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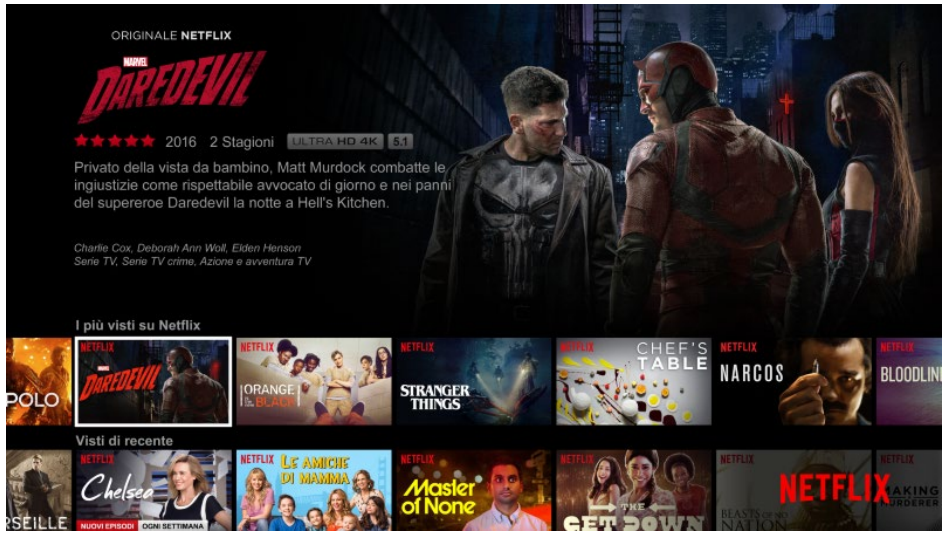
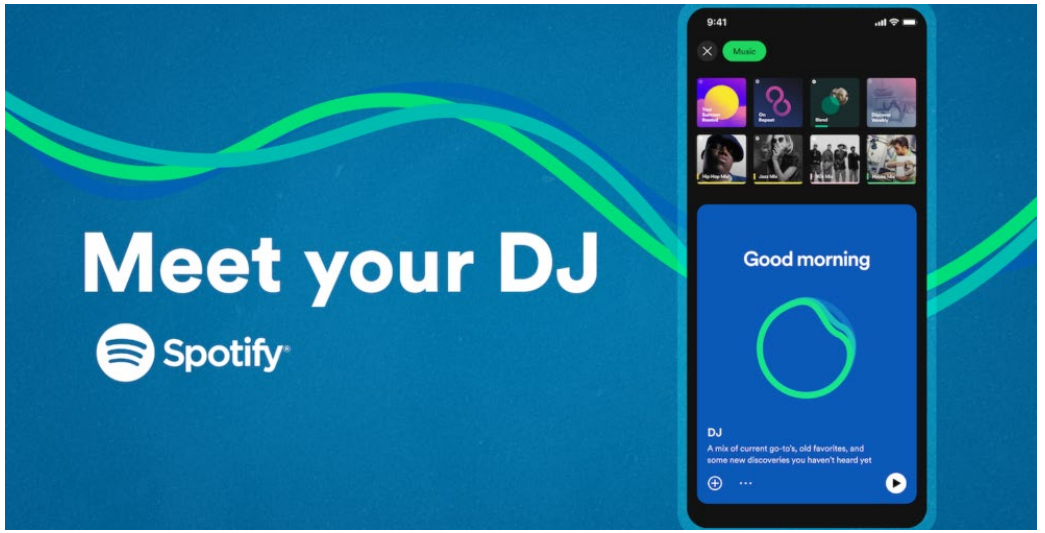
Asma e AI

Amelia Licari

Università di Pavia
Fondazione IRCCS Policlinico San Matteo


ORIGINALE NETFLIX
DAREDEVIL
2016 2 Stagioni ULTRA HD 4K 5.1
Privato della vista da bambino, Matt Murdock combatte le ingiustizie come rispettabile avvocato di giorno e nei panni del supereroe Daredevil la notte a Hell's Kitchen.
Charlie Cox, Deborah Ann Woll, Elden Henson
Serie TV, Serie TV crime, Azione e avventura TV
I più visti su Netflix
Visti di recente
STRANGER THINGS
CHEF'S TABLE
NARCOS
Chelsea
LE AMICHE DI MAMMA
Master of None
NETFLIX


Meet your DJ
Spotify
9:41
Music
Good morning
DJ
A mix of current go-to's, old favorites, and some new discoveries you haven't heard yet


15:35

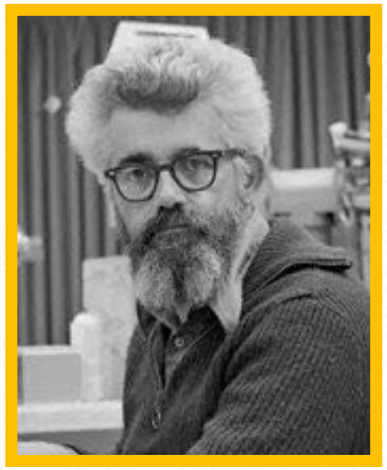

09:41
Lunedì 5 febbraio
09:41

AI = Artificial Intelligence

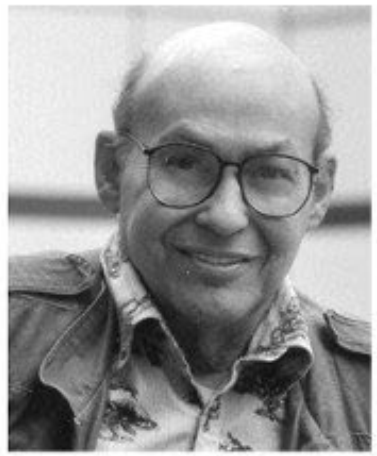
Ramo della tecnologia che consente ai computer e alle macchine di svolgere ***compiti*** che normalmente richiederebbero l'intelligenza umana:

- Riconoscimento di immagini
- Comprensione e risposta al linguaggio naturale
- Risoluzione di problemi
- Apprendimento da esperienze passate

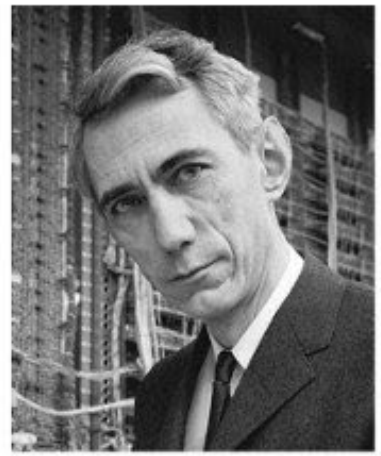
1956 Dartmouth Conference: The Founding Fathers of AI



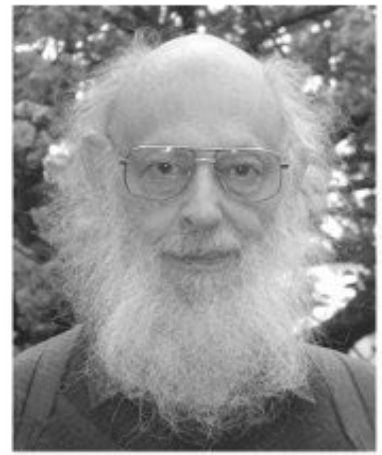
John MacCarthy



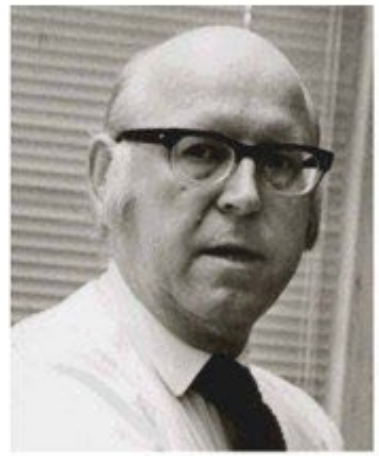
Marvin Minsky



Claude Shannon



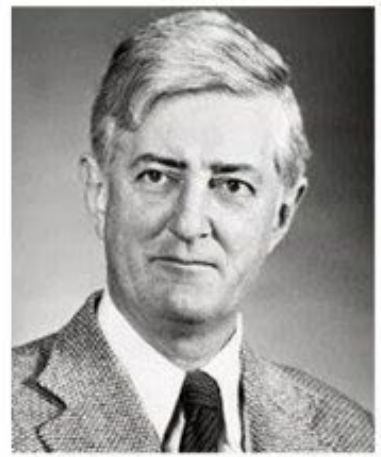
Ray Solomonoff



Alan Newell

Herbert Simon

Arthur Samuel



Oliver Selfridge

Nathaniel Rochester

Trenchard More

John MacCarthy

A PROPOSAL FOR THE

DARTMOUTH SUMMER RESEARCH PROJECT

ON ARTIFICIAL INTELLIGENCE

J. McCarthy, Dartmouth College
M. L. Minsky, Harvard University
N. Rochester, I. B. M. Corporation
C. E. Shannon, Bell Telephone Laboratories

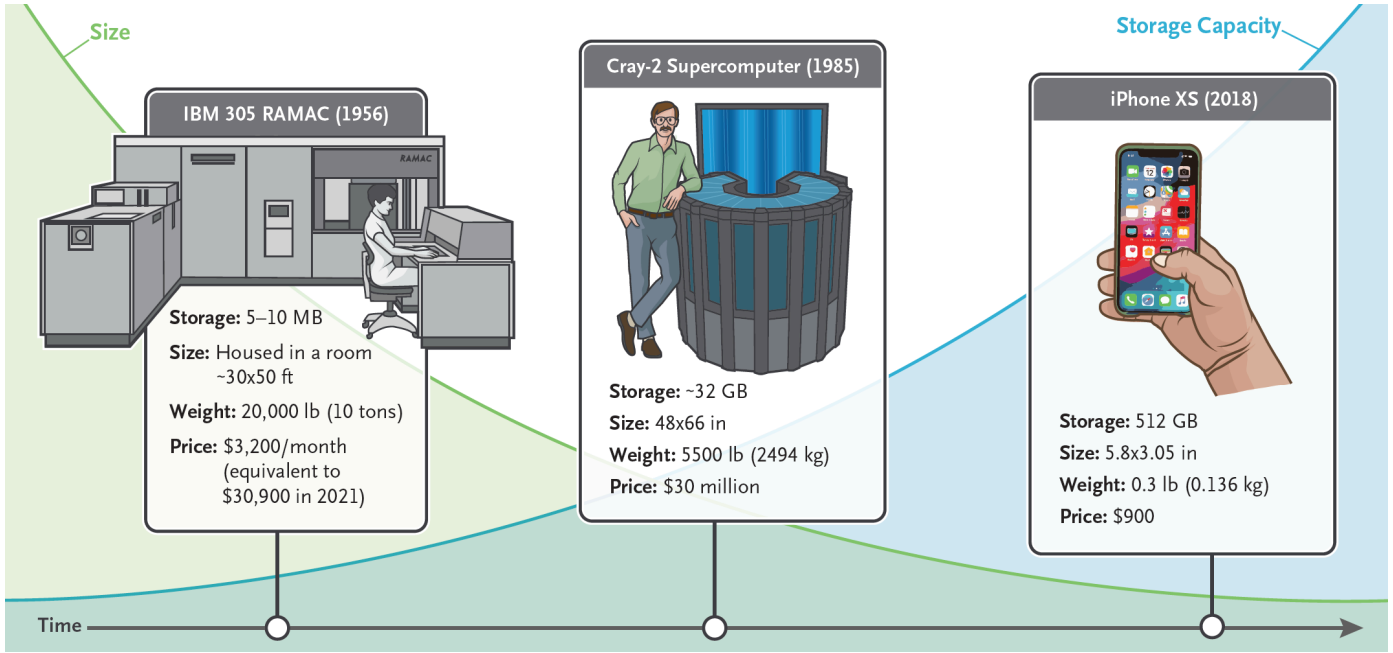
Darmouth University

Aree di studio chiave:

