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Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
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Towards a conceptual framework for designing Symbiotic AI systems

Rosa Lanzilotti

Dip. di Informatica

Università degli Studi di Bari

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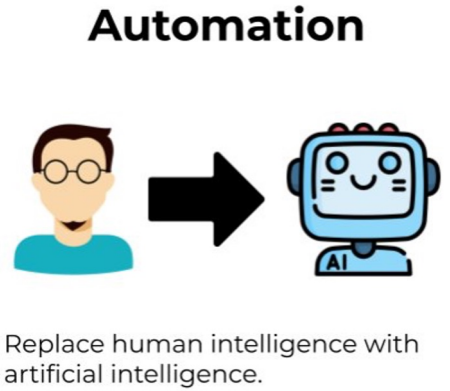
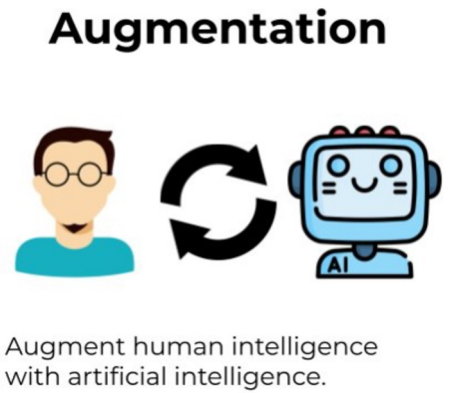
Introduction

- *Spoke 6*: Symbiotic Artificial Intelligence (SAI)
  - Lead beneficiary: UNIBA
    PI: Donato Malerba, co-PI: Giovanni Semeraro
- *TP3* "Learning and Reasoning from Individual to Communities to Society"

- SAI aims to increase human-machine collaboration, augmenting human cognitive abilities rather than replacing them
- WP6.1: Design of SAI systems
  - How to integrate SAI system design with principles and methodologies of Human-Computer Interaction?





Steven M. Moore, "Automation VS. Augmentation in AI: Designing Mixed-Initiative User Interfaces".

Main challenges in designing SAI systems

- System transparency
  - Explanations should be adequate for non-technical people

- User control
  - New interaction paradigms should empower the human to be in control and to modify the system behaviour through a collaboration with the system

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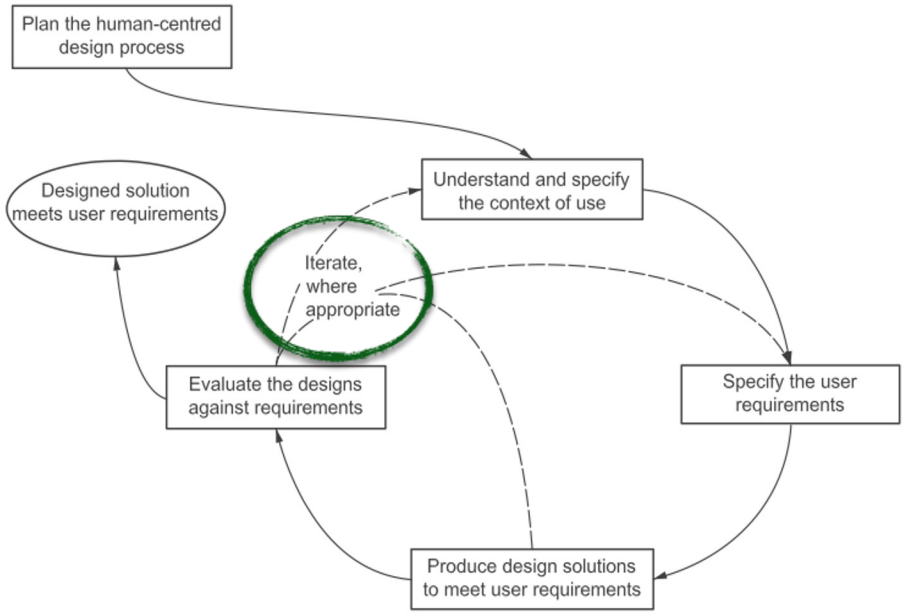
How can we mitigate these challenges?

