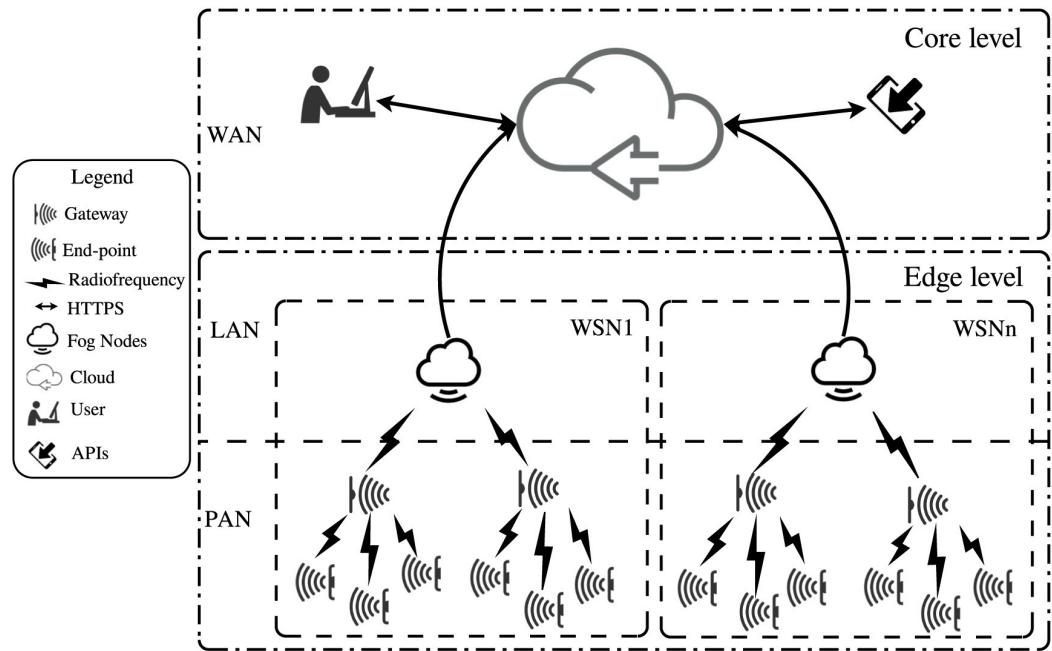
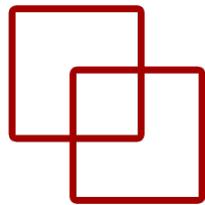
Federated- Fog Computing

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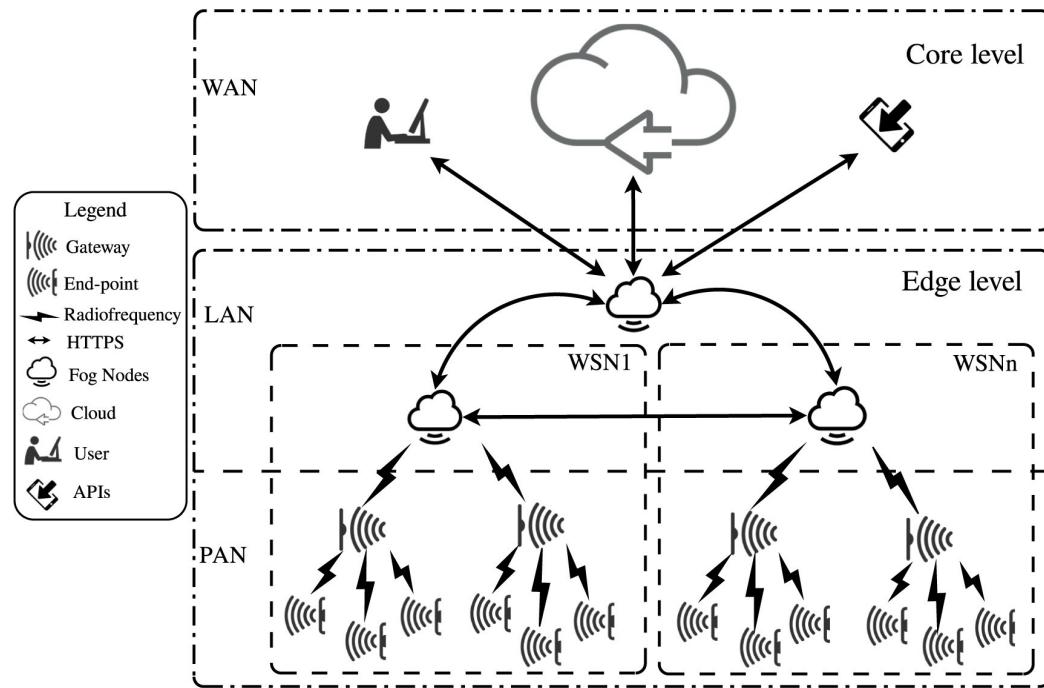


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Arquitectura



(a) Cloud and fog computing.



(b) Inverted- and federated-fog computing.

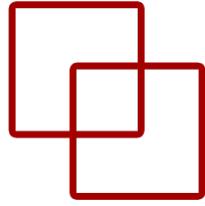
Imágenes sintéticas

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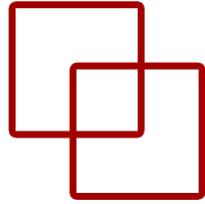
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Transformación de datos

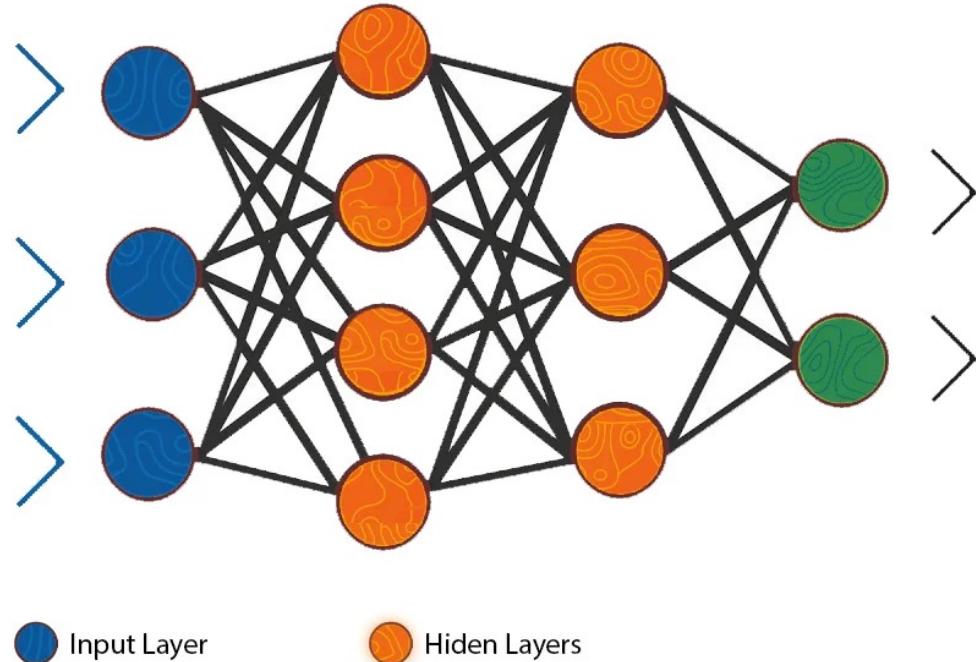
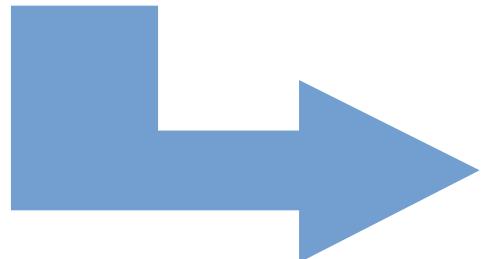


Be07	Be08	Be09	Be10	Be11	Sector
-65	-61	-74	-73	-67	1
-60	-57	-83	-62	-69	2
-66	-70	-78	-63	-73	3
...
-58	-66	-71	-73	-69	14
-60	-62	-73	-69	-57	15

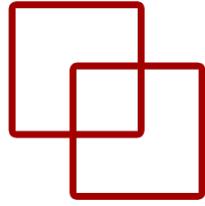
Transformación de datos



Be07	Be08	Be09	Be10	Be11	Sector
-65	-61	-74	-73	-67	1
-60	-57	-83	-62	-69	2
-66	-70	-78	-63	-73	3
...
-58	-66	-71	-73	-69	14
-60	-62	-73	-69	-57	15