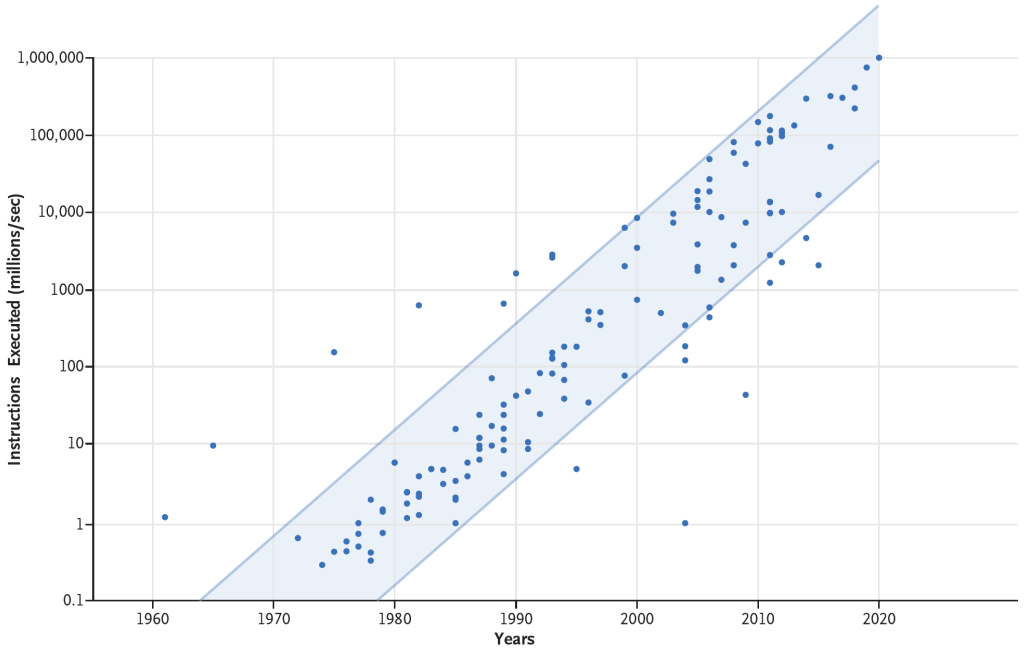
- Automazione dell'apprendimento e della risoluzione di problemi attraverso algoritmi
- Formalizzazione del linguaggio, della comprensione e della logica
- Progettazione di macchine che imitassero il ragionamento umano e la manipolazione dei simboli

Improvements over 50 Years in the Ability of Computers to Store and Process Data

Storage capacity



Speed



Haug CJ, Drazen JM. N Engl J Med. 2023 Mar 30;388(13):1201-1208.

L'Intelligenza Artificiale IMPARA

La parte più importante degli algoritmi di AI sono i DATI utilizzati per il loro sviluppo

E' molto importante tendere alla combinazione di GRANDI QUANTITÀ di dati che siano ETEROGENEI E RAPPRESENTATIVI

I sistemi di AI dovrebbero essere CONTINUAMENTE AGGIORNATI con un flusso continuo di dati perché producano risultati accurati

L'AI è una tecnica adatta a gestire informazioni MULTIMODALI (es. immagini diagnostiche, dati genetici e informazioni cliniche) per la predizione di un singolo esito

Pediatrics
NATIONWIDE
Advancing the Conversation on Child Health

Beyond the Wow Factor: Artificial Intelligence in Pediatrics

April 19, 2023 Katie Brind'Amour, PhD, MS, CHES

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AI in Medicine

Artificial Intelligence (AI) has tremendous potential to advance clinical practice and the delivery of patient care. A new Review article series, "AI in Medicine," explores the role of AI technology in clinical medicine and digital health, and examines the promise and pitfalls of its application across the health care continuum.

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Editorial | Artificial Intelligence and Pediatric Care

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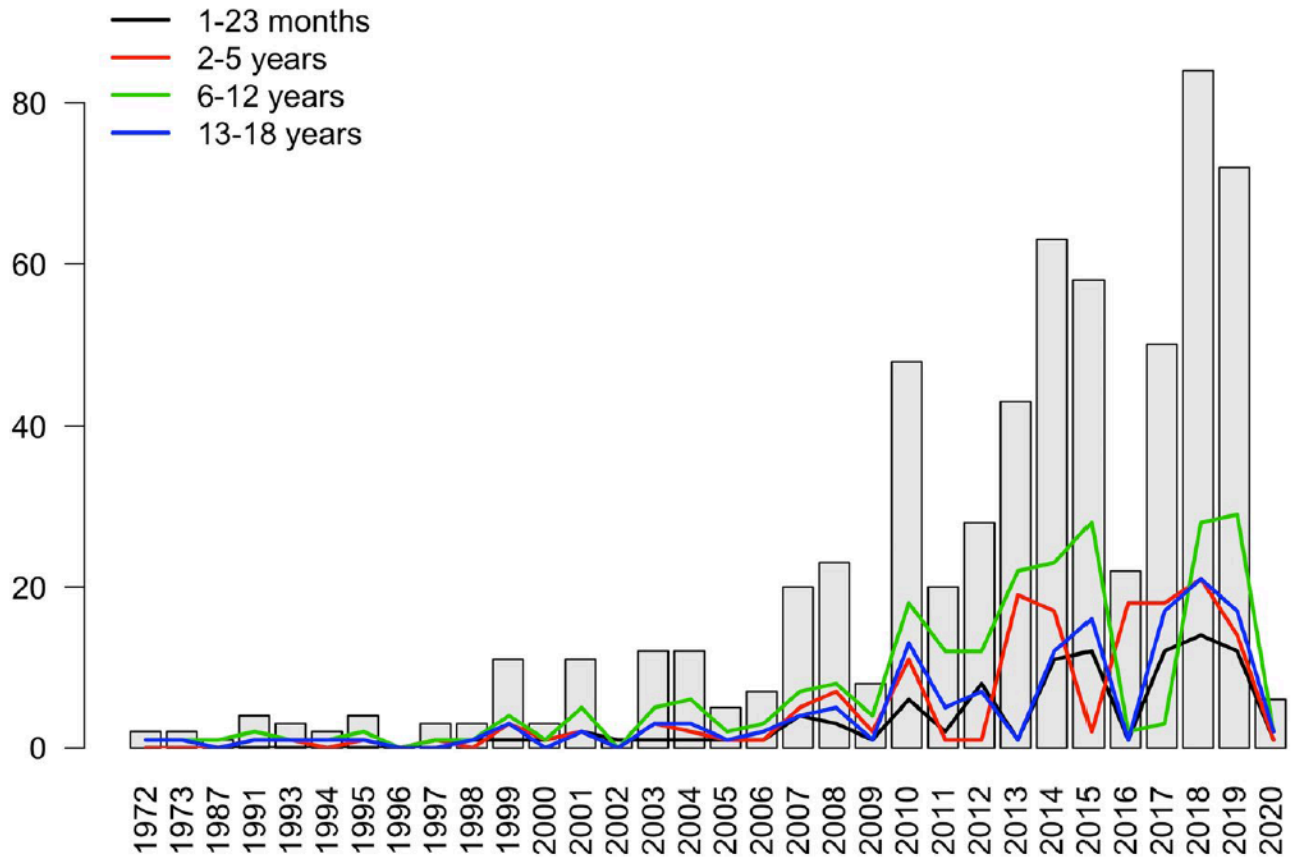
Call for Papers on Artificial Intelligence Applied to Pediatric Care

Artificial intelligence in the diagnosis of pediatric allergic diseases

Giuliana Ferrante[1] | Amelia Licari[2] | Salvatore Fasola[3] | Gian Luigi Marseglia[2] | Stefania La Grutta[3]



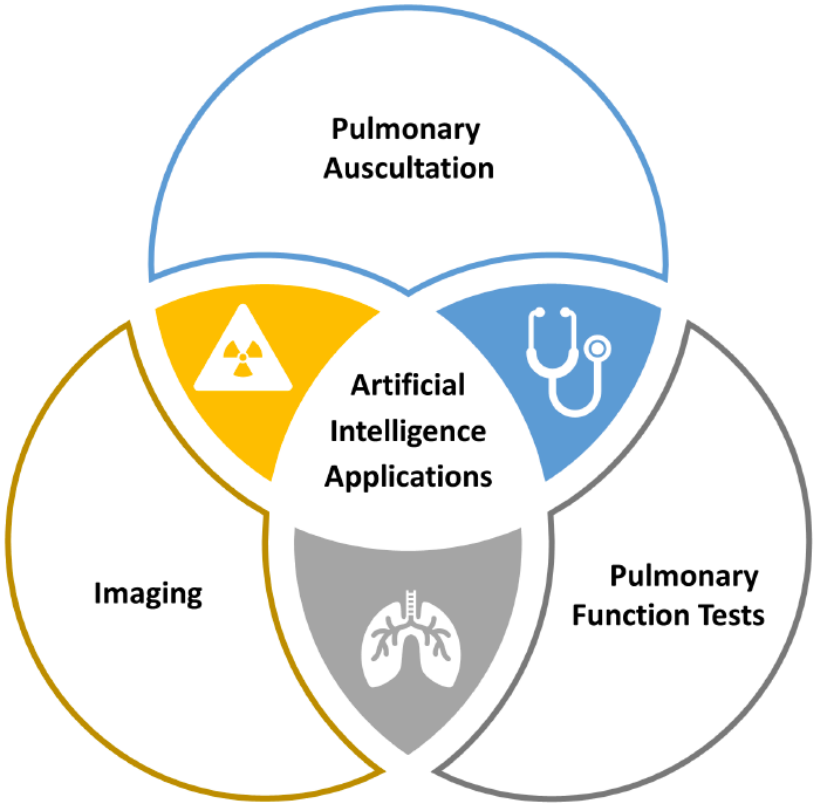
Pediatr Allergy Immunol. 2021 Apr;32(3):405-413. doi: 10.1111/pai.13419.

Official Journal of the Asian Pacific Society of Respirology
Respirology

Artificial intelligence as an emerging diagnostic approach in paediatric pulmonology

Giuliana Ferrante, MD, PhD,[1,2]* Amelia Licari, MD,[3]*
Gian Luigi Marseglia, MD[3] and
Stefania La Grutta, MD, PhD[1,2]

[1]*Department of Health Promotion Sciences, Maternal and Infant Care, Internal Medicine and Medical Specialities "G. D'Alessandro", University of Palermo, Palermo, Italy;*
[2]*Institute for Biomedical Research and Innovation (IRIB), National Research Council (CNR), Palermo, Italy;*
[3]*Pediatric Clinic, Department of Clinical, Surgical, Diagnostic and Pediatric Sciences, Fondazione IRCCS Policlinico San Matteo, University of Pavia, Pavia, Italy*



Respirology. 2020 Oct;25(10):1029-1030. doi: 10.1111/resp.13842.

What Is the Impact of Innovative Electronic Health Interventions in Improving Treatment Adherence in Asthma? The Pediatric Perspective

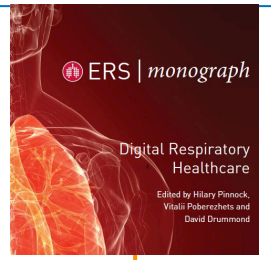
Amelia Licari, MD[a,*], Giuliana Ferrante, MD, PhD[b,*], Gian Luigi Marseglia, MD[a], Giovanni Corsello, MD[b], and Stefania La Grutta, MD, PhD[b,c] *Pavia and Palermo, Italy*

doi: 10.1016/j.jaip.2019.08.008

Medical assistive robots

Amelia Licari [1,2,3], Giuliana Ferrante[3,4], Velia Malizia [3], Agnese Augello[5] and Stefania La Grutta [3]

doi:10.1183/2312508X.10000523



Social robots and therapeutic adherence: A new challenge in pediatric asthma?