- Shifting the design paradigm from an algorithm-focused view to a human-centered perspective
- Involving users in all the phases of the system design, as suggested by the Human-Centred Design approach, to produce SAI systems that are reliable, safe, and trustworthy

Only possible if you:
- involve
- observe
- talk to

→ the user



ISO 9241-210 “Human-Centred Design for Interactive Systems”

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The new Human-AI Interaction Paradigm

- It permits a deeper collaboration between human and AI
- It consists of an iterative negotiation process based on 3 interactions strategies

Clarification: the system explains the reasons for its behaviour/decision

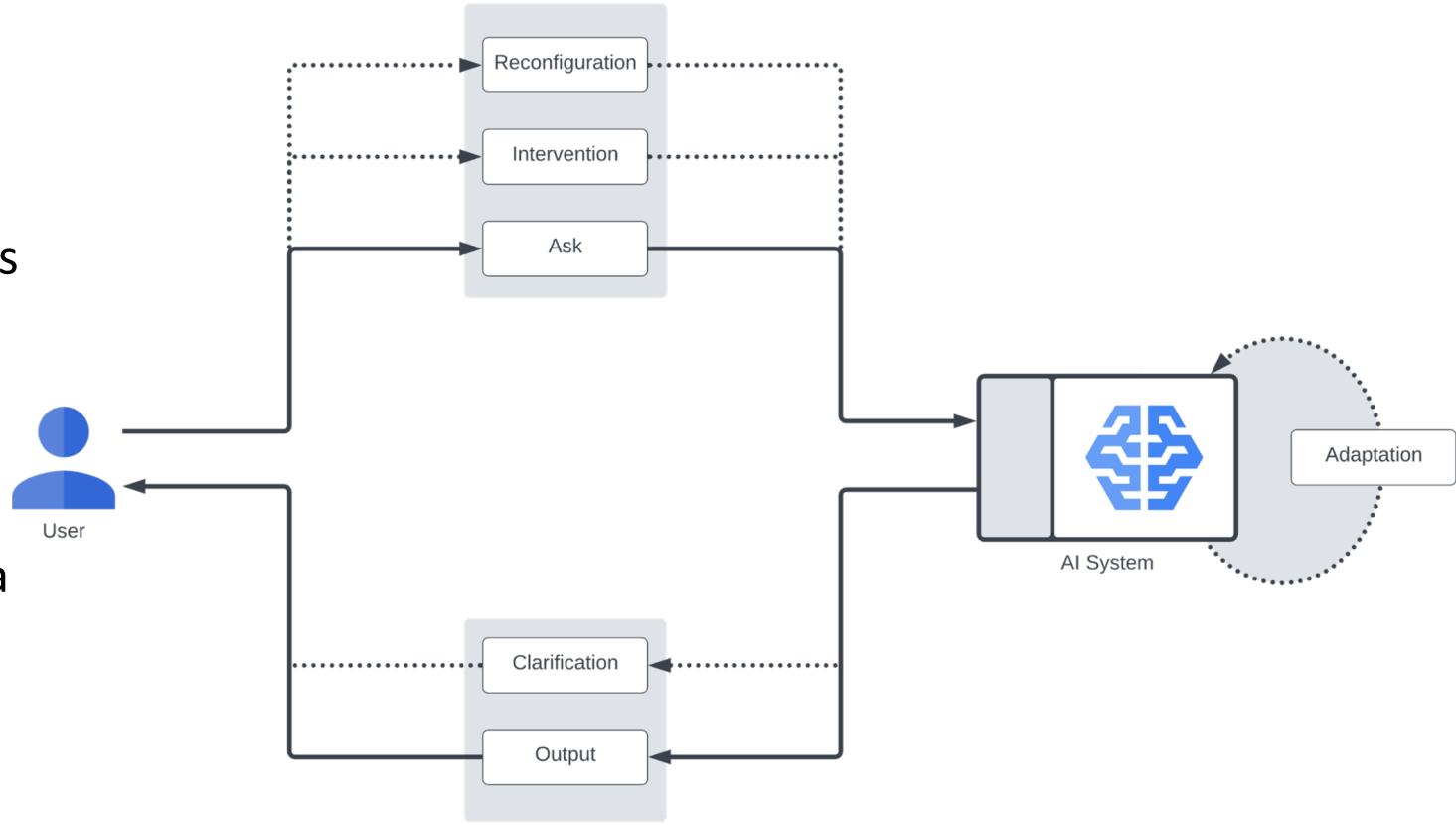
Iterative exploration: the system outcome is reached through a series of iterative steps between the user and the AI system