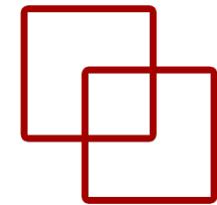


Transformación de datos

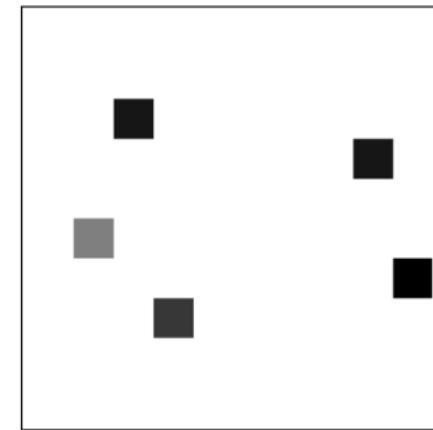
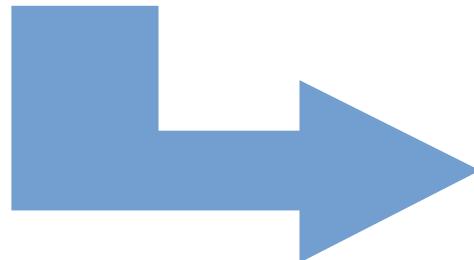


Be07	Be08	Be09	Be10	Be11	Sector
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-60	-57	-83	-62	-69	2
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...
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-60	-62	-73	-69	-57	15

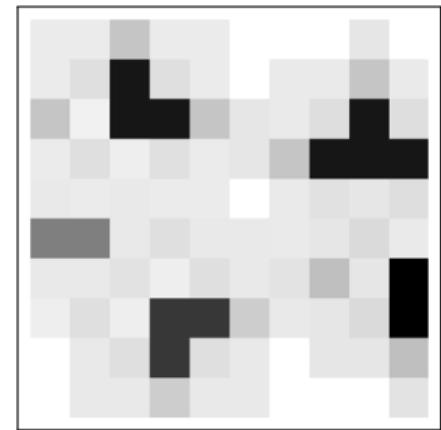
Transformación de datos



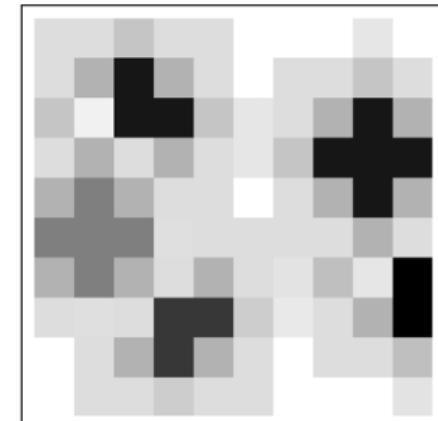
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-60	-57	-83	-62	-69	2
-66	-70	-78	-63	-73	3
...
-58	-66	-71	-73	-69	14
-60	-62	-73	-69	-57	15



(a) Without blurring.



(b) Blurring with average value.



(c) Blurring with maximum value.



TINTOlib

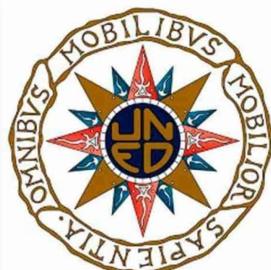
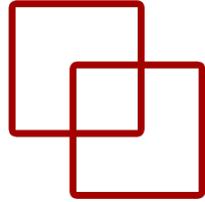


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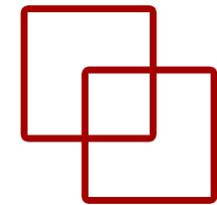
TINTOlib



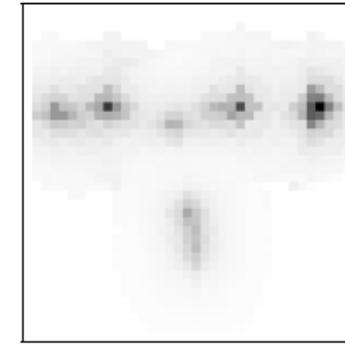
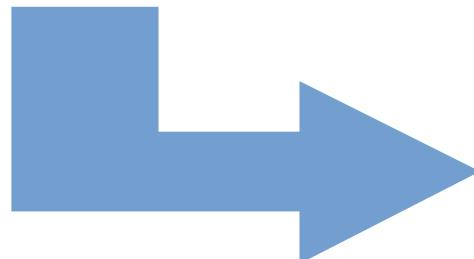
POLITÉCNICA



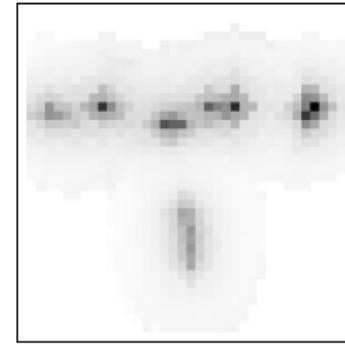
Transformación de datos



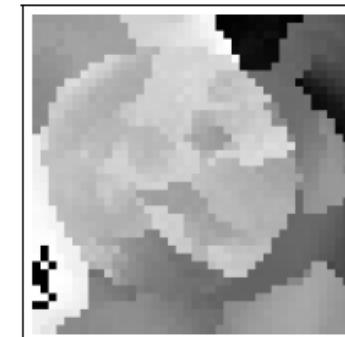
Be07	Be08	Be09	Be10	Be11	Sector
-65	-61	-74	-73	-67	1
-60	-57	-83	-62	-69	2
-66	-70	-78	-63	-73	3
...
-58	-66	-71	-73	-69	14
-60	-62	-73	-69	-57	15



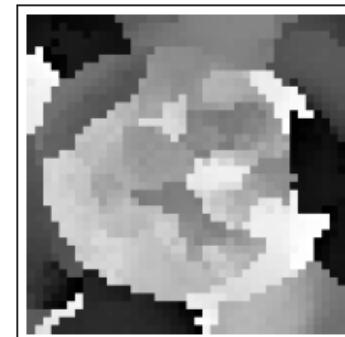
(a) TINTO - Sample 1.



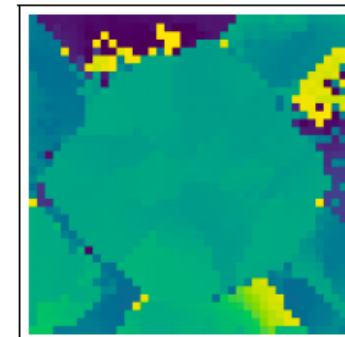
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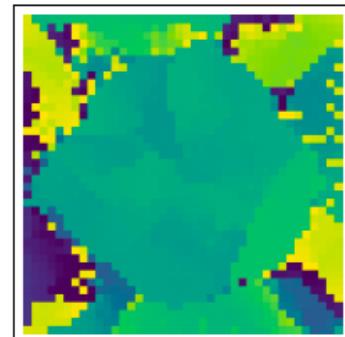
(c) IGTD - Sample 1.



(d) IGTD - Sample 50,000.

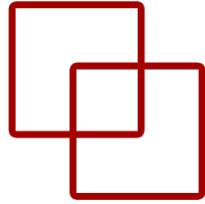


(e) REFINED - Sample 1.



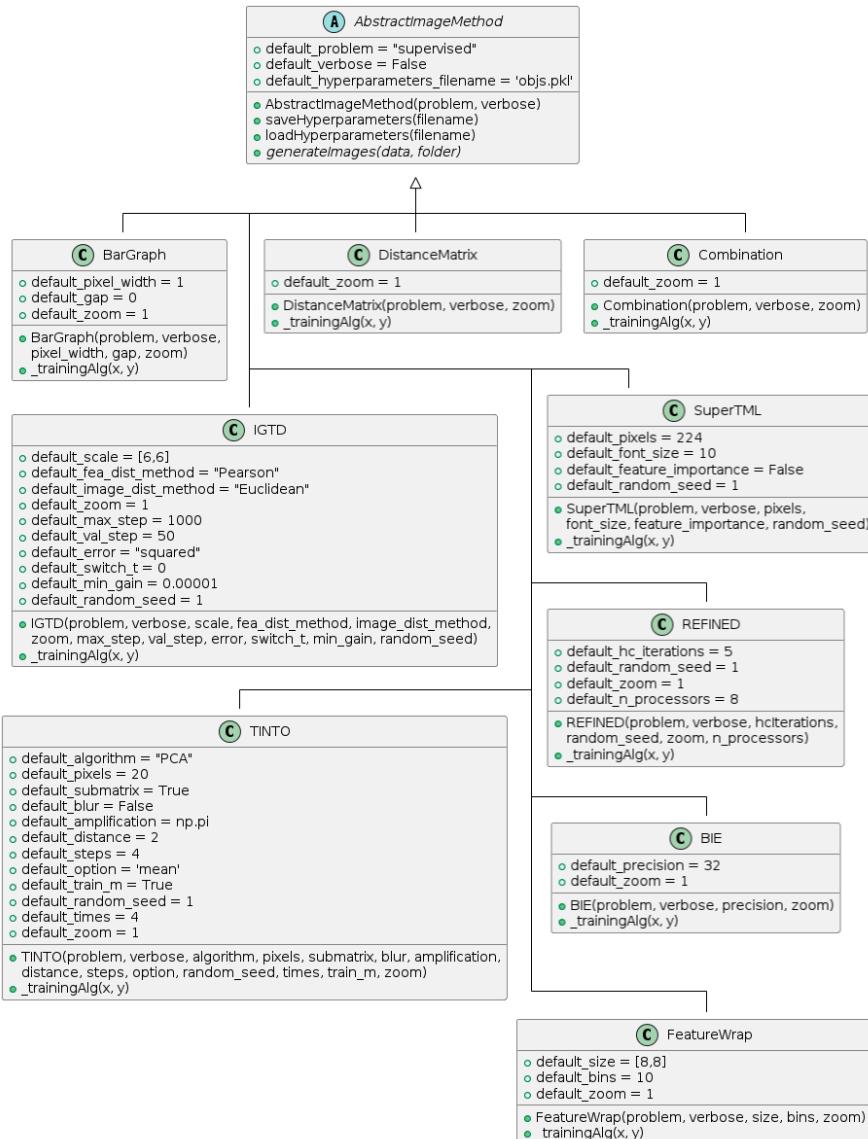
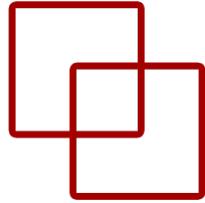
(f) REFINED - Sample 50,000.