Giuliana Ferrante [a,1], Gianpaolo Vitale [b,1], Amelia Licari [c,*], Laura Montalbano [d], Giovanni Pilato [b], Ignazio Infantino [b], Agnese Augello [b,2], Stefania La Grutta [d,2]

doi: 10.1016/j.prrv.2020.11.001

Predicting paediatric asthma exacerbations with machine learning: a systematic review with meta-analysis

Martina Votto[1,2], Annalisa De Silvestri[3], Lorenzo Postiglione[1], Maria De Filippo[1,2], Sara Manti [4], Stefania La Grutta [5], Gian Luigi Marseglia[1,2] and Amelia Licari [1,2]

doi: 10.1183/16000617.0118-2024

Digital health interventions in children with asthma

Giuliana Ferrante[1] | Amelia Licari[2] | Gian Luigi Marseglia[2] | Stefania La Grutta[3]

doi: 10.1111/cea.13793

Machine learning: A modern approach to pediatric asthma

Giovanna Cilluffo[1] | Salvatore Fasola[1] | Giuliana Ferrante[2] | Amelia Licari[3,4] Giuseppe Roberto Marseglia[5] | Andrea Albarelli[5] | Gian Luigi Marseglia[3,4] | Stefania La Grutta[1]

doi: 10.1111/pai.13624

Artificial intelligence in the diagnosis of pediatric allergic diseases

Giuliana Ferrante[1] | Amelia Licari[2] | Salvatore Fasola[3] | Gian Luigi Marseglia[2] | Stefania La Grutta[3]

doi: 10.1111/pai.13419

Machine learning-enhanced HRCT analysis for diagnosis and severity assessment in pediatric asthma

Maria De Filippo MD[1,2] | Salvatore Fasola PhD[3] | Federica De Matteis MD[4] | Maria Sole Prevedoni Gorone MD[5] | Lorenzo Preda MD[4,5] | Martina Votto MD, PhD[1,2] | Velia Malizia MD[3] | Gian Luigi Marseglia MD[1,2] Stefania La Grutta MD, PhD[3] | Amelia Licari MD[1,2] doi: 10.1002/ppul.27183

Asma e AI in pediatria oggi

Diagnosi precoce e predizione del rischio

Identificazione dei fenotipi clinici

Analisi dei Big Data

Personalizzazione del trattamento

Monitoraggio remoto

Predizione delle riacutizzazioni

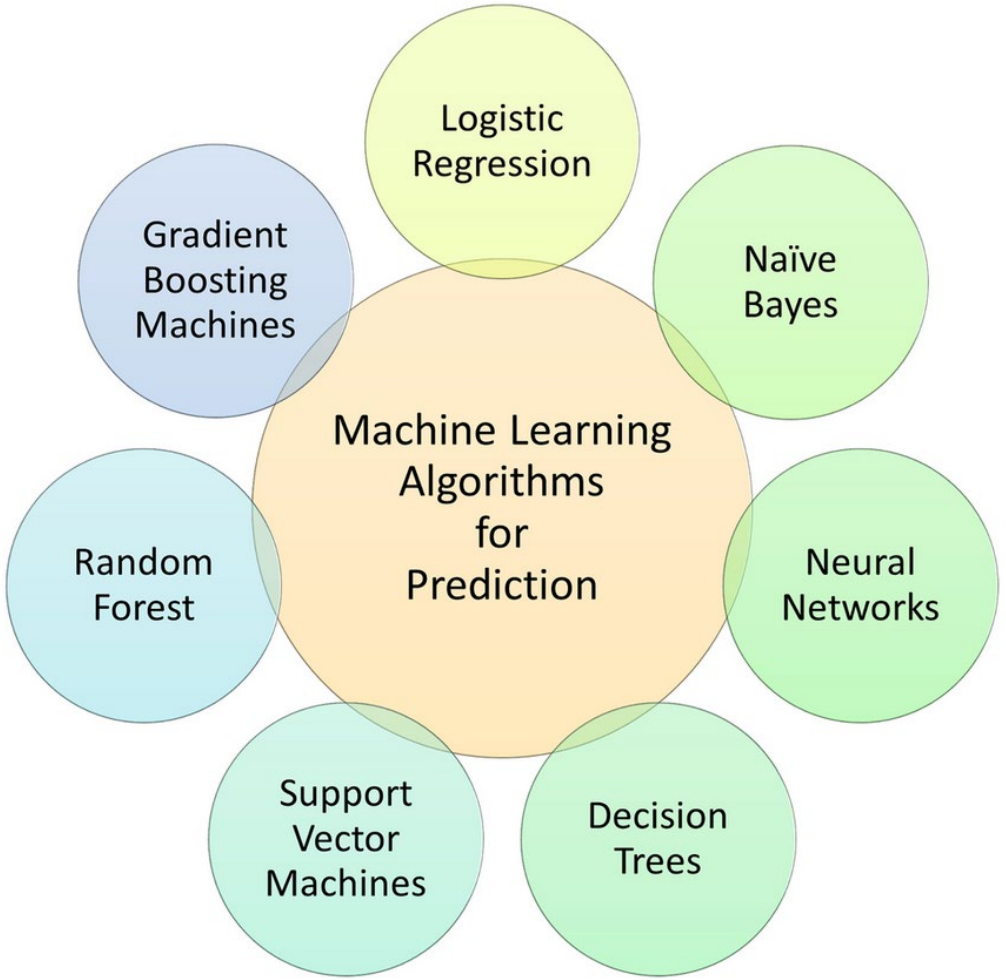
Sviluppo di farmaci e terapie

Supporto decisionale clinico

Analisi di immagini

Educazione e coinvolgimento del paziente e della famiglia

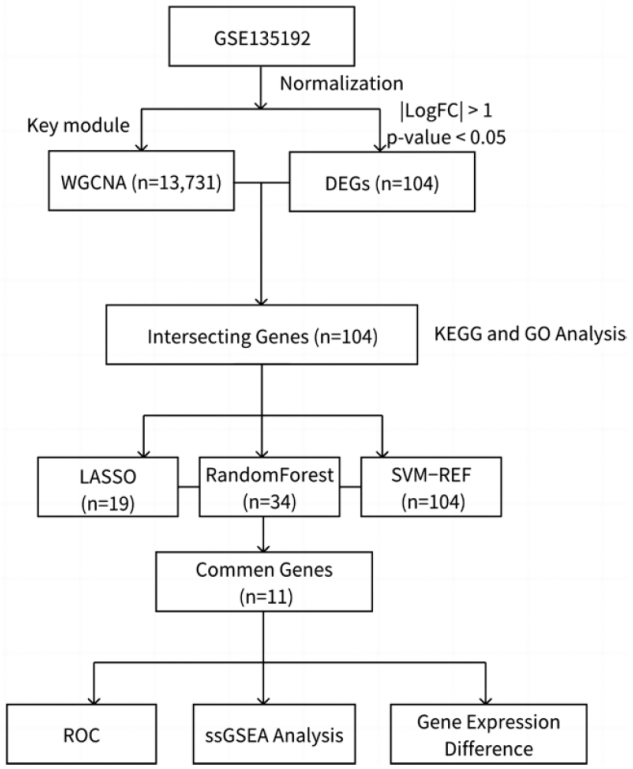
Diagnosi precoce e predizione del rischio

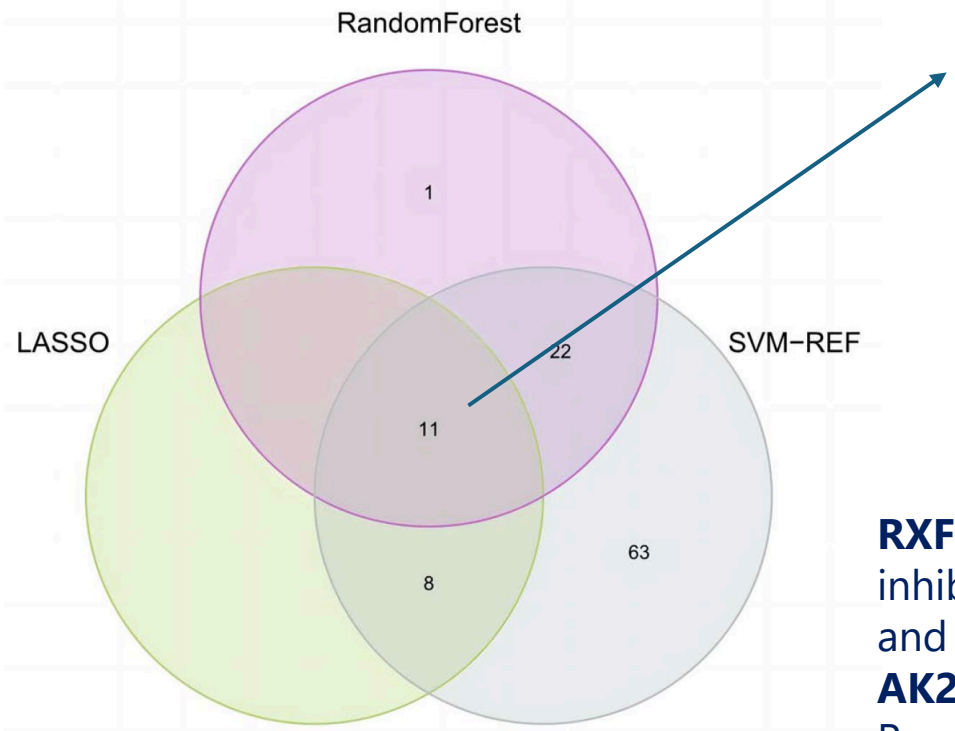


Darsha Jayamini WK, et al. J Med Syst. 2024 May 13;48(1):49.

Identification of biomarkers associated with pediatric asthma using machine learning algorithms

Three machine learning algorithms were used to cross-confirm and analyze gene expression profiles in asthmatic children based on whole transcriptome sequencing.



