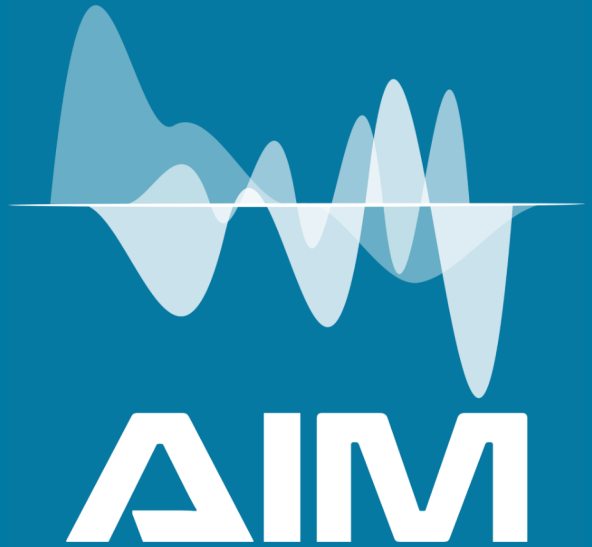
Artificial Intelligence in Medicine



Project Summary

Resp. Naz.: A. Retico (PI)
Resp. Loc.: S. Tangaro (BA), D. Remondini (BO), P. Oliva (CA),
M. Marrale (CT), C. Talamonti (FI), A. Chincarini (GE), M.E. Fantacci (PI)

AIM Annual Meeting - Pisa - February 3rd, 2020

AIM Project Overview

INFN - CSN5, 2019-2021

Several researchers from INFN divisions and University Departments collaborate with Radiologists, Clinicians and Medical Physicists in Clinical Centers to develop innovative solutions based on data mining and artificial intelligence.

Clinical partners

- IRCCS S. Martino (GE)
- IRCCS Stella Maris (PI)
- IRCCS Gaslini (GE)
- IRCCS Centro S. G. di Dio (BS)
- IRCCS G.Paolo II (BA)
- IRCCS SDN (NA)
- IMAGO7
- AOUP (PI)
- Policlinico (BA)
- Policlinico (PA)
- Osp. Pediatrico Meyer (FI)

EU / consortia

- EADC (EU)
- ADNI (US)
- ABIDE (EU/US)
- ENIGMA (WW)

Azienda Ospedaliera Universitaria Policlinico Paolo Giaccone di Palermo

IN SUPREMÆ DIGNITATIS 1343

SDN

AZIENDA OSPEDALIERA POLICLINICO BARI

Provincia Lombardo-Veneta
Ordine Ospedaliero di S. Giovanni di Dio - Fatebenefratelli
CENTRO S. GIOVANNI DI DIO - FATEBENEFRATELLI
ISTITUTO DI RICOVERO E CURA A CARATTERE SCIENTIFICO
25125 BRESCIA - Via Pilastroni, 4
Telefono 030 35011 - Telefax 030 348255

Welcome to the EADC web site
European Alzheimer's Disease Consortium

SSST Servizio Sanitario della Toscana

MEYER con cura e con passione

IRCCS Azienda Ospedaliera Universitaria San Martino – IST Istituto Nazionale per la Ricerca sul Cancro

IRCCS FONDAZIONE STELLA MARIS

Gaslini

GASLINI

ABIDE

ADNI Alzheimer's Disease Neuroimaging Initiative

Participants

	PEOPLE		FTE
BARI			**2.3**
1	Amoroso Nicola	40	
2	Bellotti Roberto	20	
3	Lella Eufemia	30	
4	Lombardi Angela	20	
5	Maggipinto Tommaso	40	
6	Tangaro Sabina	50	
1	Monaco Alfonso	30	
	Domenico Diacono	230	
BOLOGNA			**5**
1	Barbieri Marco	80	
2	Brizi Leonardo	80	
3	Castellani Gastone	30	
4	Giampieri Enrico	20	
5	Matteuzzi Tommaso	50	
6	Merlotti Alessandra	80	
7	Remondini Daniel	70	
8	Sala Claudia	0	
9	Testa Claudia	80	
1	Vistoli Maria Cristina	10	
		500	

	PEOPLE		FTE
CAGLIARI			**1.7**
1	Fanti Alessandro	30	
2	Golosio Bruno	30	
3	Oliva Piernicola	50	
1	Chiriu Daniele	50	
2	Mazzarella Giuseppe	10	
		170	
CATANIA			**3.1**
1	Bartolotta Antonio	70	
2	Collura Giorgio	70	
3	D'Oca Maria Cristina	50	
4	Marrale Maurizio	70	
5	Tomarchio Elio Angelo	50	
		310	
FIRENZE			**1.4**
1	Calusi Silvia	20	
2	Pallotta Stefania	30	
3	Piffer Stefano	50	
4	Talamonti Cinzia	40	
		140	