Métodos de transformación

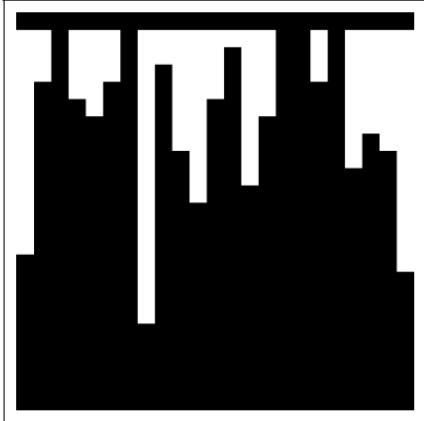
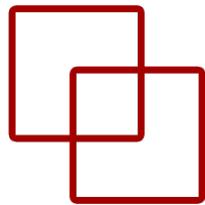


Model	Class	Features	Hyperparameters
BarGraph	<code>BarGraph()</code>		<code>problem</code> <code>verbose</code> <code>pixel_width</code> <code>gap</code> <code>zoom</code>
BIE	<code>BIE()</code>		<code>problem</code> <code>verbose</code> <code>precision</code> <code>zoom</code>
Combination	<code>Combination()</code>		<code>problem</code> <code>verbose</code> <code>zoom</code>
DistanceMatrix	<code>DistanceMatrix()</code>		<code>problem</code> <code>verbose</code> <code>zoom</code>
FeatureWrap	<code>FeatureWrap()</code>		<code>problem</code> <code>verbose</code> <code>size</code> <code>bins</code> <code>zoom</code>
IGTD	<code>IGTD()</code>		<code>problem</code> <code>verbose</code> <code>scale</code> <code>fea_dist_method</code> <code>image_dist_method</code> <code>max_step</code> <code>val_step</code> <code>error</code> <code>switch_t</code> <code>min_gain</code> <code>random_seed</code> <code>zoom</code>
REFINED	<code>REFINED()</code>		<code>problem</code> <code>verbose</code> <code>hcIterations</code> <code>random_seed</code> <code>zoom</code> <code>n_processors</code>
SuperTML	<code>SuperTML()</code>		<code>problem</code> <code>columns</code> <code>font_size</code> <code>image_size</code> <code>verbose</code>
TINTO	<code>TINTO()</code>	<code>blur</code>	<code>problem</code> <code>algorithm</code> <code>pixels</code> <code>blur</code> <code>amplification</code> <code>distance</code> <code>steps</code> <code>option</code> <code>seed</code> <code>times</code> <code>verbose</code>

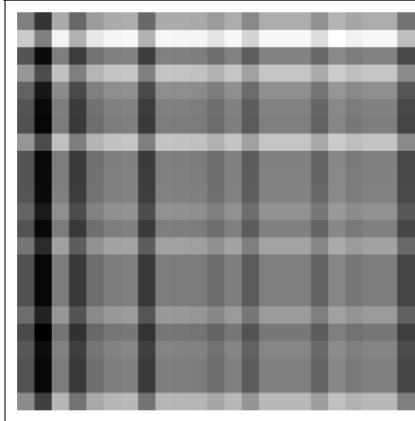
Métodos de transformación



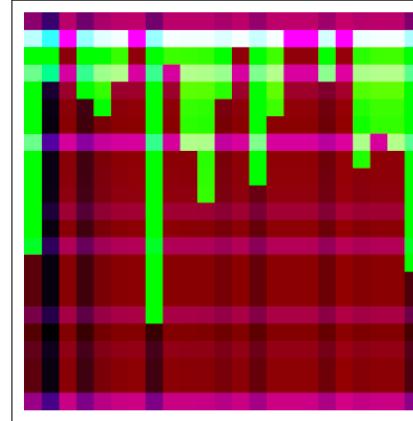
Métodos de transformación



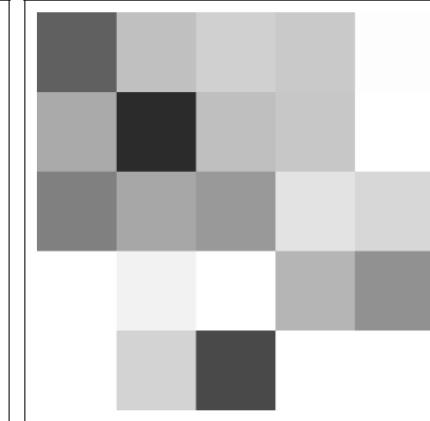
BarGraph



DistanceMatrix



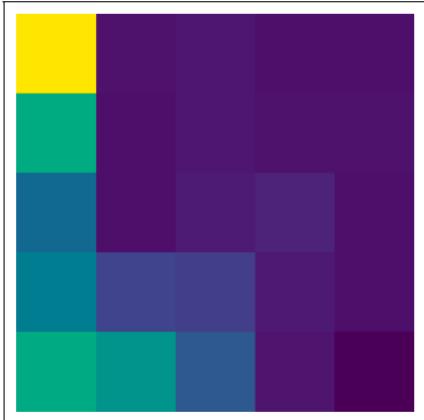
Combination



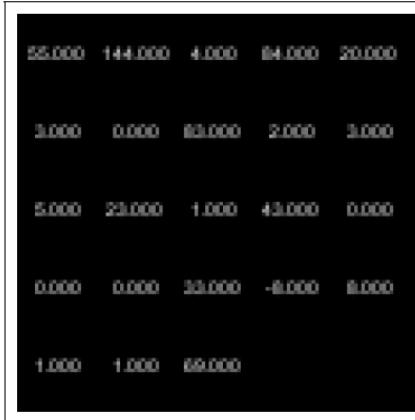
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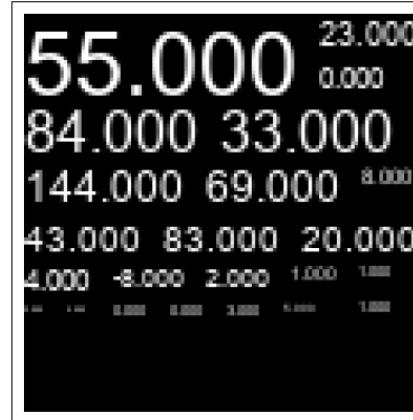
BIE