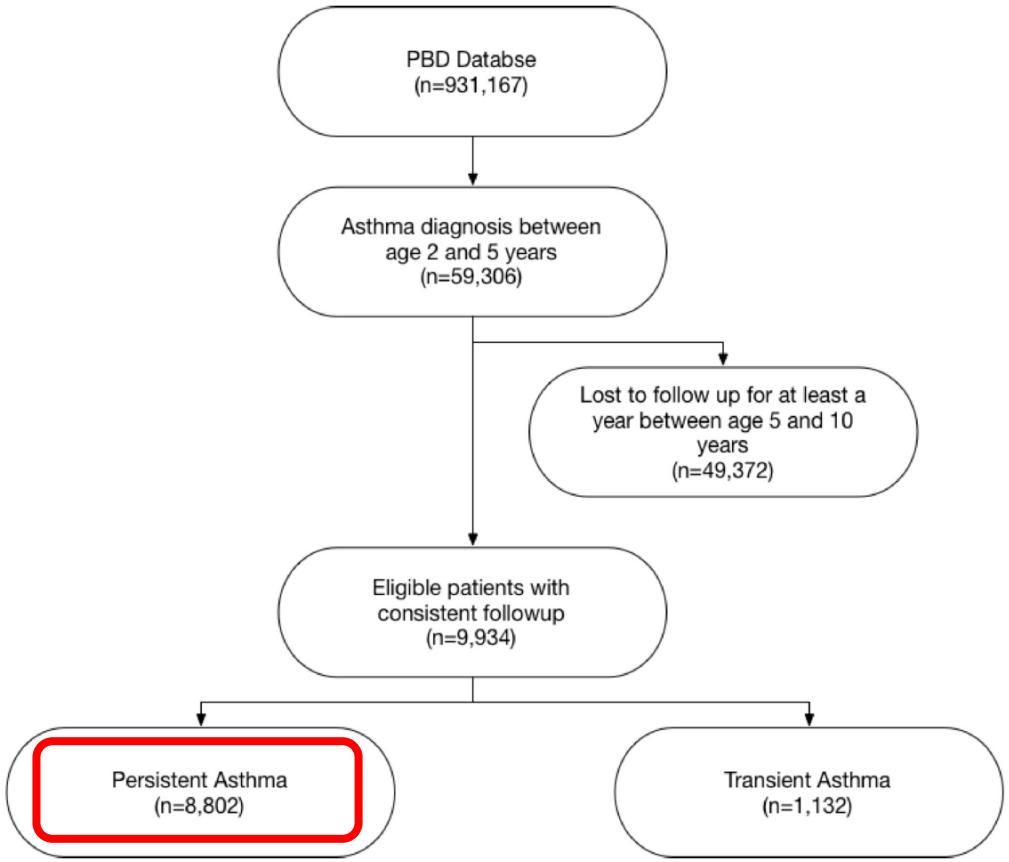


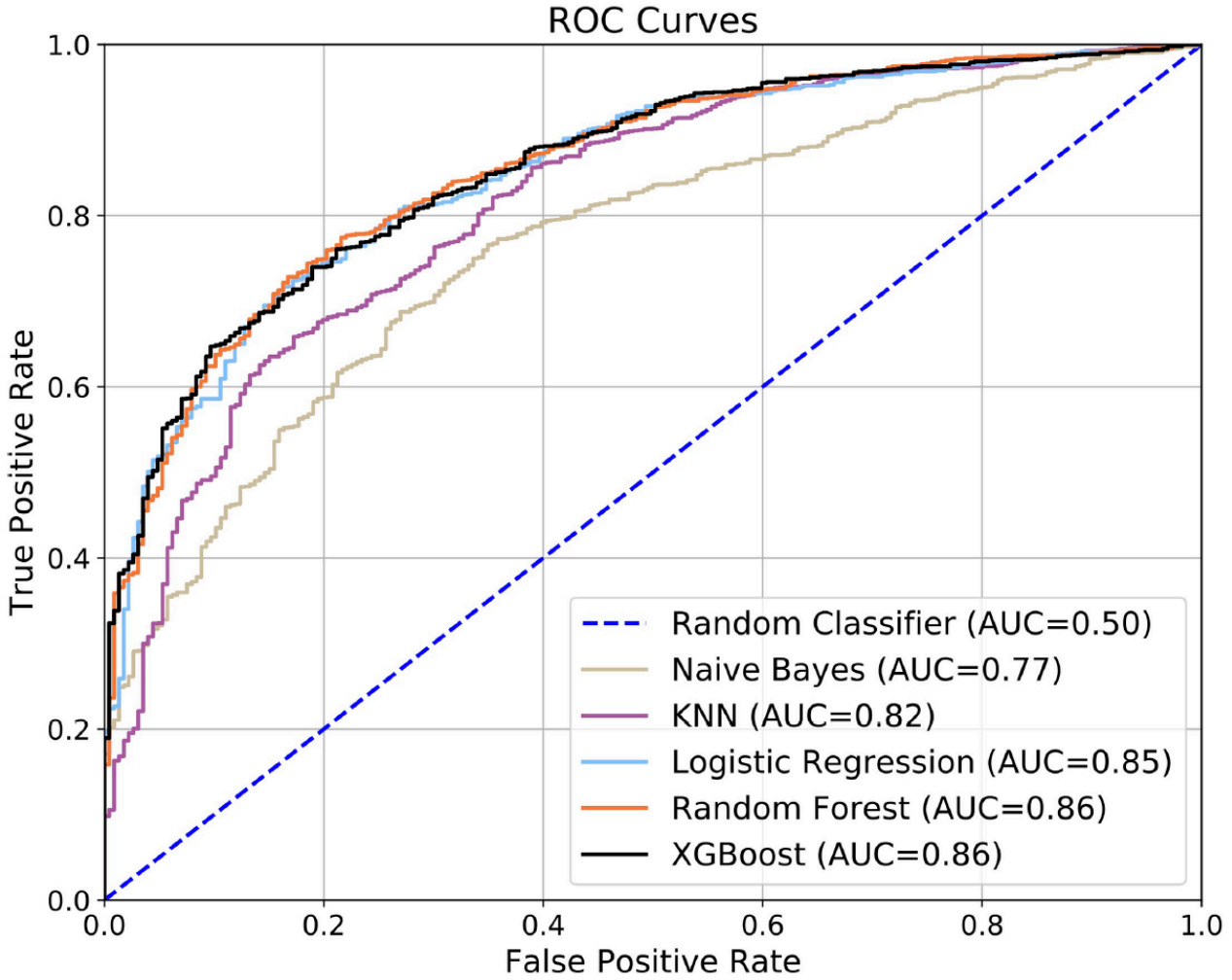
Gene	AUC
AK2	0.873
CREBZF	0.814
GZMH	0.796
LARP1B	0.783
NRL	0.792
NUMBL	0.835
PDK4	0.834
PER3	0.796
RXFP1	0.832
SCO2	0.827
VDAC3P1	0.819

RXFP1- relaxin receptor 1
inhibiting airway hyperresponsiveness and reversing established fibrosis
AK2/PDK4
Regulation of the immune responses

Lin K, et al. Medicine 2023;102:47(e36070).

Personalized prediction of early childhood asthma persistence: A machine learning approach



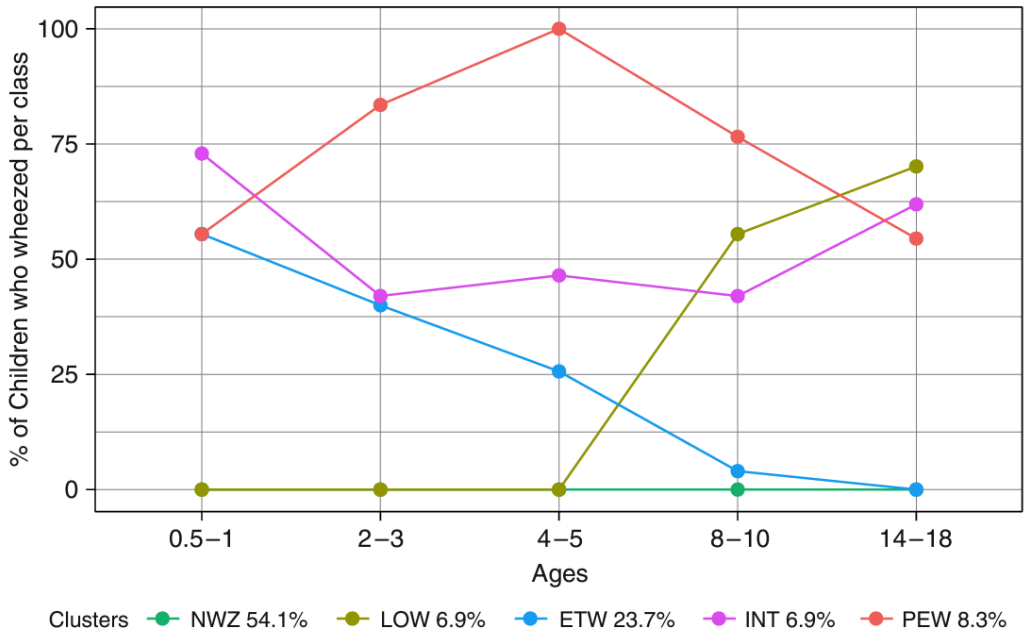


Bose S, et al. PLoS One. 2021 Mar 1;16(3):e0247784.

Understanding progression from pre-school wheezing to school-age asthma: Can modern data approaches help?

Five UK population-based birth cohorts (7,719 children):

1. ALSPAC (Avon Longitudinal Study of Parents and Children)
2. Ashford
3. IOW (Isle of Wight)
4. SEATON (Aberdeen) cohorts
5. MAAS (Manchester Asthma and Allergy Study)

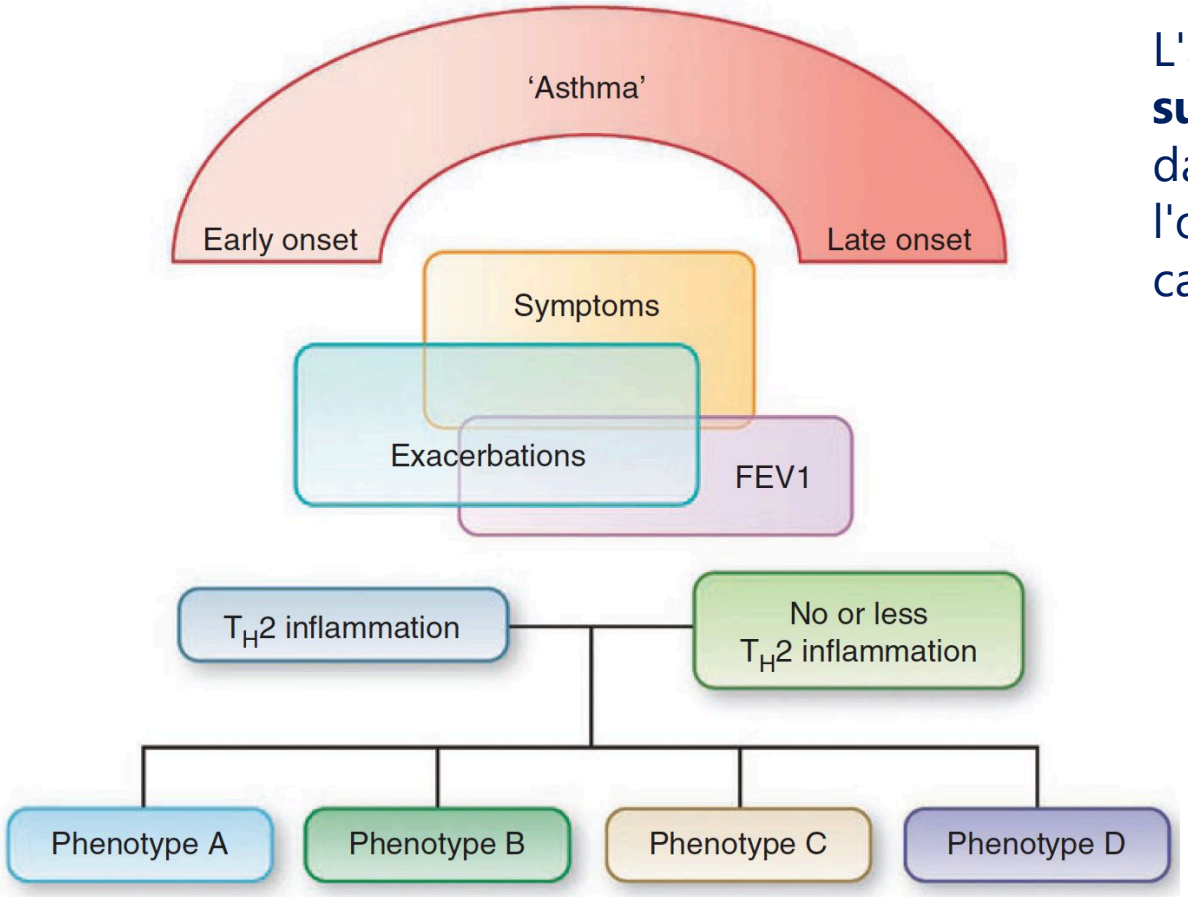


	Associations with Lung Function in Adolescence*		
	z-Scores for FEV_1‡	z-Scores for FVC‡	z-Scores for FEV_1/FVC‡
Never wheeze	Reference	Reference	Reference
Early transient	−0.103 (−0.19 to −0.02)	−0.014 (−0.10 to 0.07)	−0.151 (−0.24 to −0.07)
P value	**0.021**	0.748	**<0.0001**
Intermittent	−0.168 (−0.29 to −0.05)	0.054 (−0.06 to 0.17)	−0.379 (−0.49 to −0.27)
P value	**0.005**	0.37	**<0.0001**
Persistent	−0.326 (−0.45 to −0.20)	0.079 (−0.05 to 0.21)	−0.707 (−0.83 to −0.59)
P value	**<0.0001**	0.221	**<0.0001**
Late onset	−0.003 (−0.13 to 0.13)	0.159 (0.03 to 0.29)	−0.302 (−0.43 to −0.18)
P value	0.959	**0.015**	**<0.0001**

All wheeze phenotypes were associated with diminished lung function in adolescence and early adulthood, with the greatest impairment in PEW and INT.

Custovic D, et al.Pediatr Allergy Immunol. 2023 Dec;34(12):e14062.
Haider S, et al.Am J Respir Crit Care Med. 2022 Apr 15;205(8):883-893.