	PEOPLE		FTE
GENOVA			**2.4**
1	Alchera Nicola	100	
2	Boccacci Patrizia	20	
3	Peira Enrico	50	
4	Sensi Francesco	50	
1	Corosu Mirko	20	
		240	
PISA			**5.55**
1	Barca Patrizio	40	
2	Bosco Paolo	10	
3	Buonincontri Guido	20	
4	Costagli Mauro	20	
5	Fantacci Maria Evelina	70	
6	Ferrari Elisa	100	
7	Lamastra Rocco	30	
8	Lizzi Francesca	100	
9	Marfisi Daniela	30	
10	Retico Alessandra	70	
11	Tosetti Michela	10	
12	Tucciariello Raffaele M.	30	
1	Arezzini Silvia	10	
2	Ciampa Alberto	10	
3	Mazzoni Enrico	5	
	Scapicchio Camilla	555	
	Berti Andrea		
	Ubaldi Leonardo		
	Laruina Francesco		

51 Total people **21.45 Total FTE**

Project timeline

AIM workpackages and timeline

AIM 1: Data harmonization

AIM1.T1 - Multi-site data harmonization in MRI (PI, BA, BO)

AIM1.T2 - Multi-site data harmonization in mammography (PI, CA)

AIM 2: Quantification

AIM2.T1 - Quantification models in PET (GE, BO)

AIM2.T2' - Machine-learning (ML) and deep-learning (DL) methods for quantitative MRI (BO)

AIM 3: Predictive models

AIM3.T1 - Predictive models for Radiation Therapy treatments (FI, PI, CA, CT)

AIM3.T2 - Predictive models for mammography and CESM (PI, CA, BA)

AIM3.T3 - Predictive models for transcranial-MR-guided Focused Ultrasound Surgery (CT, BO)

AIM3.T4 - Predictive models for Systems Medicine (BO)

AIM3.T5 - Predictive models for tumor classification (BO,CT)

		I year		II year		III year	
AIM1: DATA HARMONIZATION	T1.1		*	*			*
	T1.2		*		*		
AIM2: QUANTIFICATION	T2.1		*		*		
	T2.2'		*		*	*	
AIM3: PREDICTIVE MODELS	T3.1		*		*		*
	T3.2	*		*	*	*	*
	T3.3		*		*		*
	T3.4		*		*		
	T3.5		*		*		*

Milestones 2019

Deadline	Milestone	Brief description of completed work (July); updates (July->December 2019)	Degree of completion	
			July 2019	Dec. 2019
30/06/2019	M3.2a - Development and validation of a Convolutional Neural Network for automatic classification of breast density according to the 4 BIRADS classes	This task is completed. The four-class CNN classifier has been trained and validated on 1962 mammographic exams (7848 images/single projections). Work presented at Bionformatics 2020 conference (Lizzi et al. and VIMABI Conference (Lizzi et al.) and published in the proceedings.	100%	100%
31/12/2019	M1.1 Identification and coding of Generative Adversarial Network (GAN) for MRI data harmonization	The GAN architecture has been identified. The training and validation procedures of GAN on 3D images have been setup. This architecture has been identified and trained on 3D MRI and it is now ready to be tested next year on the ABIDE data in the MRI-siteA <==> MRI-siteB conversions	50%	100%
31/12/2019	M1.2 Implementation of first prototype of the harmonization algorithm for mammograms	The algorithm has been completed. A first version of the reconstruction model has been implemented and is validated in clinical conditions but only for materials of which dedicated physical phantoms are been made. Master thesis discussed in october 2020 (supervisors: M.E Fantacci and P. Oliva).	40%	70 %
31/12/2019	M2.1 Paper submitted, describing an innovative method of amyloid- PET quantification	The paper is published! Eur J Nucl Med Mol Imaging. 2020 Jan 25. doi: 10.1007/s00259-020-04689-y. “A kinetics-based approach to amyloid PET semi-quantification.”	50%	100%
31/12/2019	M2.2 Characterisation of PET dataset and its association to clinical variables	The construction of the entire PET dataset is completed. The association with clinical variables (EEG) with ML techniques is done. (master's degree). Work submitted to conference	50%	100 %
31/12/2019	M3.1 Creation of database for predictive models for Radiation Therapy treatments	Patients were selected. MRI, CT and dose distributions related to radiotherapy treatment were extracted from the different databases at Meyer and at the Radiotherapy Unit of Careggi Hospital (FI). The image database has been collected and it is ready for radiomic and dosiomic analysis. Clinical labels are available (under revision by clinical experts).	60%	100%
31/12/2019	M3.2b - Development and validation of an automatic classification method in CESM	A fully automatic system for automated breast cancer diagnosis based on CESM data has been designed as a diagnostic support tool for clinicians. The system performance is currently under evaluation on the available CESM data collection. A first paper on the clinical relevance of the technique has been published.	50%	100%
31/12/2019	M3.3 Database creation and development of analysis software for predictive models for transcranial-MR-guided Focused US Surgery	The Imaging database is almost completed, the clinical database is under construction because we are waiting for the 3- and 6-months follow-up after treatment. Software development is almost completed. Master Thesis completed and PhD Thesis in progress (supervisor: M. Marrale).	50%	90%
31/12/2019	M3.4 Development of a pipeline for the integration of multiple omics data in relation to drug target identification	Created a meta-database to integrate different types of data (Genomics, Metabolomics, drug-disease, disease-symptoms). A paper is in progress, and within the end of the year the meta-database has been tested internally by several visualization and search algorithms. The network is very big, so further computational optimization is necessary for full functionality.	80%	85 %
31/12/2019	M3.5 Database creation and development of analysis software for predictive models for tumor classification	The first batch of data have been acquired (June 2019) and the analysis pipeline has been implemented. The classification performance will be ultimately estimated when all the data will be made available. The full acquisition of data is still underway, even if a full analysis pipeline has been run on the data available up to now.	80%	85 %