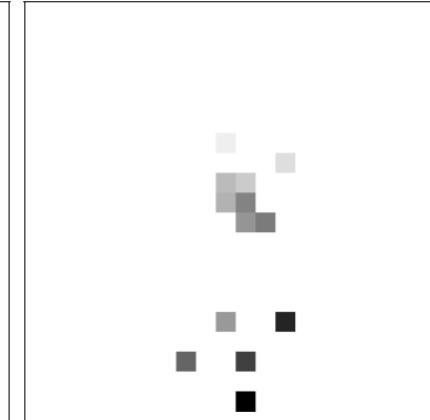
REFINED



SuperTML-EF



SuperTML-VF



TINTO



Feature Wrap

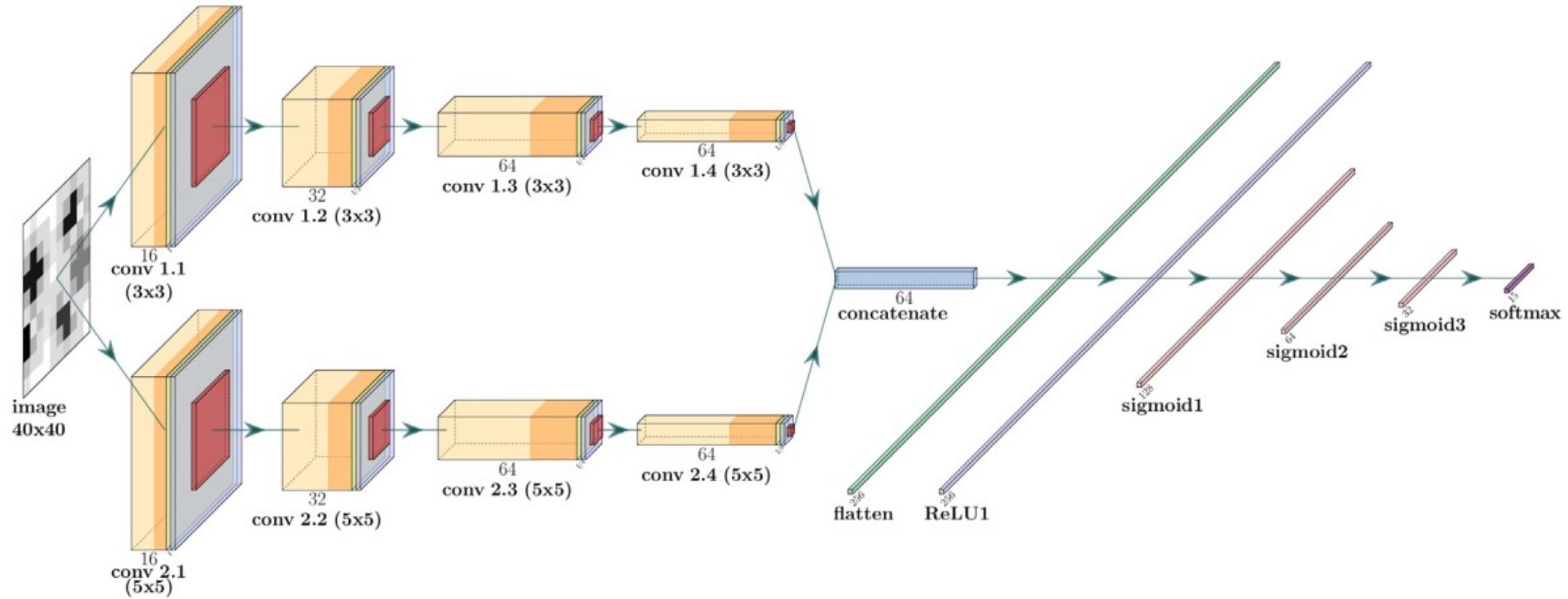
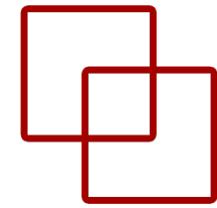
\Arquitecturas Neuronales

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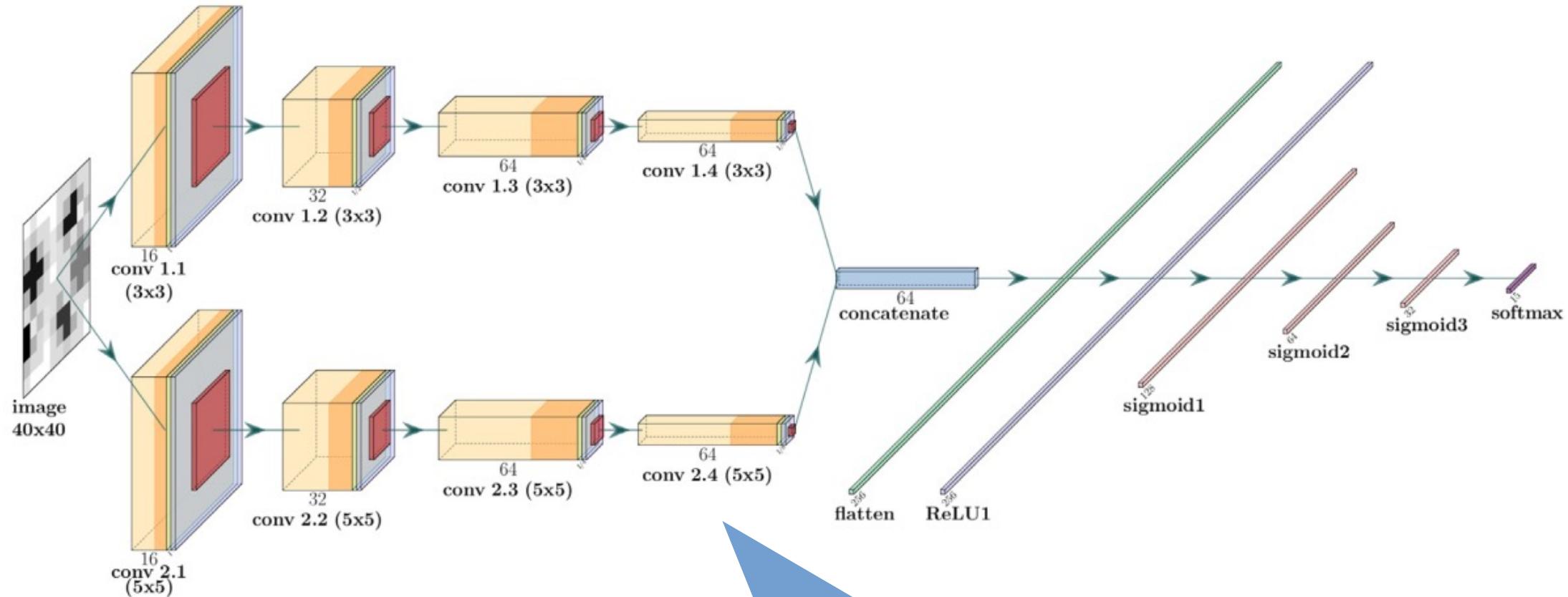
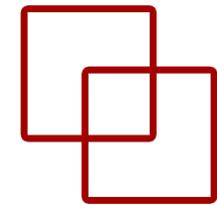


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CNN Puras

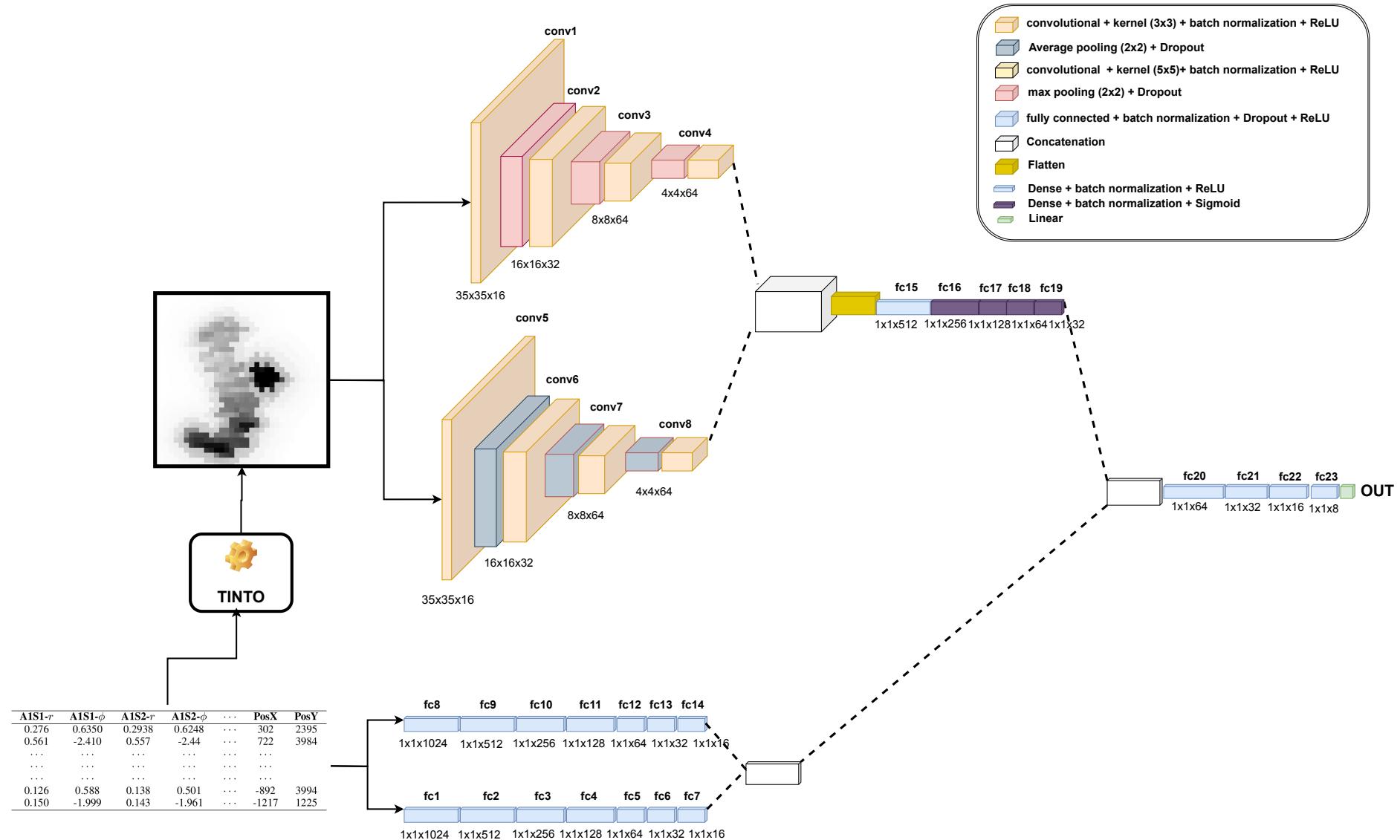
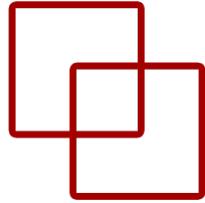