Reconfiguration: the user is allowed to initiate the retraining of AI models based on user feedback

Desolda G., Dimauro G., Esposito A., Lanzilotti R., Matera M., Zancanaro M. A Human–AI interaction paradigm and its application to rhinocytology. Special issue on Human-Centered Artificial Intelligence for One Health, Artificial Intelligence in Medicine, Vol. 155 (2024).

The Human-AI interaction model

- Human-AI Interaction paradigm enables a *negotiation process*
- The human not only understands the reasons that determine a specific system behaviour, but also to intervene and modify it through iterative reconfigurations
- The negotiation process is characterized by a sequence of actions, continuous feedback and adaptations



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Application of the new interaction paradigm

- Healthcare context
  - GOAL: Creating a new version of the Rhino-Cyt prototype, in order to allow rhinocytologists to collaborate with the system for a correct classification of the nasal mucosa cells




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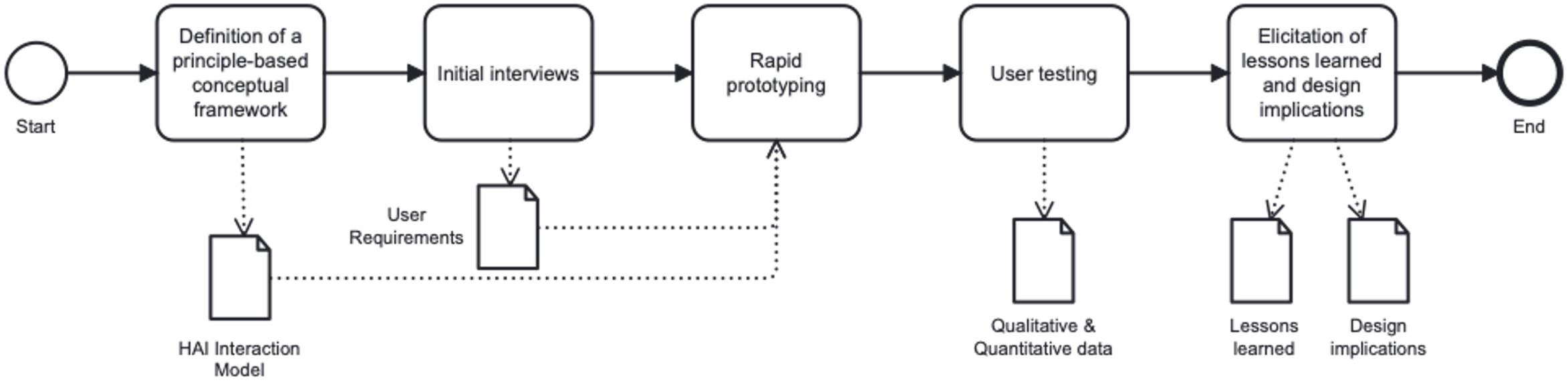
Our HCD Process