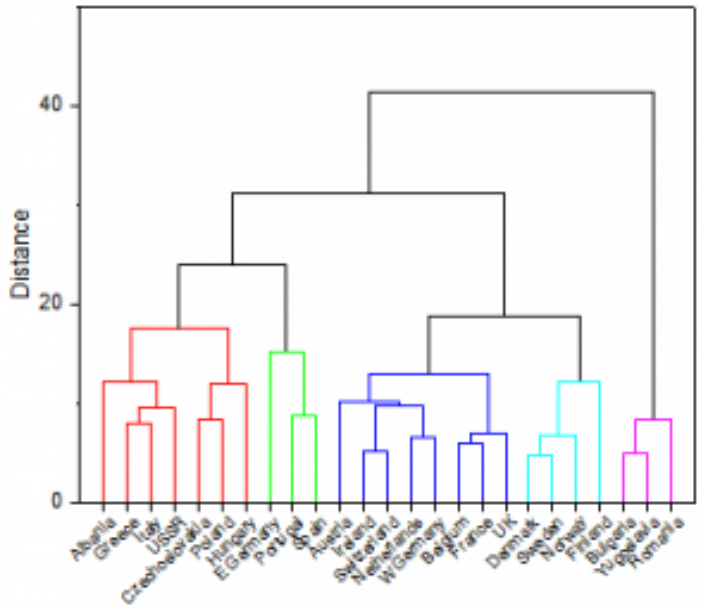
Identificazione dei fenotipi clinici



Wenzel SE. Nat Med. 2012 May 4;18(5):716-25.

Analisi dei cluster (clustering)

L'analisi dei cluster è una tecnica di **apprendimento non supervisionato** usata per identificare gruppi (cluster) in un dataset. Non ci sono etichette predefinite nei dati, quindi l'obiettivo è scoprire gruppi nascosti basati su determinate caratteristiche o metriche di somiglianza.



Identificazione dei fenotipi clinici

ML approach	Study design and participants	Distinctive features of asthma clusters	Clusters identified	Ref.
Hierarchical clustering	Cross-sectional, 613 asthmatic children	Age of onset, allergic sensitization, severity, and exacerbations in the previous year	– Early-onset mild atopic asthma – Early-onset mild non-atopic asthma – Late-onset asthma – Difficult asthma – Exacerbation-prone asthma	Deliu et al.[1]
k-means clustering	Cross-sectional, 351 asthmatic children from the Taiwanese Consortium of Childhood Asthma Study	Lung function, symptom frequency, healthcare utilization, percentages of eosinophils and neutrophils in peripheral blood, and serum IgE	– Asthma with elevated RBC and wheeze episodes – Neutrophil-predominant asthma – Allergic asthma with preserved pulmonary function – Eosinophil-predominant asthma with poor pulmonary function – Asthma with low wheeze episodes	Su et al.[2]
LCA	Cross-sectional, 2593 children with mild to moderate persistent asthma	Demographic features, asthma control, sensitization, type 2 inflammatory markers, and lung function	– Multiple sensitization with partially reversible airflow limitation – Multiple sensitization with reversible airflow limitation – Lesser sensitization with reversible airflow limitation – Multiple sensitization with normal lung function – Lesser sensitization with normal lung function	Fitzpatrick et al.[3]

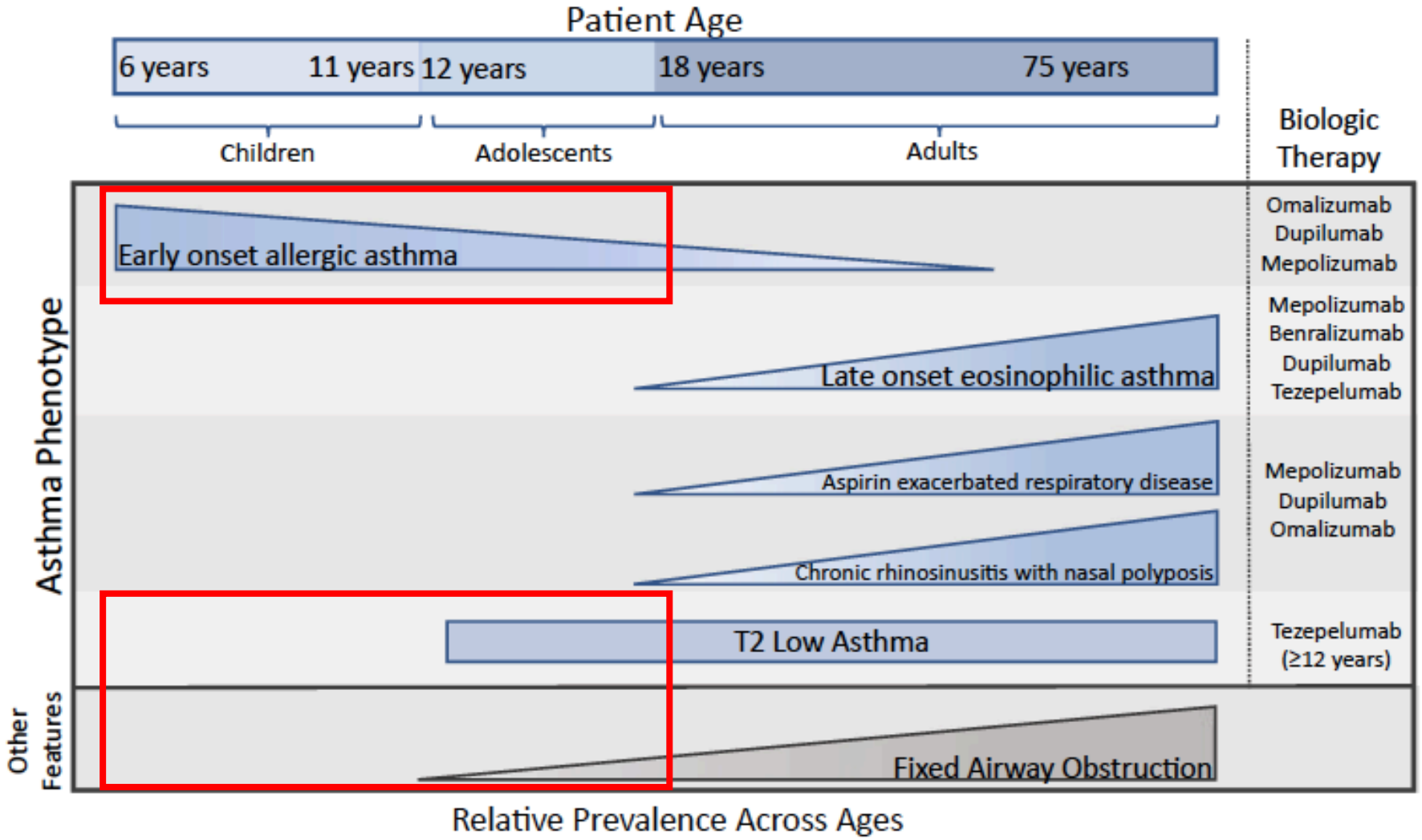
Cilluffo G, Fasola S, Ferrante G, Licari A, Marseglia GR, Albarelli A, Marseglia GL, La Grutta S. Pediatr Allergy Immunol. 2022 Jan;33 Suppl 27(Suppl 27):34-37.

Identificazione dei fenotipi clinici

	SARP	Asthma Phenotypes in the Inner City (APIC)
Age of cohort	School-age children	Low-income urban children/ adolescents
No. of clusters	4	5
Primary distinctions between clusters within each study	• Asthma duration • Number of controller medications • Baseline lung function	• Asthma and rhinitis severity • Airway obstruction, baseline bronchodilator response • Allergic sensitization/ inflammation
Notable findings in clusters	• Clusters determined as much by the magnitude of allergic sensitization and duration of asthma as by airflow limitation and hyperinflation • All clusters had some degree of atopy, though the magnitude of allergic sensitization differed	• Four clusters had striking parallel relationships between allergic sensitization and indicators of asthma/ rhinitis severity • One cluster with comparatively low allergy and modestly impaired pulmonary physiology (remained highly symptomatic)
Severe asthma	Severe asthma participants existed across all clusters	Severe asthma often co-clustered with highly atopic children

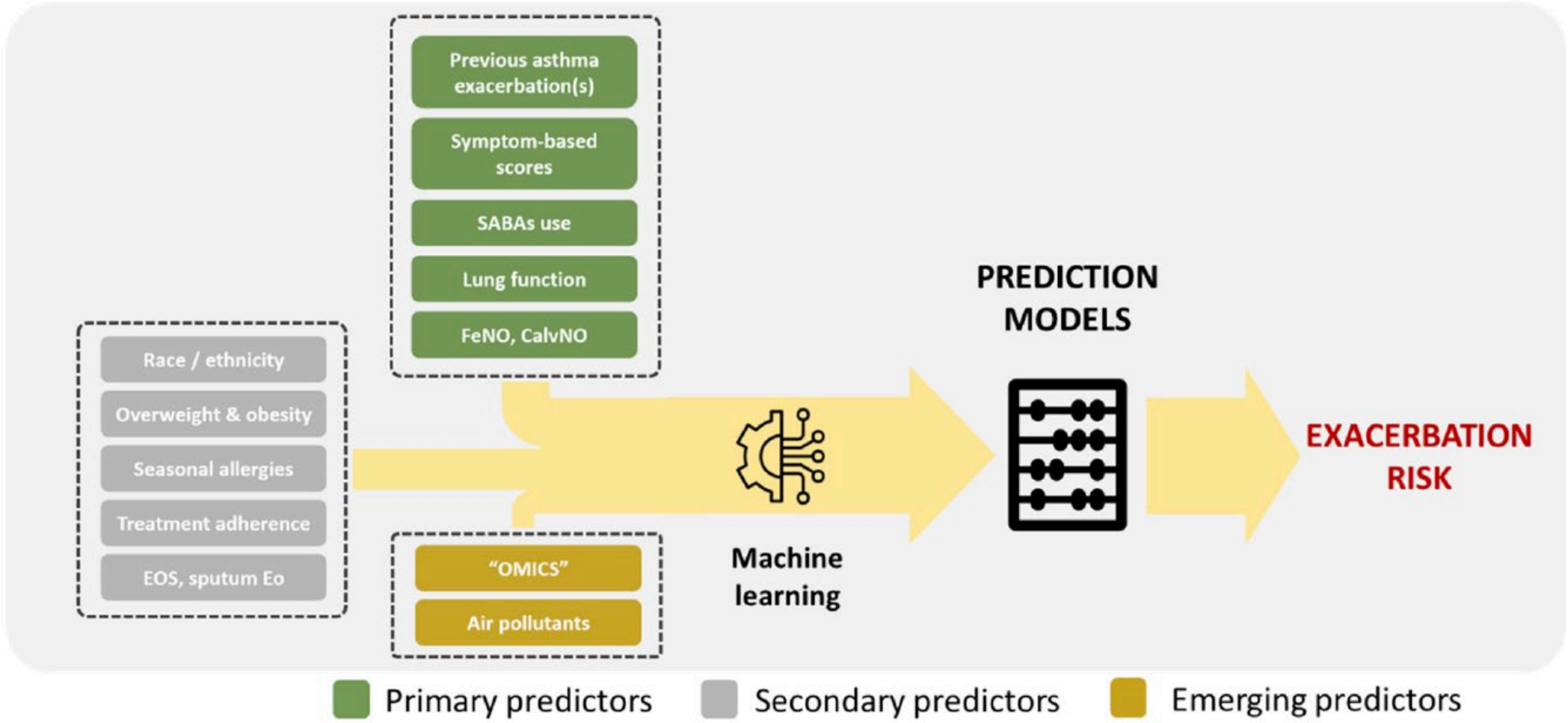
Gaberino CL et al. J Allergy Clin Immunol Pract. 2023 Sep;11(9):2673-2682.

Identificazione dei fenotipi clinici



Gaberino CL et al. J Allergy Clin Immunol Pract. 2023 Sep;11(9):2673-2682.

Predizione delle riacutizzazioni



Votto M, De Silvestri A, Postiglione L , Manti S, La Grutta S, Marseglia GL, Licari A. Eur Respir Rev. 2024. 240118 [DOI: 10.1183/16000617.0118-2024].