Financial resources

Assegnazioni 2020 - Workspace

Menu : Expand All | Contract All

Bilancio 2020 > Globale > Gruppo V > Esperimento AIM > Riassuntivo assegnazioni

2020

Sez. & Suf.	MISS			CON			ALTRICONS			TRA			SEM			PUB			MAN			INV			LIC-SW			APP			SPSERVIZI			TOTALE		
	SJ	Dot.	Ant.	SJ	Dot.	Ant.	SJ	Dot.	Ant.	SJ	Dot.	Ant.	SJ	Dot.	Ant.	SJ	Dot.	Ant.	SJ	Dot.	Ant.	SJ	Dot.	Ant.	SJ	Dot.	Ant.	SJ	Dot.	Ant.	SJ	Dot.	Ant.	SJ	Dot.	Ant.
BA	4.0			1.0																													5		
	3.0			0.5																													3.5		0
BO	2.0			1.5																					1.0								4.5		
	2.0			1.0																					1.0								4.0		0
CA	3.0			1.0																													4		
	2.5			0.5																													3.0		0
CT	4.0			1.0																								1.0					6		
	3.5			0.5																								1.0					5.0		0
FI	4.0																																4		
	3.0																																3.0		0
GE	7.0			2.0																					1.0			5.5					15.5		
	5.5			1.0																					1.0			0.0		5.5			7.5		5.5
PI	6.0			0.5																								4.0					10.5		
	5.5			0.5																								3.0					9.0		0
TOTALE	30			7																					2			10.5					49.5	0	
			30			7			0			0			0			0			0			0			2			10.5			0			49.5	
	25	0	0	4	0	0																			2	0	0	4	0	5.5			35	0.0	5.5
			25.0			4.0			0.0			0.0			0.0			0.0			0.0			0.0			2.0			4.0			0.0			35.0	

Assegnazioni 2020 - Workspace

Menu : Expand All | Contract All

Bilancio 2019 > Globale > Gruppo V > Esperimento AIM > Riassuntivo assegnazioni

2019

Sez. & Suf.	MISS		CON		ALTRICONS		TRA		SEM		PUB		MAN		INV		LIC-SW		APP		SPSERVIZI		TOTALE	
		SJ		SJ		SJ		SJ		SJ		SJ		SJ		SJ		SJ		SJ		SJ		SJ
BA	7.0		2.0														2.0						11	
	2.5		0.5														2.0						5.0	
BO	2.0		1.5												4.5								8	
	1.5		0.5												2.5								4.5	
CA	3.0		1.0												1.5		1.0						6.5	
	1.5		0.5												1.5		1.0						4.5	
CT	5.0		1.0														1.5						7.5	
	1.5		0.5														1.5						3.5	
FI	4.5		1.0												1.5								7	
	1.5		0.5												1.0								3.0	
GE	3.5																1.0		10.5				15	
	1.5																1.0		9.0				11.5	
PI	4.5		3.0												7.5		7.0				2.0		24	
	3.0		1.0												0.0		4.5				0.0		8.5	
TOTALE	29.5		9.5												15		12.5		10.5		2		79	0
		29.5		9.5		0		0		0		0		0		15		12.5		10.5		2		79
	13		3.5												5		10		9		0		40.5	
		13.0		3.5		0.0		0.0		0.0		0.0		0.0		5.0		10.0		9.0		0.0		40.5