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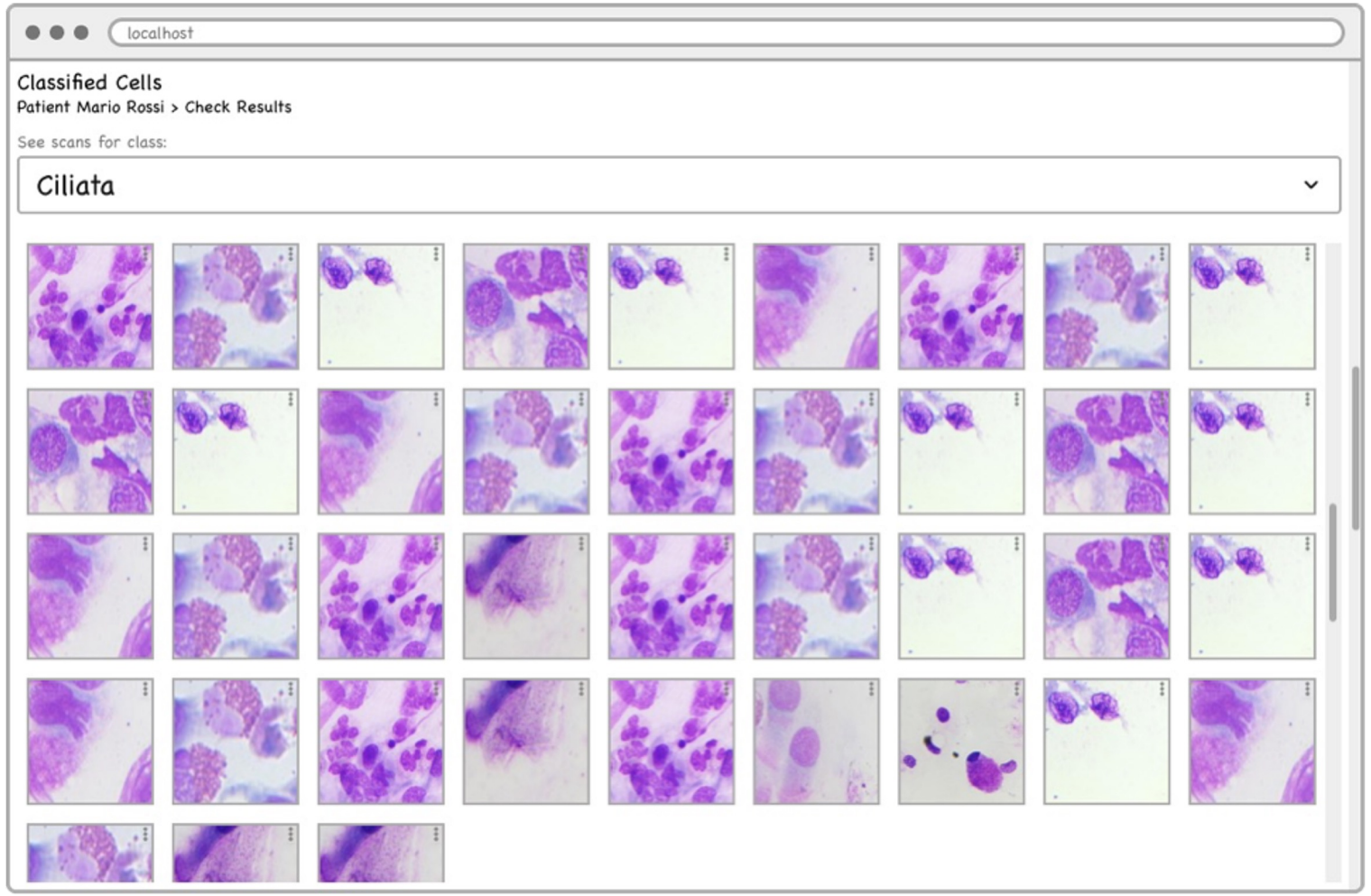
The Rhino-Cyt prototype