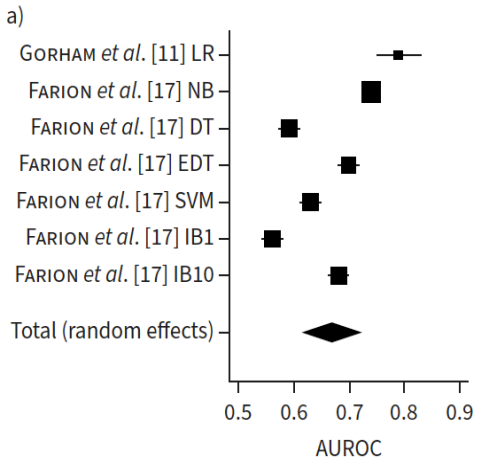
Predicting paediatric asthma exacerbations with machine learning: a systematic review with meta-analysis

- **Study characteristics**: Seven studies included; 17 ML-based models were analyzed.
- **Types of Models**: Logistic regression, random forests, and gradient boosting were the most common algorithms.
- **Predictors**: Age, past asthma-related admissions, inhaled steroid use, and air quality were common predictors.

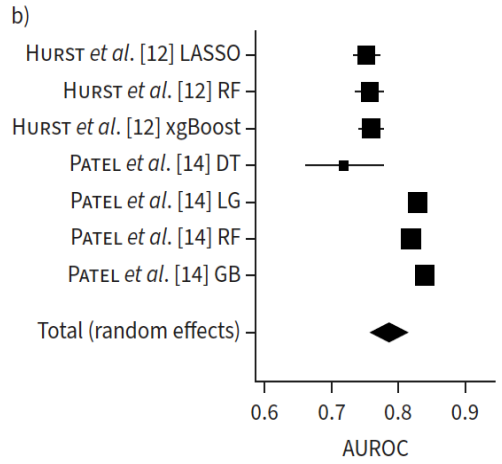
► **Strengths of ML Models**: Potential to improve early identification of high-risk children.

► **Limitations**: High heterogeneity between studies; lack of standardized asthma diagnostic criteria across studies; need for further validation of ML models.

ED admission (0.67)



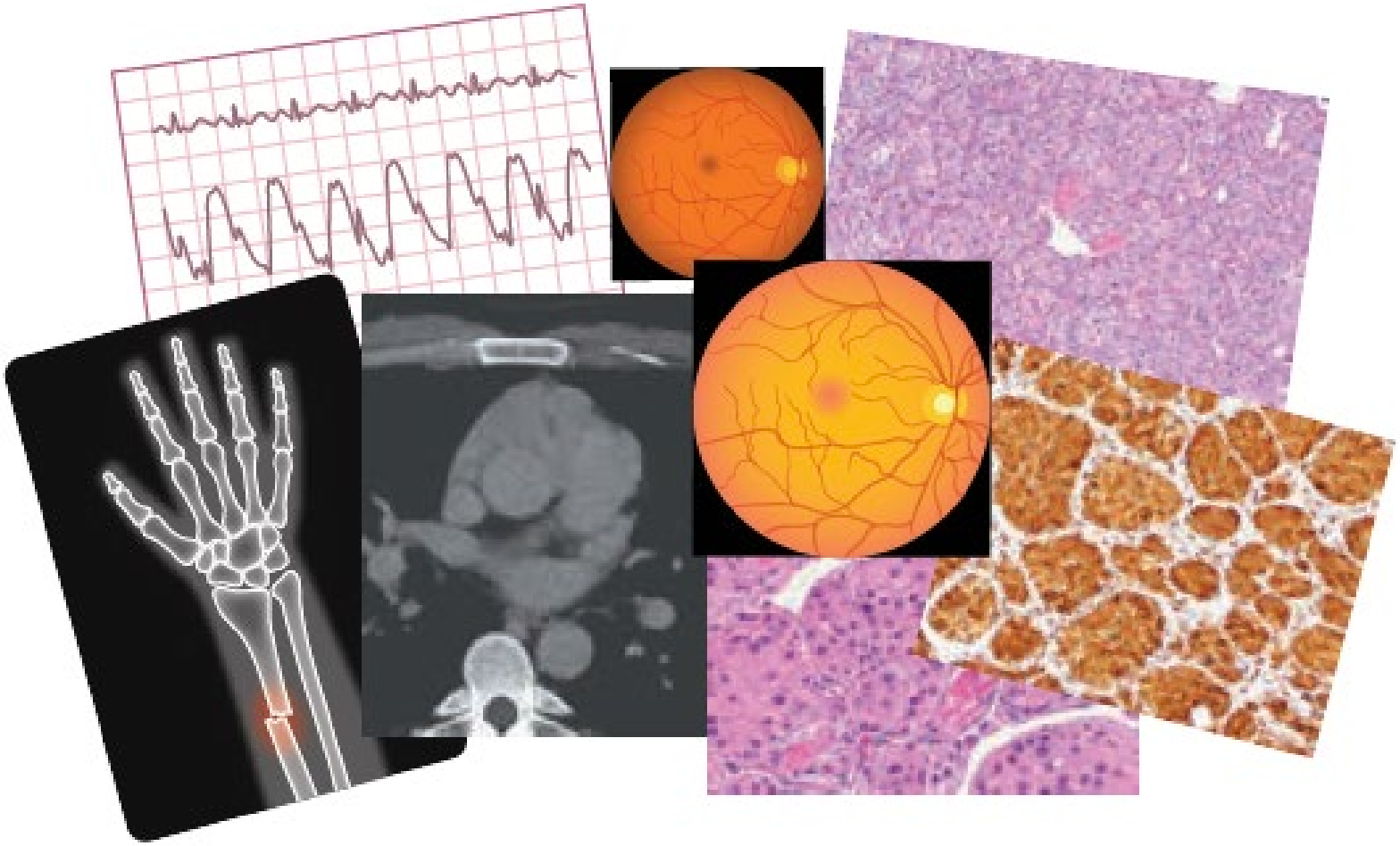
Hospitalization (0.79)



*ML algorithms show promise for predicting pediatric asthma exacerbations, **particularly hospitalizations**, but require further validation before clinical implementation.*

Votto M, De Silvestri A, Postiglione L , Manti S, La Grutta S, Marseglia GL, Licari A. Eur Respir Rev. 2024. 240118 [DOI: 10.1183/16000617.0118-2024].

Analisi di immagini



Pediatric severe asthma: high-resolution ct features

Maria De Filippo, Salvatore Fasola, Martina Votto, Maria Sole Prevedoni Gorone, Gian Luigi Marseglia, Stefania La Grutta, Amelia Licari

Chest high-resolution computed tomography (HRCT) is conditionally recommended to rule out conditions that mimic or coexist with severe asthma in children.

- **Retrospective case-control study** compared children with **SA** (as defined by ERS/ATS guidelines) to age- and sex-matched controls without asthma (**C**).
- 20 children with **SA** (40% females, mean age 10.4 years) and 21 **C** (48% females, mean age 11.4 years).
- Chest HRCT examinations were performed using a **64-sectionmultidetector CT scanner** (Aquilion Toshiba One) at full inspiration (total lung capacity) following a dedicated low-dose volumetric protocol.
- **Software**: COPD (Chronic Obstructive Pulmonary Disease) application within IntelliSpace Portal release 9 (Philips Medical Systems Best, the Netherlands).

ClinicalTrials.gov ID: NCT05140889

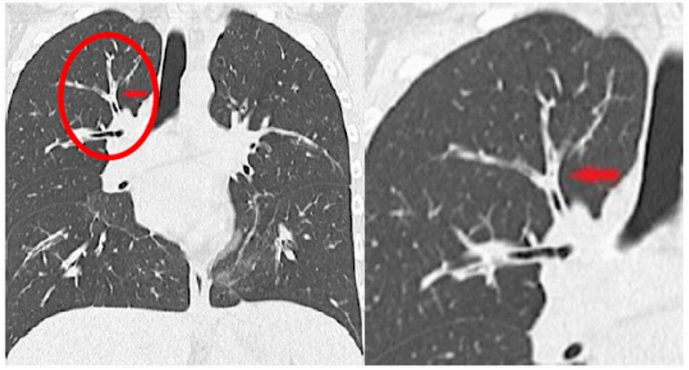
This study is a part of the research project"Integrating deep learning CT-scan model, biological and clinical variables to predict severity of asthma in children" (BREATHE, protocol number 0003233/22) funded by the 5×1000, Ricerca Corrente, Fondazione IRCCS Policlinico San Matteo, Pavia, Italy.

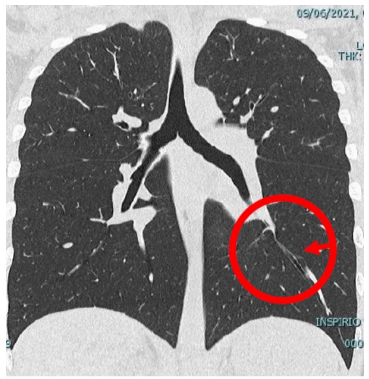
European Respiratory Journal 2023 62: PA2083; DOI: 10.1183/13993003.congress-2023.PA2083

Pediatric severe asthma: high-resolution ct features

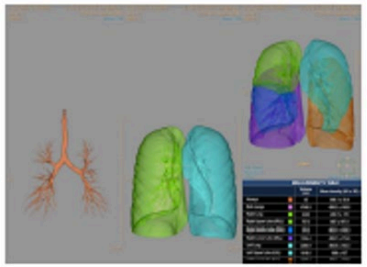
Maria De Filippo, Salvatore Fasola, Martina Votto, Maria Sole Prevedoni Gorone, Gian Luigi Marseglia, Stefania La Grutta, Amelia Licari

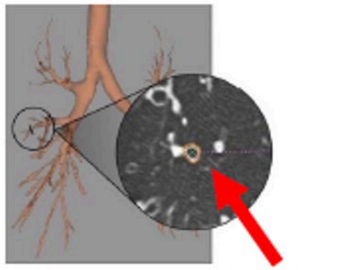
	C	SA	P
Bronchial thickening (BT)	0.0	0.9	<0.001
Airway wall thickness percentage (AWT%)	34.8	43.9	<0.001
Bronchiectasis grading (BG) score	0.0	0.2	0.016
Bronchiectasis severity grading (BS) score	0.0	0.2	0.016
Mucus plugging	0.0	6	0.009
Centrilobular emphysema	0.0	6	0.009

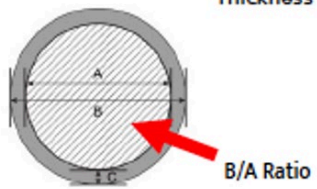




- The percentage of airway wall thickness (**AWT%**) was calculated as follows: **AWT% = [(Do-Di)/Do] x 100**; outer (Do) and inner (Di) diameters.







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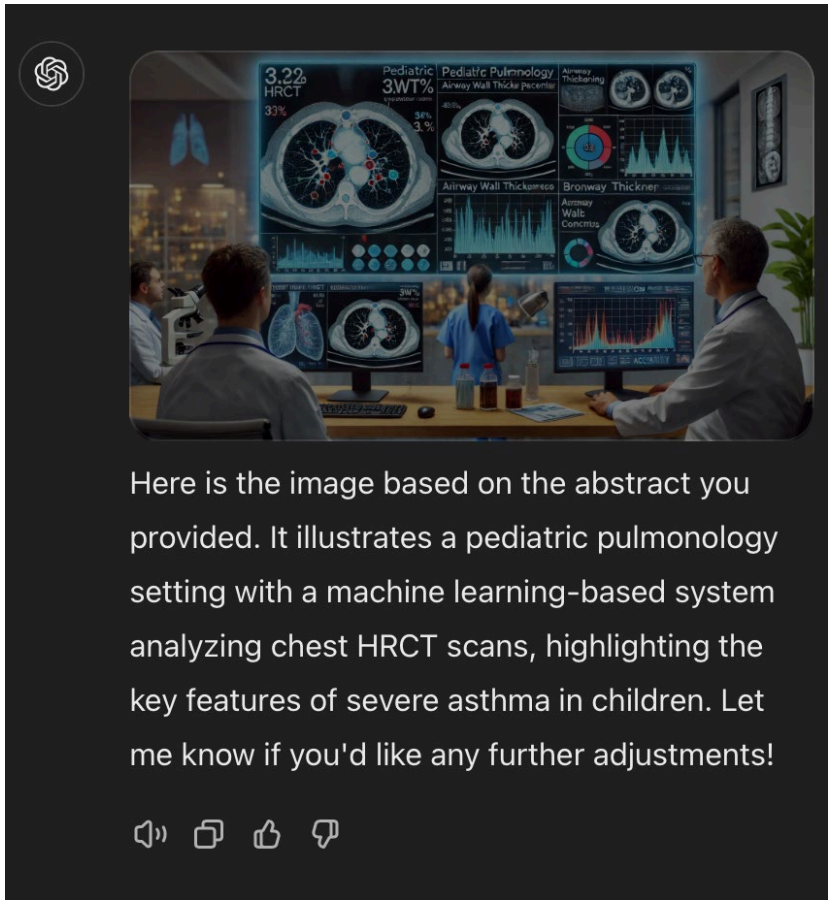
Machine learning-enhanced HRCT analysis for diagnosis and severity assessment in pediatric asthma



De Filippo M, Fasola S, De Matteis F, Gorone MSP, Preda L, Votto M, Malizia V, Marseglia GL, La Grutta S, Licari A. Pediatr Pulmonol. 2024 Jul 23. doi: 10.1002/ppul.27183. Epub ahead of print.