CNN Puras

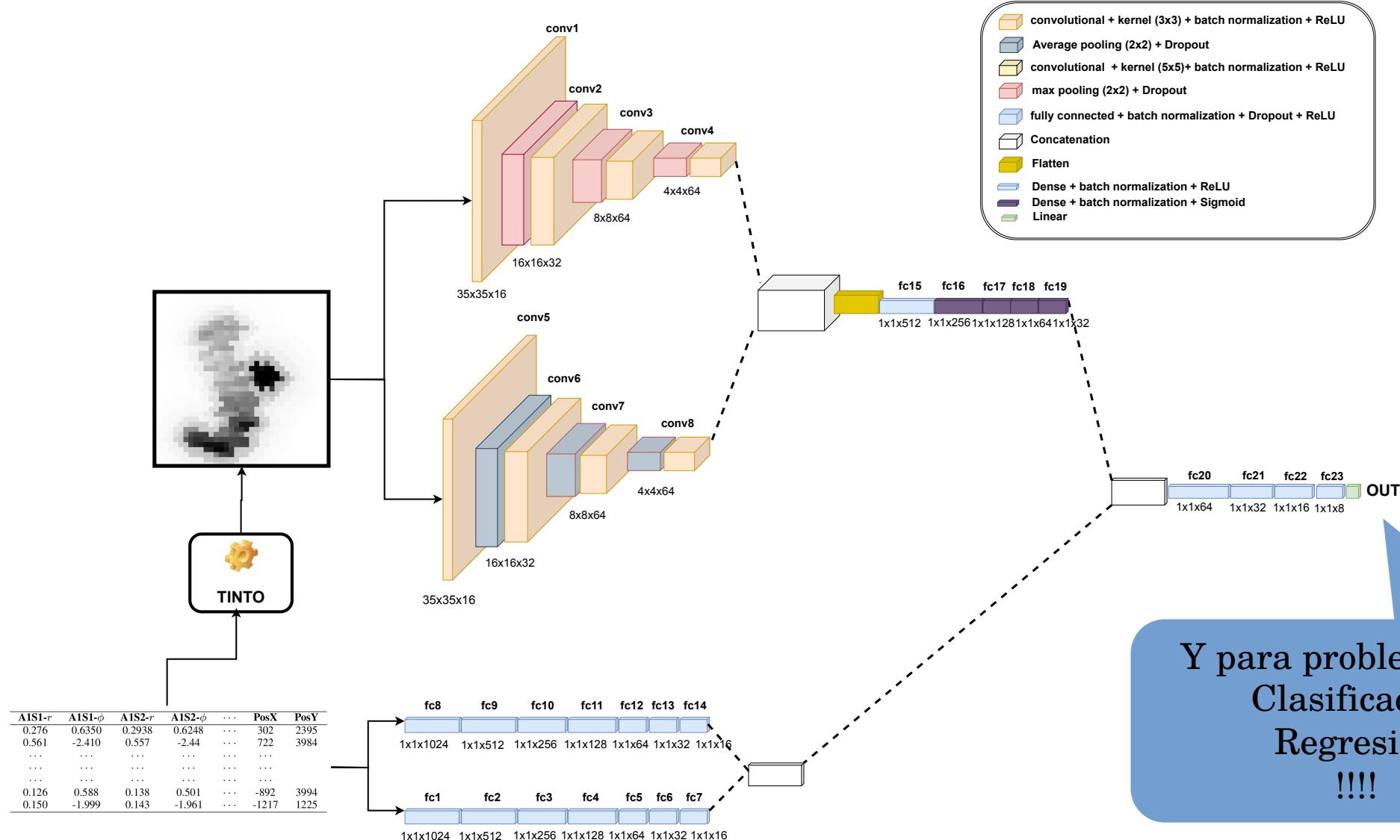
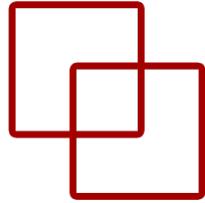


Pero no sólo
CNNs

Hybrid Neural Network

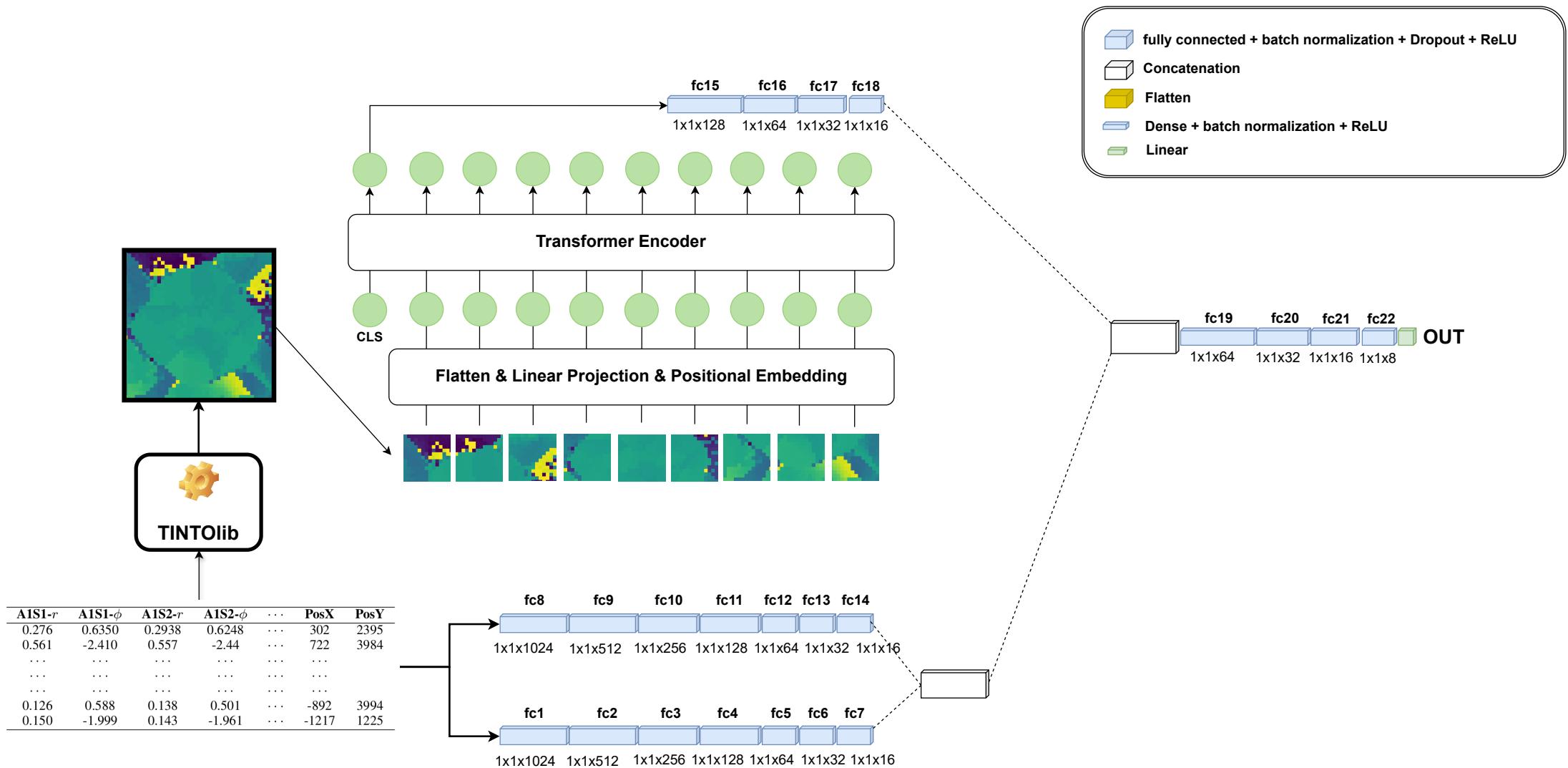
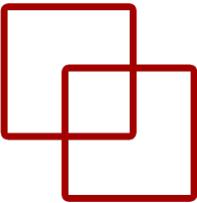


Hybrid Neural Network



Y para problemas de:
Clasificación
Regresión
!!!!