"Traditional" version



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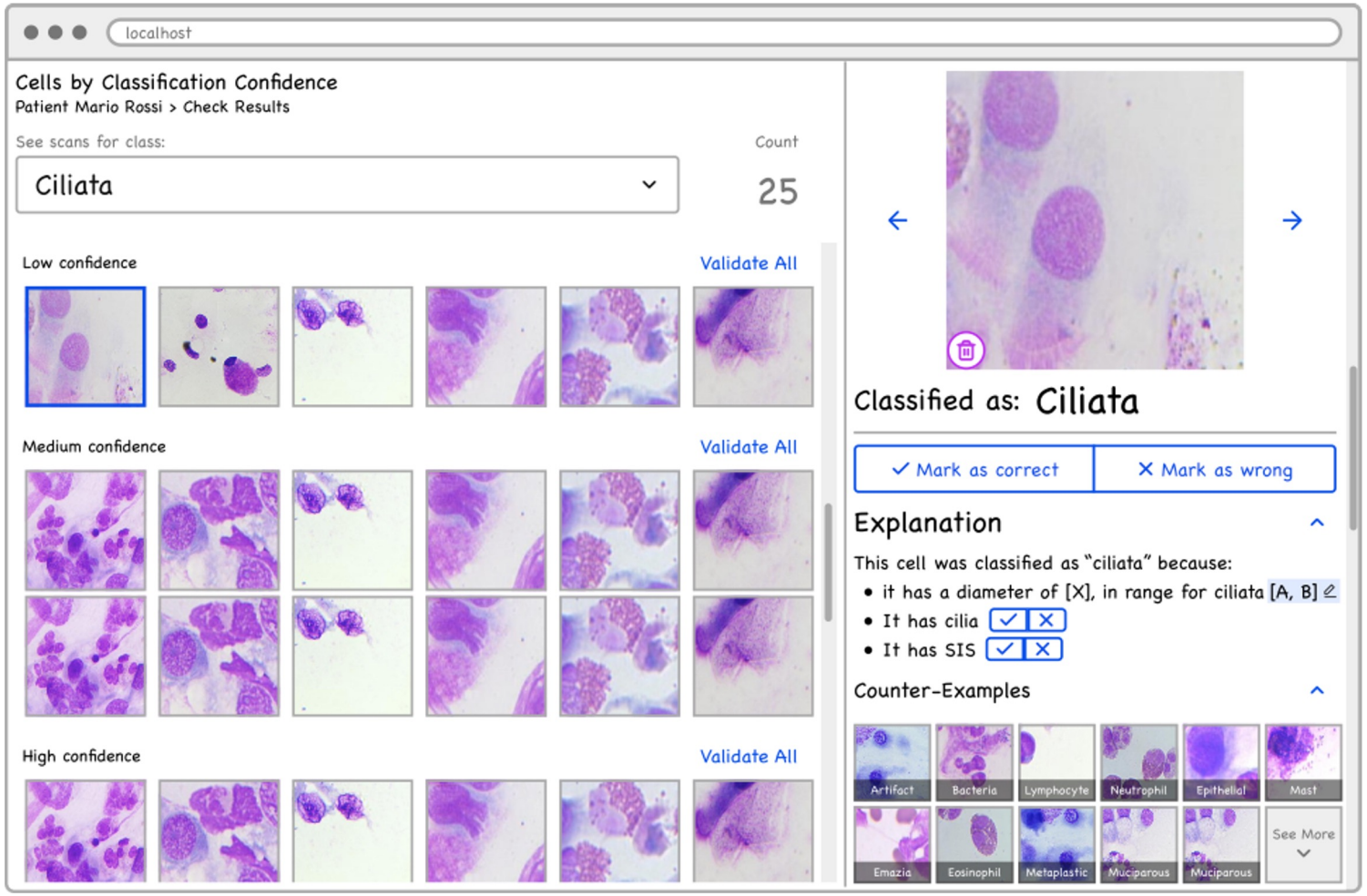
The Rhino-Cyt prototype