Assegnazioni 2020 - Workspace

Menu : Expand All | Contract All

Bilancio 2018 > Globale > Gruppo V > Esperimento AIM > Riassuntivo assegnazioni

2018 (ant)

Sez. & Suf.	MISS		CON		ALTRICONS		TRA		SEM		PUB		MAN		INV		LIC-SW		APP		SPSERVIZI		TOTALE	
		SJ		SJ		SJ		SJ		SJ		SJ		SJ		SJ		SJ		SJ		SJ		SJ
PI															7.5								7.5	
															0.0									
TOTALE															7.5								7.5	0
	0		0		0		0		0		0		0		7.5		0		0		0		7.5	
															0								0	
	0.0		0.0		0.0		0.0		0.0		0.0		0.0		7.5		0.0		0.0		0.0		7.5	

	Budget
2019 (+ant 2018)	48 kE
2020	35 kE

Today's Agenda

https://agenda.infn.it/event/21746/

AIM General Meeting

Pisa, INFN Division,
Largo B. Pontecorvo 3, 56127
Ed. C, Galileo Galilei meeting room (131), ground floor

Agenda - February 3rd, 2020
https://agenda.infn.it/event/21746/

9:30- 9:45 Welcome and Project summary (A. Retico, PI)

9:45-15:00 Reports by project tasks

AIM 1: Data harmonization

AIM1.T1 - Multi-site data harmonization in MRI (PI, BA, BO)
9:45-10:00 Uncovering the causes of site signature in MRI features of multicenter data [P. Bosco, PI]
10:00-10:15 An attempt to account for site effects in multicenter MRI data analysis with ML [F. Laruina, PI]

AIM1.T2 - Multi-site data harmonization in mammography (PI, CA)
10:15-10:30 Data harmonization in mammography: the tissue equivalent representation (P. Oliva, CA)

AIM 2: Quantification

AIM2.T1 - Quantification models in PET (GE, BO)
10:30-10:45 Status of the DORIAN initiative [F. Sensi, GE]
10:45-11:00 Update on amyloid PET: quantification, classification and clinics [E. Peira, GE]

11.00-11.30 Coffee break

11:30-11:45 Quality, harmonization and parcellation [N. Alchera, GE]

AIM2.T2 - Machine-learning (ML) and deep-learning (DL) methods for quantitative MRI (BO)
11:45-12:00 BYRON: a Deep Learning library for advanced Machine Learning (N. Curti, BO)
12:00-12:15 Deep Learning implementation of MRF data reconstruction [L. Peretti, PI]
12:15-12:30 Advancements in QSM data analysis (C. Testa, BO)

AIM 3: Predictive models

AIM3.T1 - Predictive models for Radiation Therapy (RT) treatments (FI, PI, CT)
12:30-12:45 Collection of the dataset for Radiomic and Dosiomic analysis in RT [S. Piffer, FI]
12:45-13:00 Preliminary classification results on data from Lung RT [M. Marrale, CT]
13:00-13:15 Challenges in ML analysis implementation on RT data [L. Ubaldi, PI]

AIM3.T2 - Predictive models for mammography and CESM (PI, CA, BA)
13:15-13:30 Update on predictive models for CESM data [S. Tangaro, BA]

13.30-14.15 Lunch break

AIM3.T3 - Predictive models for transcranial-MR-guided Focused Ultrasound Surgery (CT, BO)
14:15-14.30 Thalamic parcellation through probabilistic tractography for tcMRgFUS treatments. Preliminary results of fMRI analyses on TcMRgFUS patients (Remondini, BO; Marrale, Collura, CT)

AIM3.T4 - Predictive models for Systems Medicine (BO)
14:30-14.45 CHIMERA: a network of networks in medicine (D. Remondini, BO)

AIM3.T5 - Predictive models for tumor classification (BO,CT)
14.45-15:00 A short update (D. Remondini, Mengucci, BO, Marrale, CT)

15:00-16:30 Hot Topics in ML: Explainability and Interpretability of ML models

15:00-15:30 Explaining Explanation Methods: Overview and Applications (R. Guidotti, Dip. Comp. Sc. PI)
15:30-15:50 Explainable ML Framework for Multi-site Harmonization (A. Lombardi, BA)
15:50-16:10 Explainable ML in mammography (F. Lizzi, C. Scapicchio, PI)

16:10-17:00 Discussion, General Remarks and Conclusions

thank you