HyViT



‘Caso de uso: Localización en interiores con MIMO

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Escenario

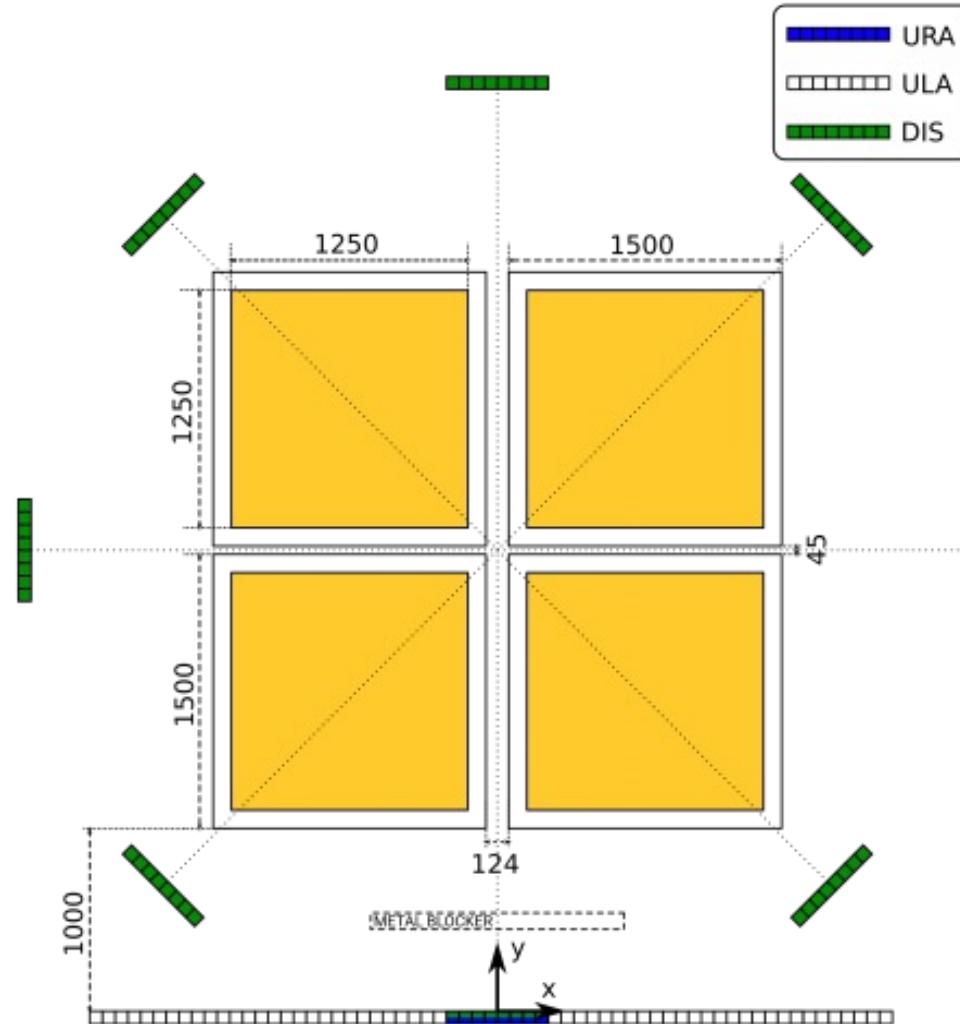
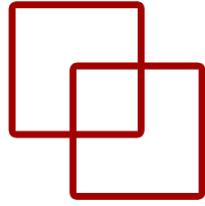
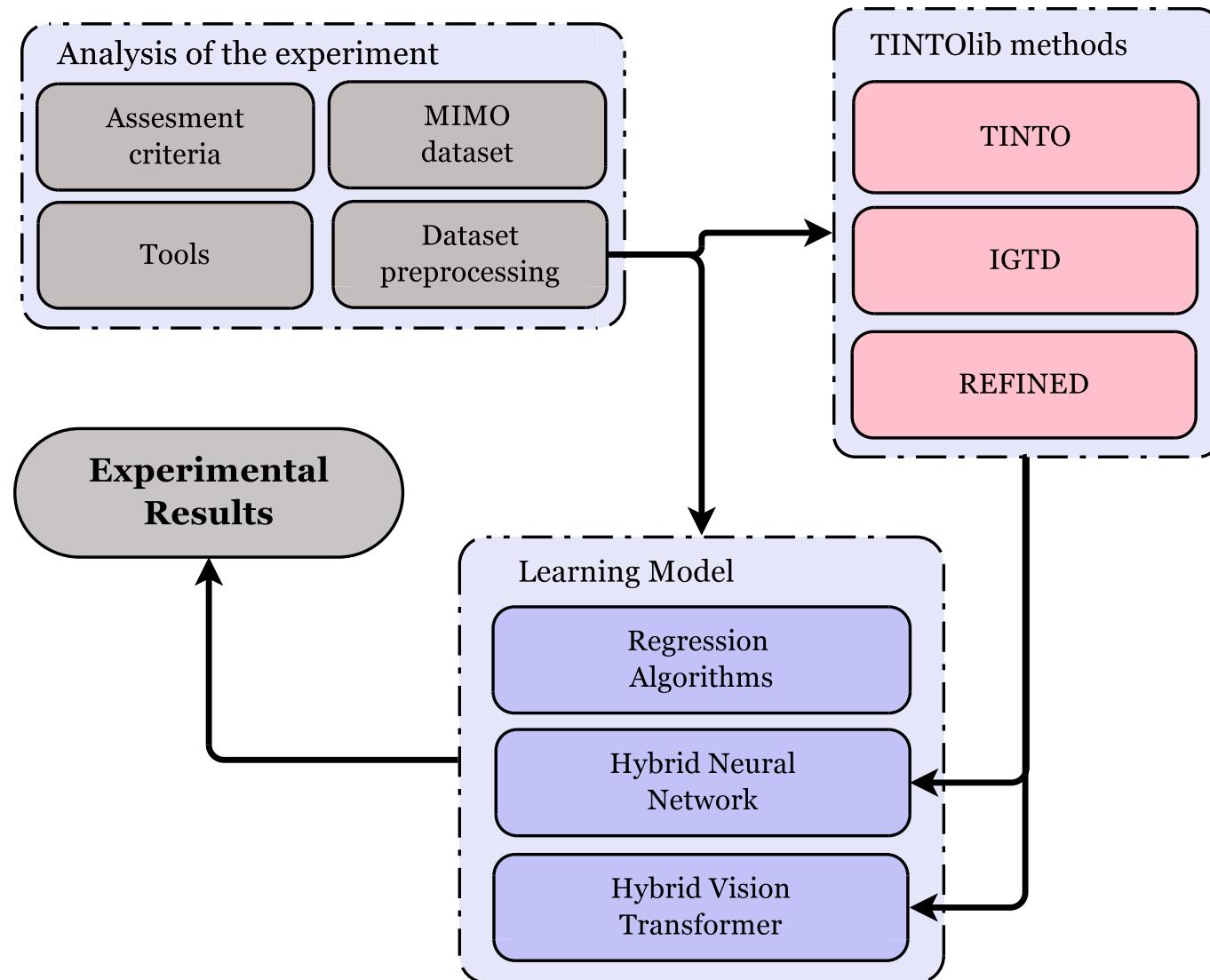
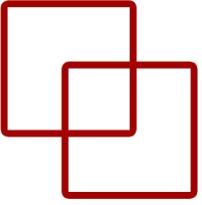
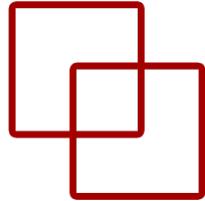


Figure taken from the paper: S. D. Bast, A. P. Guevara and S. Pollin, "CSI-based Positioning in Massive MIMO systems using Convolutional Neural Networks," 2020 IEEE 91st Vehicular Technology Conference (VTC2020-Spring), Antwerp, Belgium, 2020, pp. 1-5

Metodología



Imágenes sintéticas



A1C1- <i>m</i>	A1C1- ϕ	A1C2- <i>m</i>	A1C2- ϕ	...	PosX	PosY
0.276	0.6350	0.2938	0.6248	...	302	2395
0.561	-2.410	0.557	-2.44	...	722	3984
...
...
...
0.126	0.588	0.138	0.501	...	-892	3994
0.150	-1.999	0.143	-1.961	...	-1217	1225