"SAI" version



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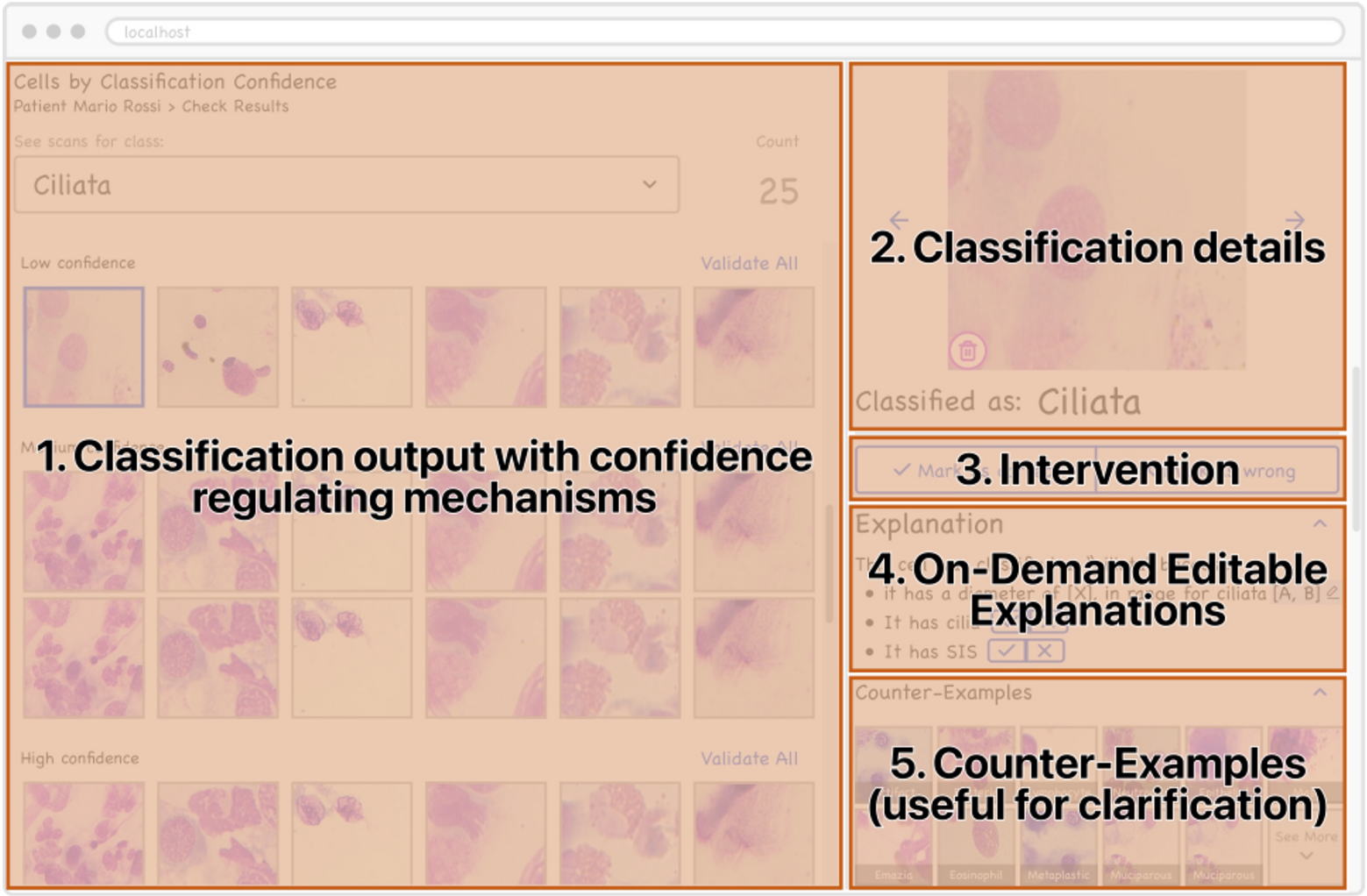
The Rhino-Cyt prototype