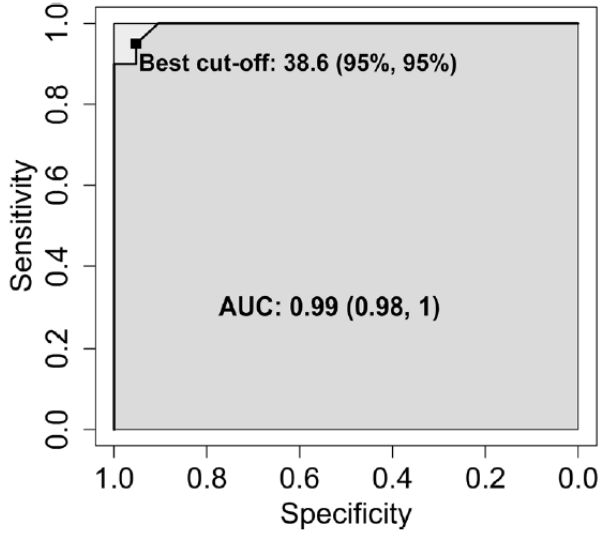
Machine learning-enhanced HRCT analysis for diagnosis and severity assessment in pediatric asthma

The study aimed to develop a machine learning (ML) model classifying severe asthma cases based on radiological findings.

	Classification tree		Random Forest		AWT% ≥ 38.6	
	Training set	Cross-validated	Training set	Cross-validated	Training set	Cross-validated
Sensitivity	95%	90%	95%	95%	95%	90%
Specificity	100%	90%	100%	100%	95%	90%
Accuracy	98%	90%	98%	98%	95%	90%

Statistical analysis: classification trees, random forests, and conventional ROC analysis to identify the most significant imaging features that mark **SA** from **C**.

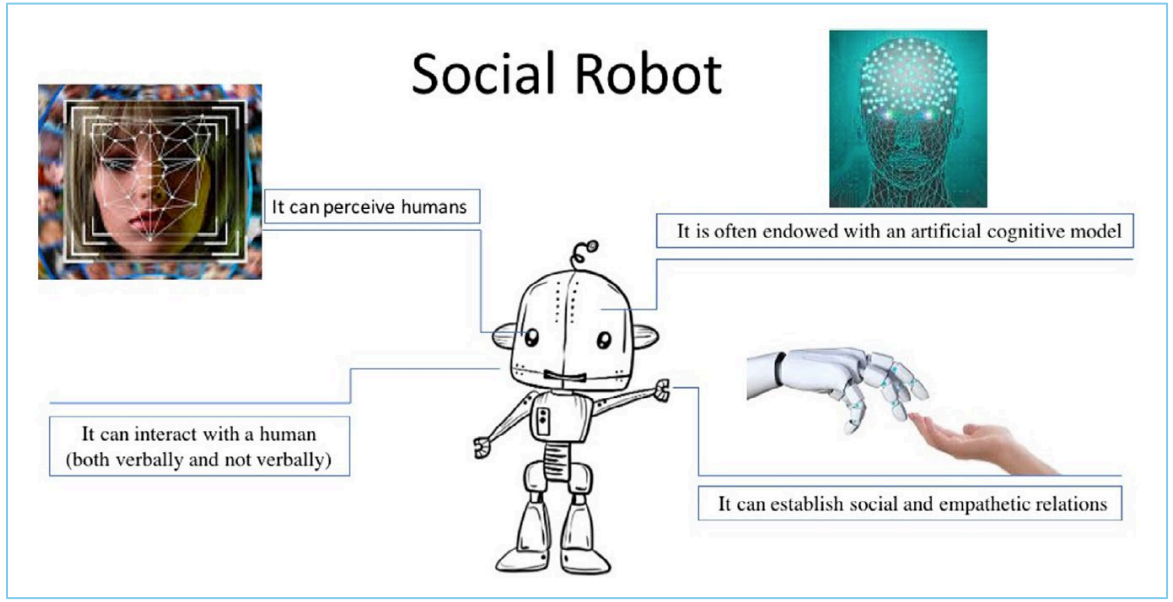
Using **airway wall thickness percentage AWT%** as the predictor in conventional ROC analysis, an **AWT% ≥ 38.6 emerged as the optimal classifier for discriminating severe asthmatics from controls, with 95% sensitivity, specificity, and overall accuracy.**



ClinicalTrials. gov (NCT0514088)

De Filippo M, Fasola S, De Matteis F, Gorone MSP, Preda L, Votto M, Malizia V, Marseglia GL, La Grutta S, Licari A. Pediatr Pulmonol. 2024 Jul 23. doi: 10.1002/ppul.27183. Epub ahead of print.

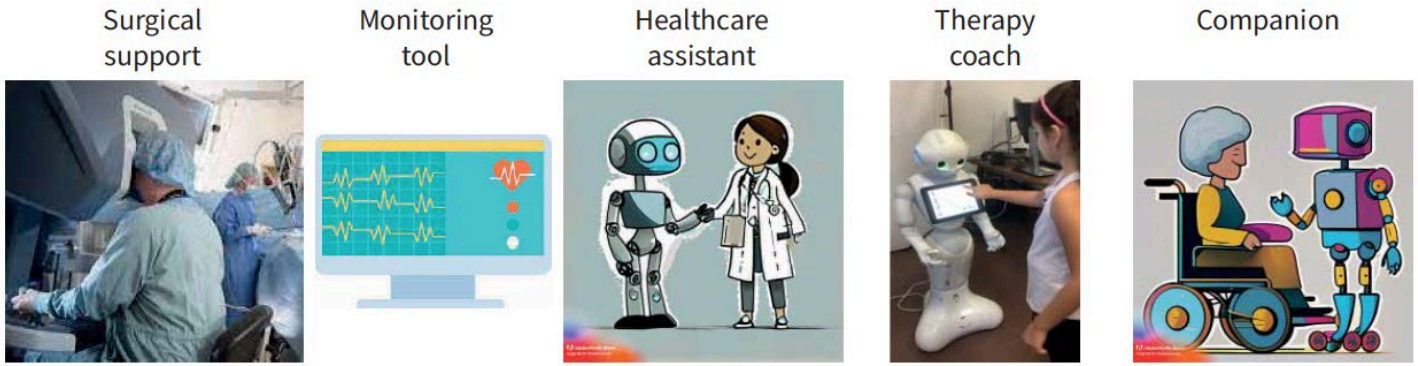
Educazione e coinvolgimento del paziente e della famiglia



A **social robot** is an autonomous or semi- autonomous robot that interacts and communicates with humans by following the behavioral norms expected by the people with whom the robot is intended to interact.

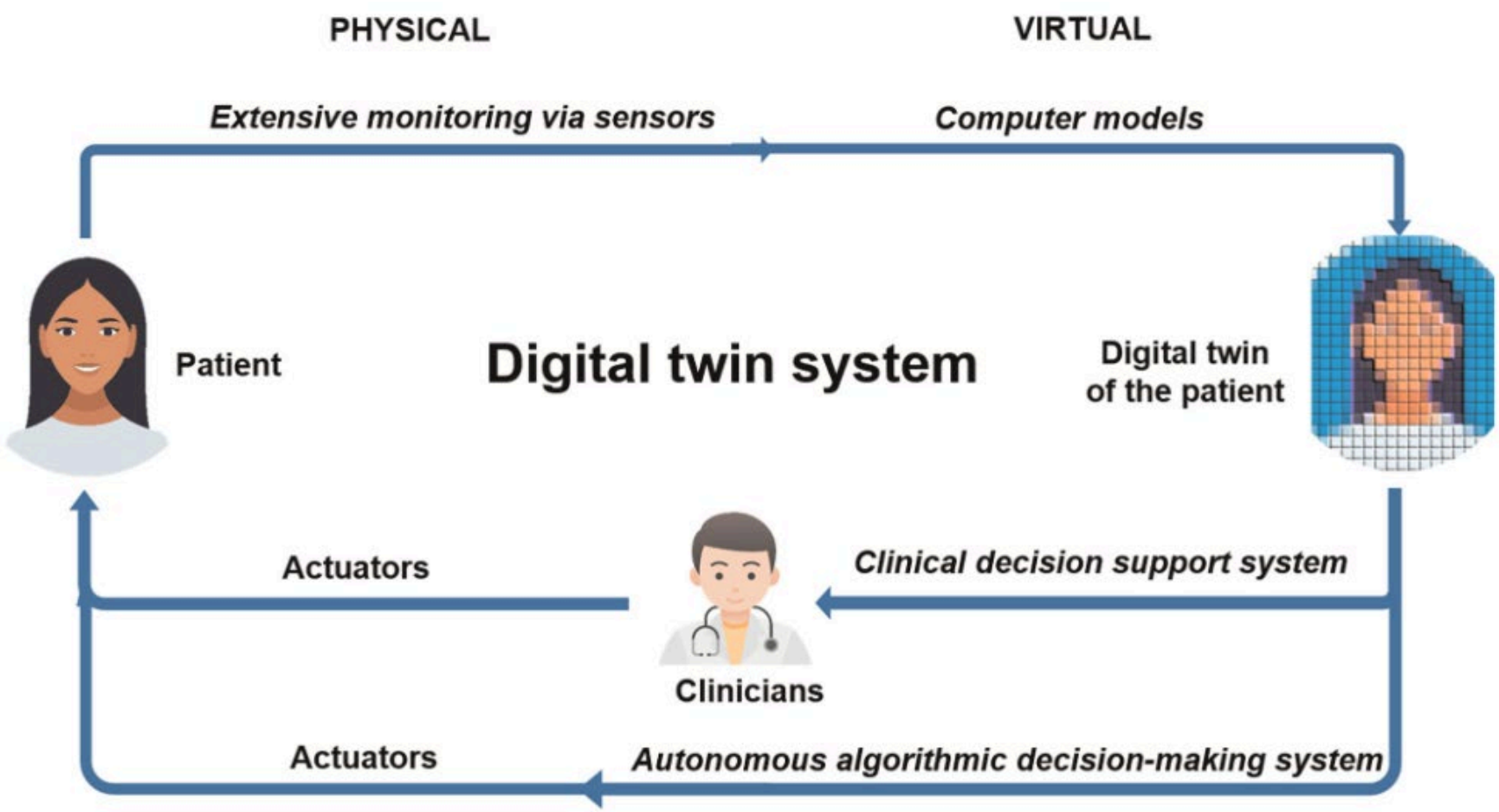
Ferrante G, et al. Paediatr Respir Rev. 2021 Dec;40:46-51