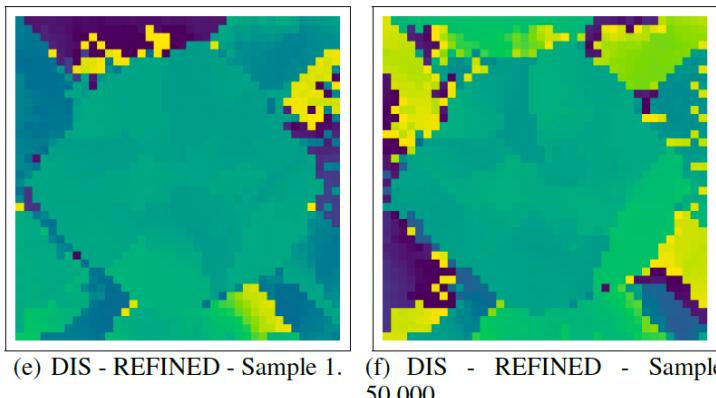
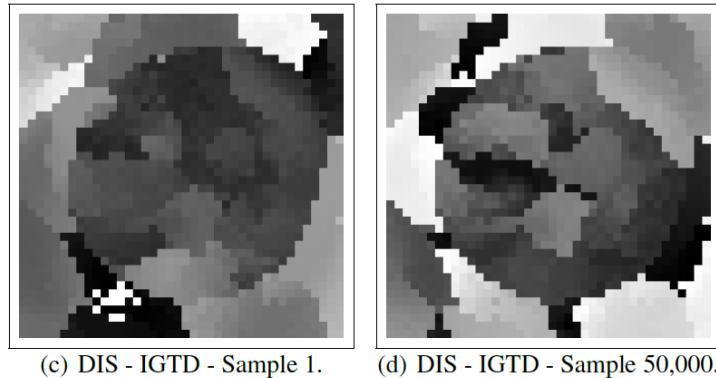
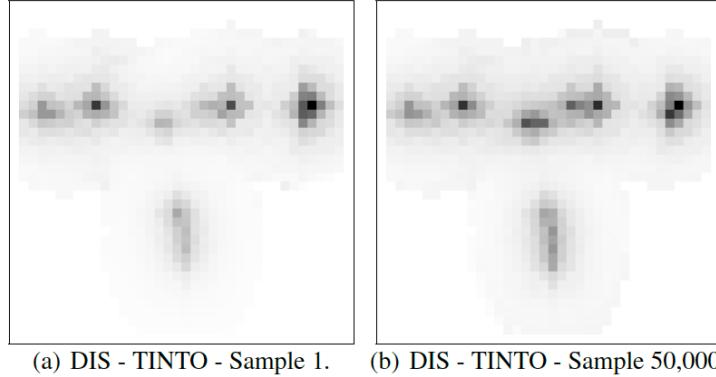
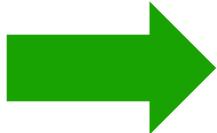
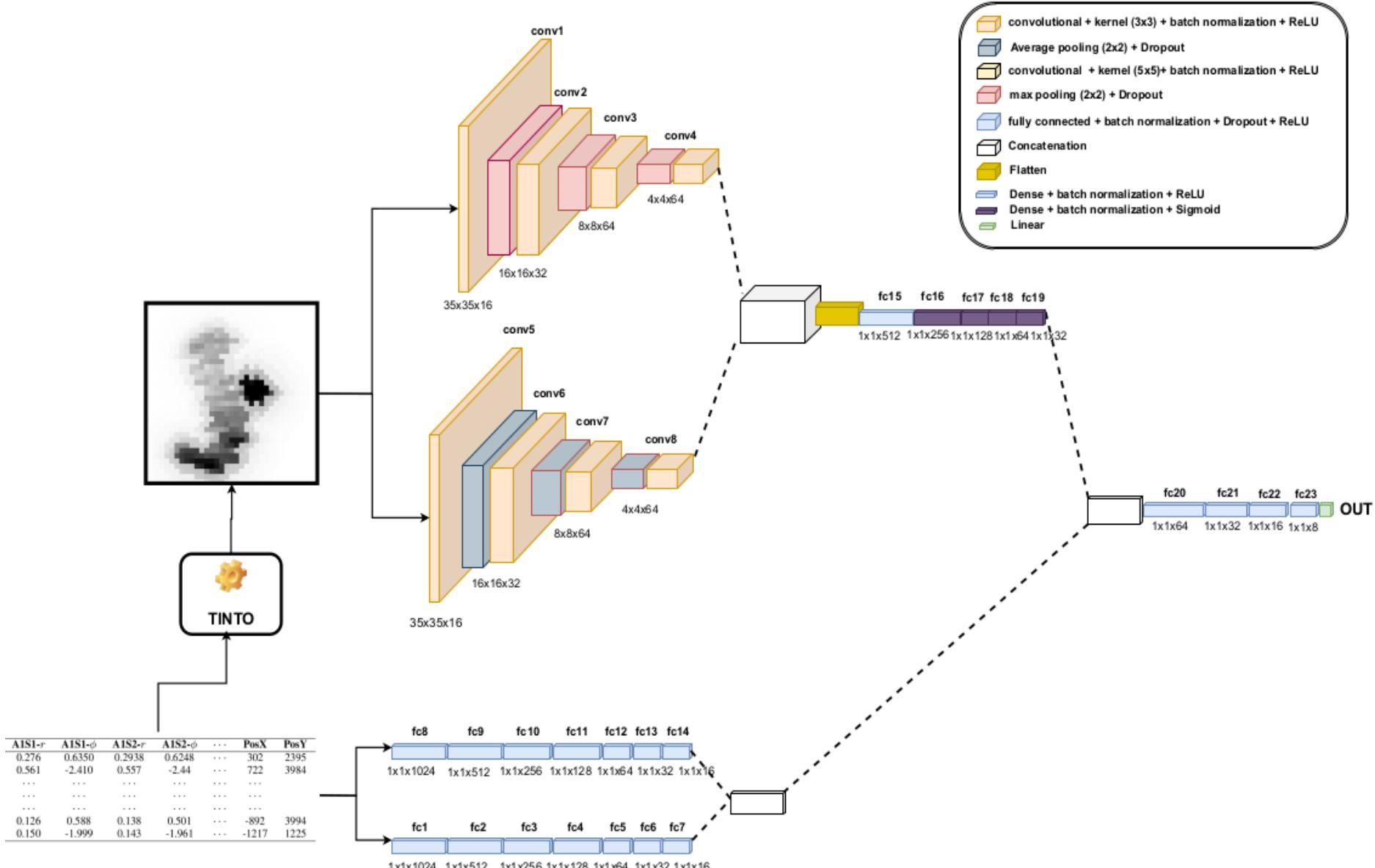
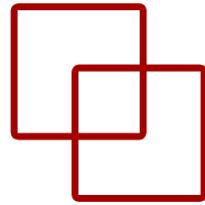
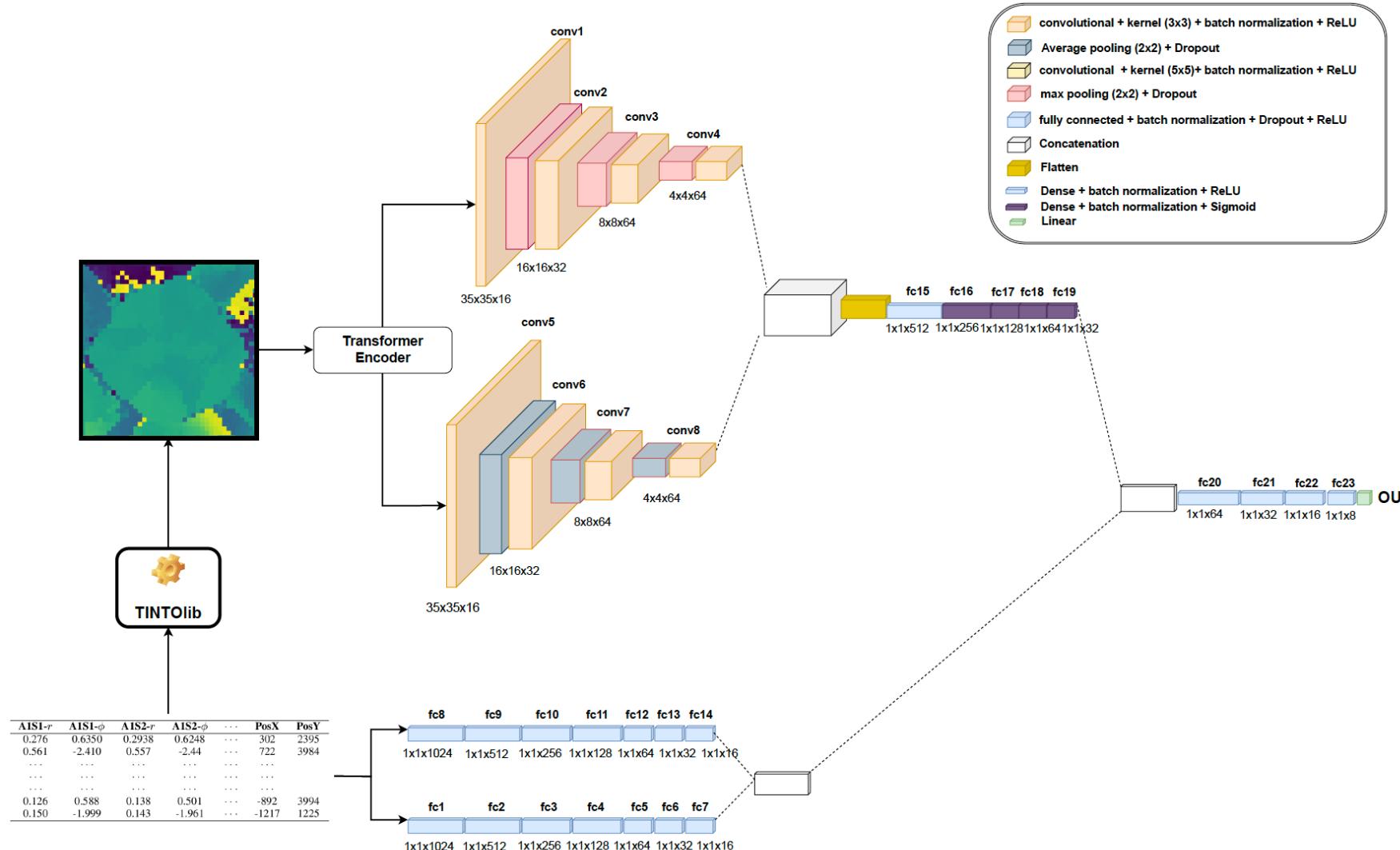
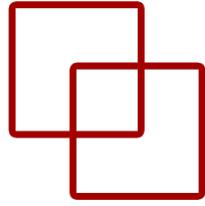


Figure 3. Synthetic image samples generated by TINTOlib for different samples in 8 antennas DIS scenario.