"SAI" version



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Evaluation study

- Goal: Evaluating the new interaction strategies that allow rhinocytologists to collaborate with the SAI system
- Participants: 9 rhinocytologists
- Design: Within-subjects design (Traditional vs SAI)
- Used techniques
  - Direct observation with the Thinking-aloud protocol
  - Questionnaires:
    - NASA Task Load Index (NASA-TLX) - Workload
    - Unified Theory of Acceptance and Use of Technology (UTAUT) - Acceptability
    - Trust in Automated Systems Test (TOAST) - Trust
  - Content analysis of video recordings - User experience

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Evaluation study – Results of Quantitative data

- Workload: No significant difference emerged

	NASA-TLX		Mental Demand		Physical Demand		Temporal Demand		Performance		Effort		Frustration	
	$\bar{x}$	Mdn	$\bar{x}$	Mdn	$\bar{x}$	Mdn	$\bar{x}$	Mdn	$\bar{x}$	Mdn	$\bar{x}$	Mdn	$\bar{x}$	Mdn
Classic	25.00	21.70	36.66	30.00	24.44	20.00	28.88	20.00	15.55	10.00	26.66	20.00	17.77	10.00
Redesigned	23.70	21.70	33.33	30.00	18.88	20.00	25.55	20.00	14.44	10.00	34.44	20.00	15.55	10.00
w-Test	$Z = -0.2$ $p = .859$ $r = -0.06$		$Z = -0.5$ $p = .608$ $r = -0.2$		$Z = -0.9$ $p = .395$ $r = -0.3$		$Z = -0.09$ $p = .931$ $r = -0.03$		$Z = -0.3$ $p = .766$ $r = -0.1$		$Z = 0.3$ $p = .792$ $r = 0.1$		$Z = 0$ $p = 1.000$ $r = 0$	

- Acceptability: No significant difference emerged

	TAM		Performance Expectancy		Effort Expectancy		Attitude Toward Using Technology		Behavioral Intention to Use the System		Self-Efficacy		Social Influence	
	$\bar{x}$	Mdn	$\bar{x}$	Mdn	$\bar{x}$	Mdn	$\bar{x}$	Mdn	$\bar{x}$	Mdn	$\bar{x}$	Mdn	$\bar{x}$	Mdn
Classic	3.87	4.00	3.7	4.0	4.5	4.5	4.2	4.5	3.8	4.3	4.4	4.8	2.5	2.5
Redesigned	3.98	4.20	4.0	4.5	4.6	4.8	4.6	4.8	3.9	4.3	4.4	4.5	2.9	3.0
w-Test	$Z = 0.4$ $p = .676$ $r = 0.1$		$Z = 0.7$ $p = .514$ $r = 0.2$		$Z = 0.3$ $p = .752$ $r = 0.1$		$Z = 0.7$ $p = .512$ $r = 0.2$		$Z = 0.2$ $p = .833$ $r = 0.07$		$Z = 0.2$ $p = .833$ $r = 0.09$		$Z = 0.2$ $p = .833$ $r = 0.09$	

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Evaluation study - Results of Quantitative data

- Trust: No significant difference emerged

	TOAST		Reliability		Transparency	
	$\bar{x}$	Mdn	$\bar{x}$	Mdn	$\bar{x}$	Mdn
Classic	5.69	5.87	5.97	6	5.42	6
Redesigned	5.75	6.00	5.94	6	5.55	6
W-test	$Z = 13$ $p = .547$ $r = 0.2$		$Z = -0.07$ $p = .944$ $r = -0.02$		$Z = 0.2$ $p = .866$ $r = 0.06$	

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Evaluation study - Results of Qualitative data

- The implemented strategies are valuable
- Participants seem to trust the SAI version of Rhino-Cyt
- It is important to offer explanations that can be customized and accessed “on demand”
- Useful lessons for AI in medicine are learned
  - Explanations must be expertise-driven
  - Let users customizing explanations
  - Intervention is needed
  - Localize explanations
  - Allow transparent learning
  - Consider experts knowledge limitations
  - Mitigate risks to human values
  - Efficiency and objectivity drive adoption

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Thank you for the attention!

rosa.lanzilotti@uniba.it