It can be employed in healthcare contexts to perform assistive functionalities



Licari A, et al. In ERS Monograph, Digital Respiratory Healthcare, 2023

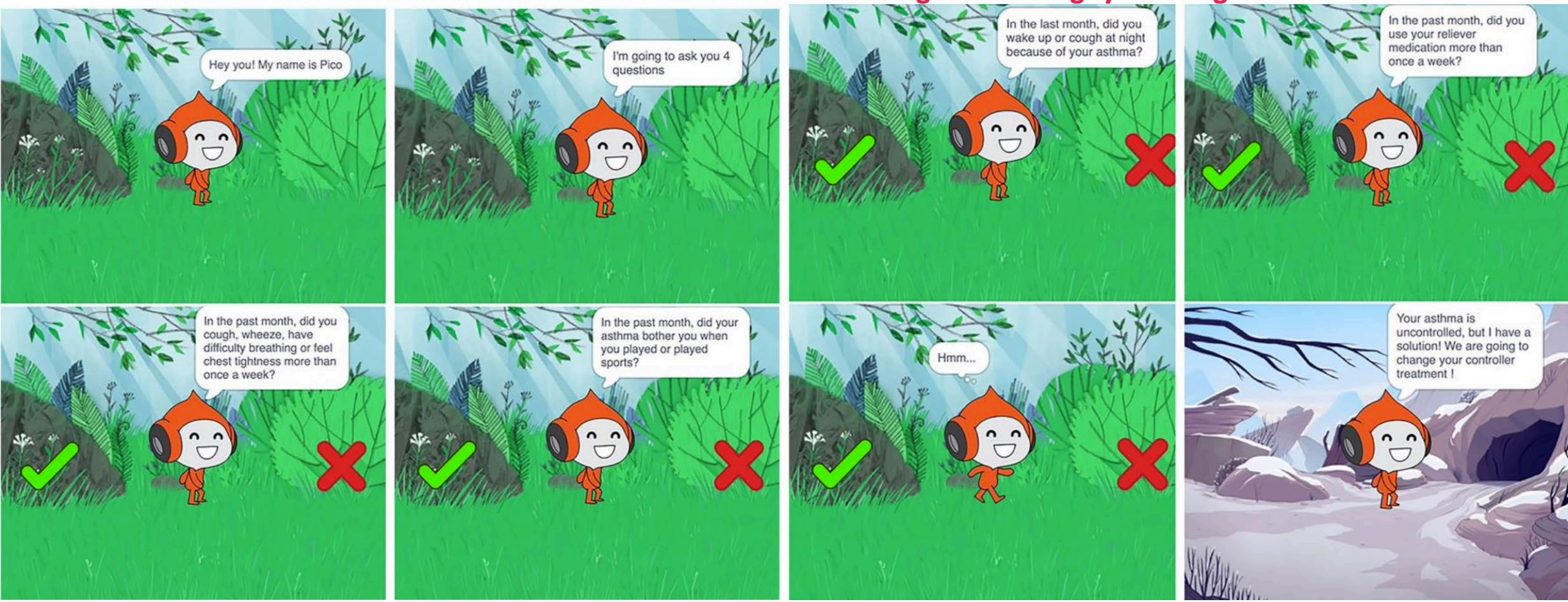
Educazione e coinvolgimento del paziente e della famiglia



Drummond D, Roukema J, Pijnenburg M. Home monitoring in asthma: towards digital twins. Curr Opin Pulm Med. 2023 Jul 1;29(4):270-276.

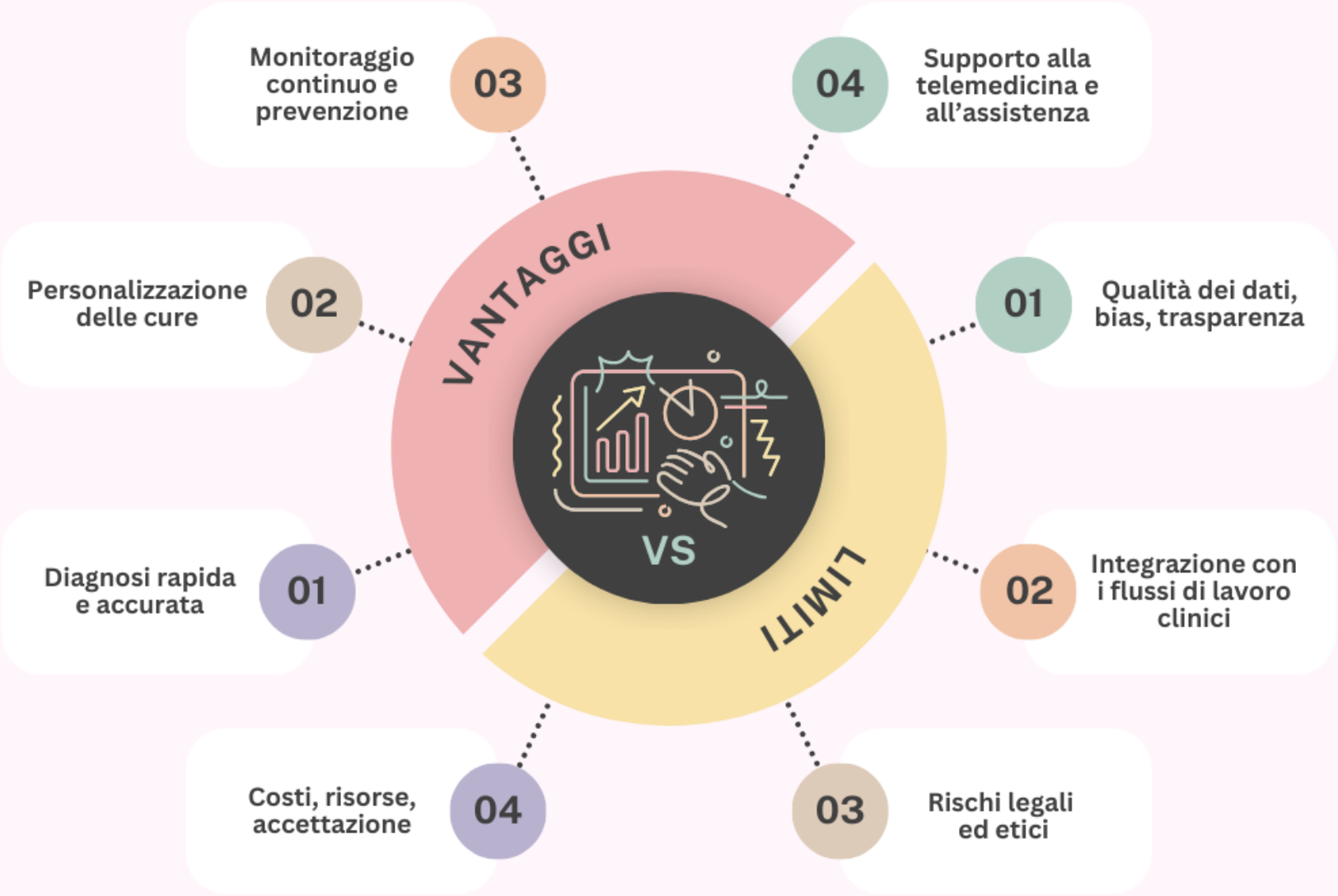
Educazione e coinvolgimento del paziente e della famiglia

Animation created to show children what the interface of the digital twinning system might look like

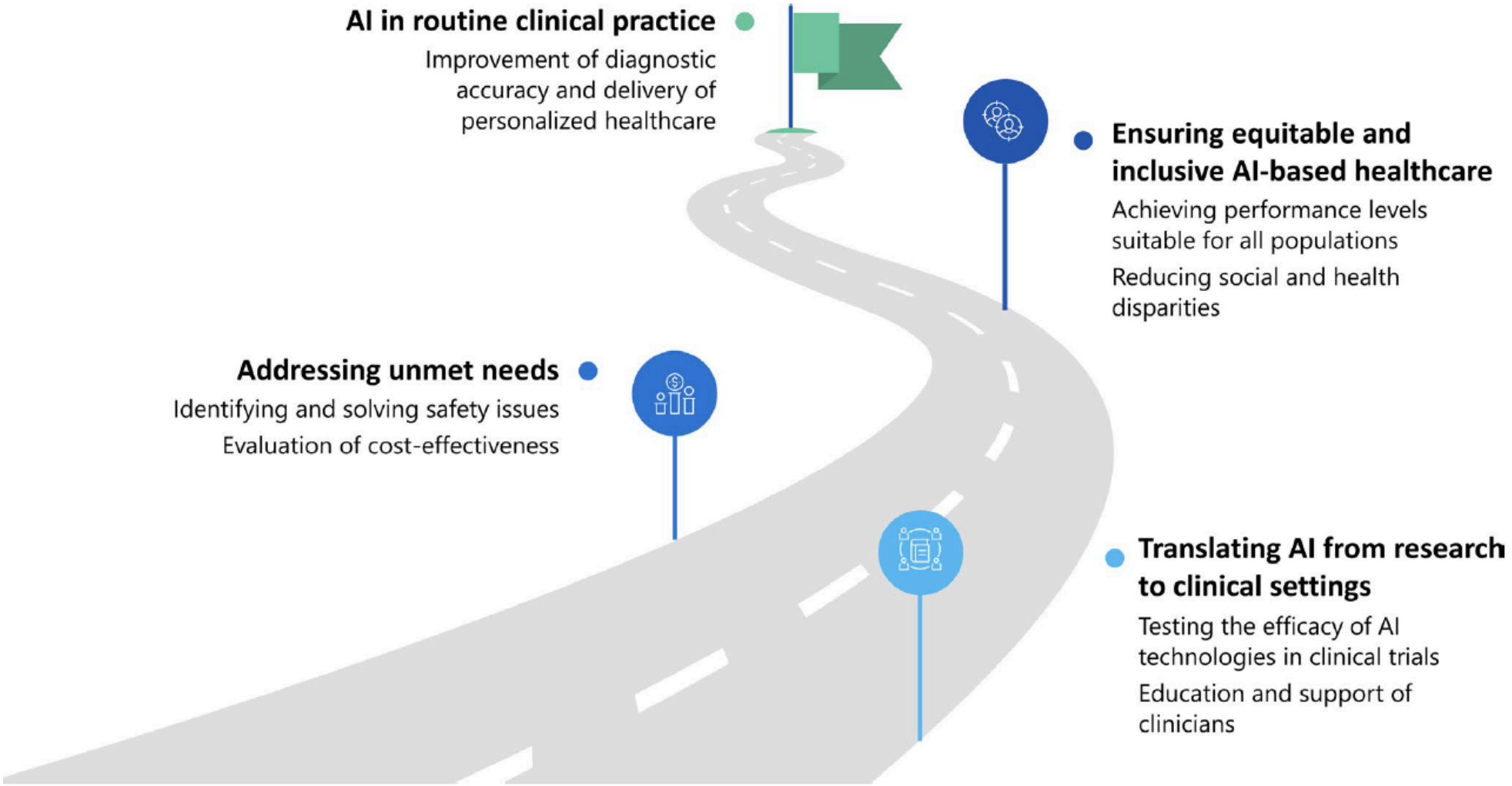


Gonsard A, et al. Children's views on artificial intelligence and digital twins for the daily management of their asthma: a mixed-method study. Eur J Pediatr. 2023 Feb;182(2):877-888.

Vantaggi e Limiti dell'AI in Pediatria



Prospettive future



Ferrante G, Licari A, Fasola S, Marseglia GL, La Grutta S.. Pediatr Allergy Immunol. 2021 Apr;32(3):405-413.

Promoting implementation research into sustainable, equitable, connected digital respiratory care in diverse healthcare systems.

https://www.ersnet.org/science-and-research/ongoing-clinical-research-collaborations

CONNECT
An ERS Clinical Research Collaboration

ERS

I. Build a multidisciplinary research network

II. Create an EU-wide repository of respiratory healthcare technologies

III. Scope published research on implementation of digital respiratory care

IV. Develop position papers on societal infrastructure and core outcomes for trials

V. Secure future funding for research into digital respiratory health

https://www.simri.it/evento/tecnologie-digitali-innovative-per-lassistenza-respiratoria-pediatrica/

SIMRI
società italiana per le malattie respiratorie infantili

Pediatric Digital Technologies for Respiratory Care: PeDiTCare

- To develop a national multidisciplinary network that promotes research on the implementation of digital healthcare in childhood respiratory diseases
- To map the knowledge and use of digital technologies across Italian pediatric pulmonology centers
- To implement digital respiratory healthcare in pediatric pulmonology
- To publish a summary document through the creation of a national research network