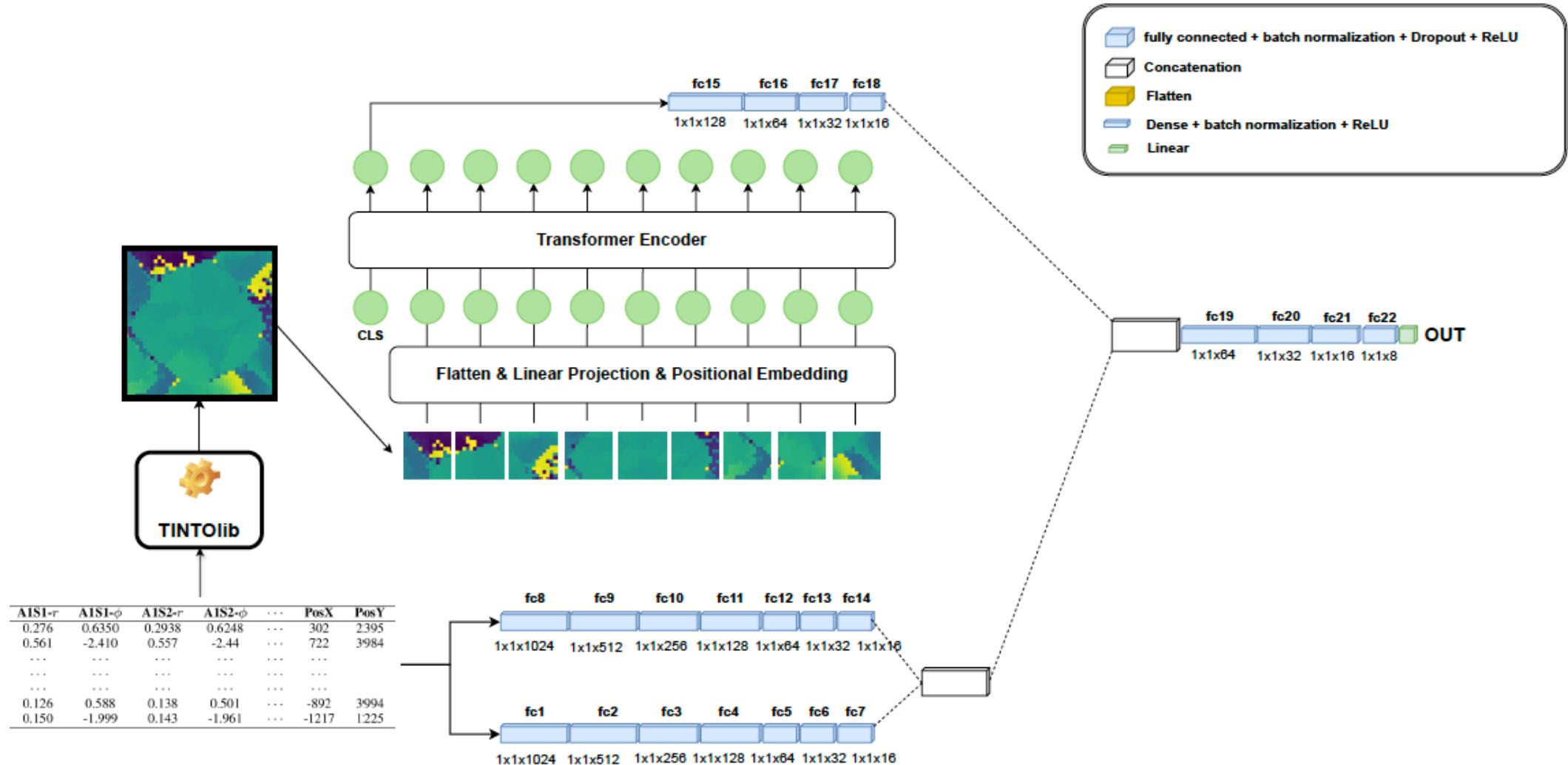
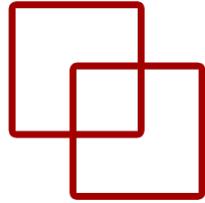
HyNN → CNN+MLP



HyNN → Transformer+CNN+MLP



HyViT → ViT+MLP



Baseline Results

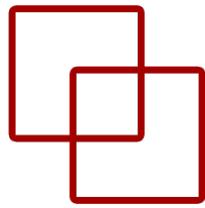


Table 2. RMSE (in mm) in validation (Val) and test split. Best results are shown in bold.

Algorithm	PosX		PosY	
	Val	Test	Val	Test
BR	226.05	225.00	251.43	255.54
ET	163.15	161.65	180.00	185.70
HGB	194.10	194.97	236.55	236.46
KNN	110.50	110.54	133.70	140.16
LiR	383.05	386.95	432.83	439.10
MLP	179.80	178.82	326.11	334.76
RF	226.09	225.18	251.37	255.62
RCV	383.04	386.94	432.80	439.06
XGB	178.41	180.03	202.45	201.66
LGB	194.14	194.15	231.19	232.89

Hybrid Neural Networks Results

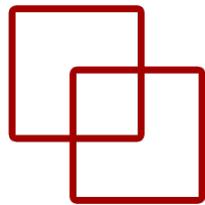


Table 2. RMSE (in mm) in validation (Val) and test split. Best results are shown in bold.

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LiR	383.05	386.95	432.83	439.10
MLP	179.80	178.82	326.11	334.76
RF	226.09	225.18	251.37	255.62
RCV	383.04	386.94	432.80	439.06
XGB	178.41	180.03	202.45	201.66
LGB	194.14	194.15	231.19	232.89

Table 3. RMSE (in mm) for the different HyNNs architectures and HyViT in Validation (Val) and test. Best results are shown in bold.

Position	Model	TINTO		IGTD		REFINED	
		Val	Test	Val	Test	Val	Test
PosX	HyCNN	187.10	188.10	92.8	92.21	105.69	105.38
	HyTNN	178.28	179.25	119.59	119.62	115.90	114.98
	HyTTNN	181.96	184.19	179.01	180.05	193.56	196.09
	HyGTNN	176.71	176.43	173.42	174.20	173.38	174.02
	HyViT	103.27	104.17	46.57	45.77	41.38	41.84
PosY	HyCNN	152.19	151.94	101.01	99.45	115.40	114.69
	HyTNN	143.10	143.29	95.95	95.83	112.27	112.02
	HyTTNN	151.35	151.97	155.35	154.12	147.22	146.01
	HyGTNN	155.06	153.40	154.68	154.50	157.10	155.39
	HyViT	121.77	123.90	70.84	68.93	90.11	90.56

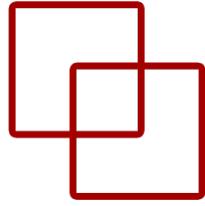
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Más información



- Documentación oficial de TINTOlib:
<https://tintolib.readthedocs.io/en/latest/>
- Librería TINTOlib en PyPI: <https://pypi.org/project/TINTOlib/>
- GitHub con el código de TINTOlib: <https://github.com/oeg-upm/TINTOlib>
- GitHub con el código de TINTO: <https://github.com/oeg-upm/TINTO>
- Artículo sobre TINTO y su aplicación en indoor localization. Incluye la definición formal matemática: <https://doi.org/10.1016/j.inffus.2022.10.011>
- Artículo sobre TINTO y su definición formal en Python:
<https://doi.org/10.1016/j.softx.2023.101391>



Materiales

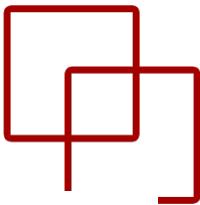
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Materiales

Github – TINTOlib



<https://bit.ly/3YzTRzi>



¡Gracias!



Dr. Manuel Castillo-Cara

www.manuelcastillo.eu

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Escuela Técnica Superior de Ingeniería Informática
Universidad Nacional de Educación a Distancia (UNED)**