ACIS ADVANCED COMPUTING & INFORMATION SYSTEMS

HuMaIN: Human- and Machine-Intelligent Network Software Elements

Ícaro Alzuru, Andréa Matsunaga, Maurício Tsugawa , and José A.B. Fortes

Introduction and Motivation

Data scientists spend extensive **time, effort, and resources** collecting, integrating, curating, transforming, and assessing data quality before actually performing discovery analysis.

Data is often in **non-structured** form and **incompatible** with analytics tools.

There are two main approaches to deal with these challenges:

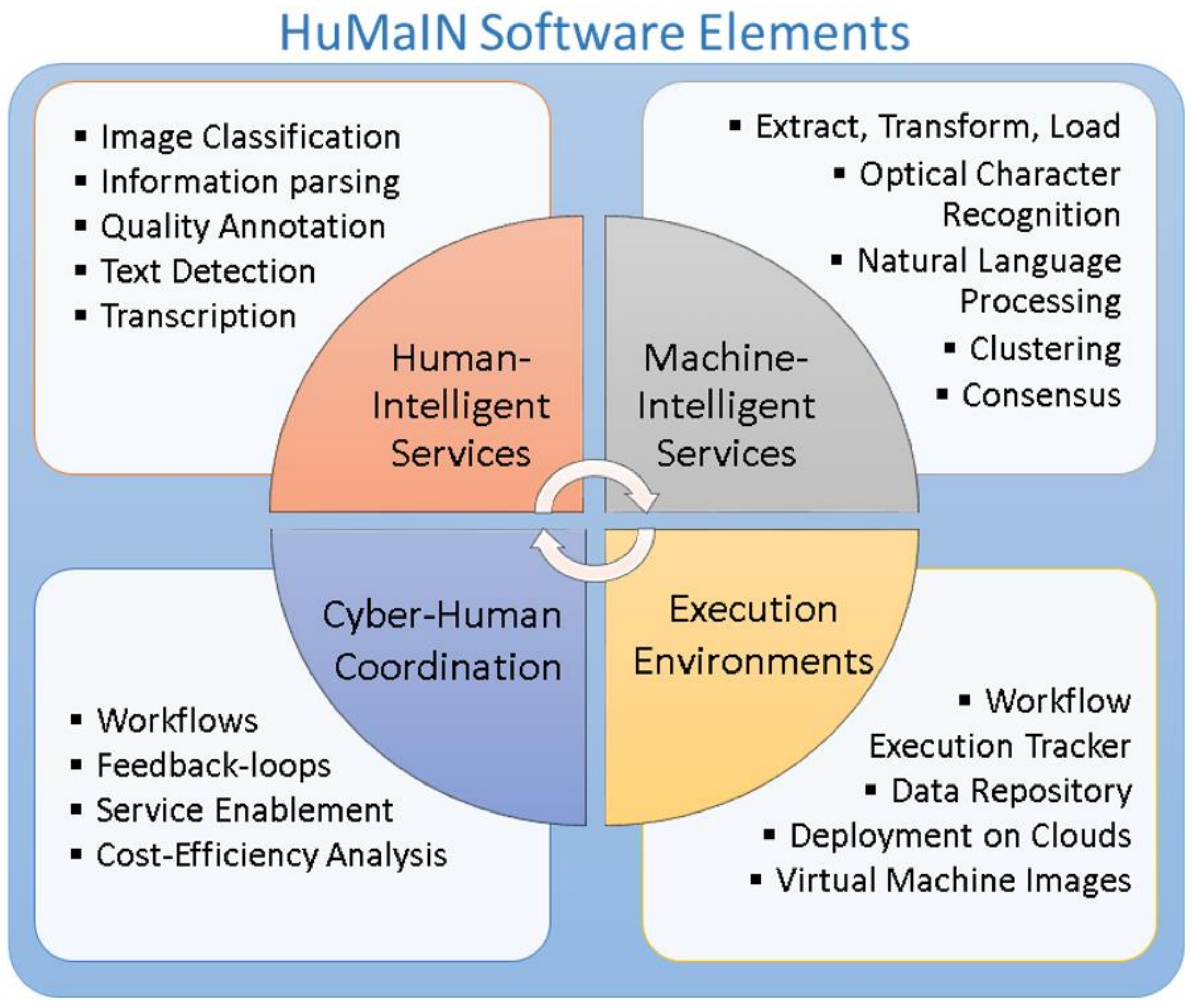
❑ **Crowdsourcing** (Human-Intelligent processes)

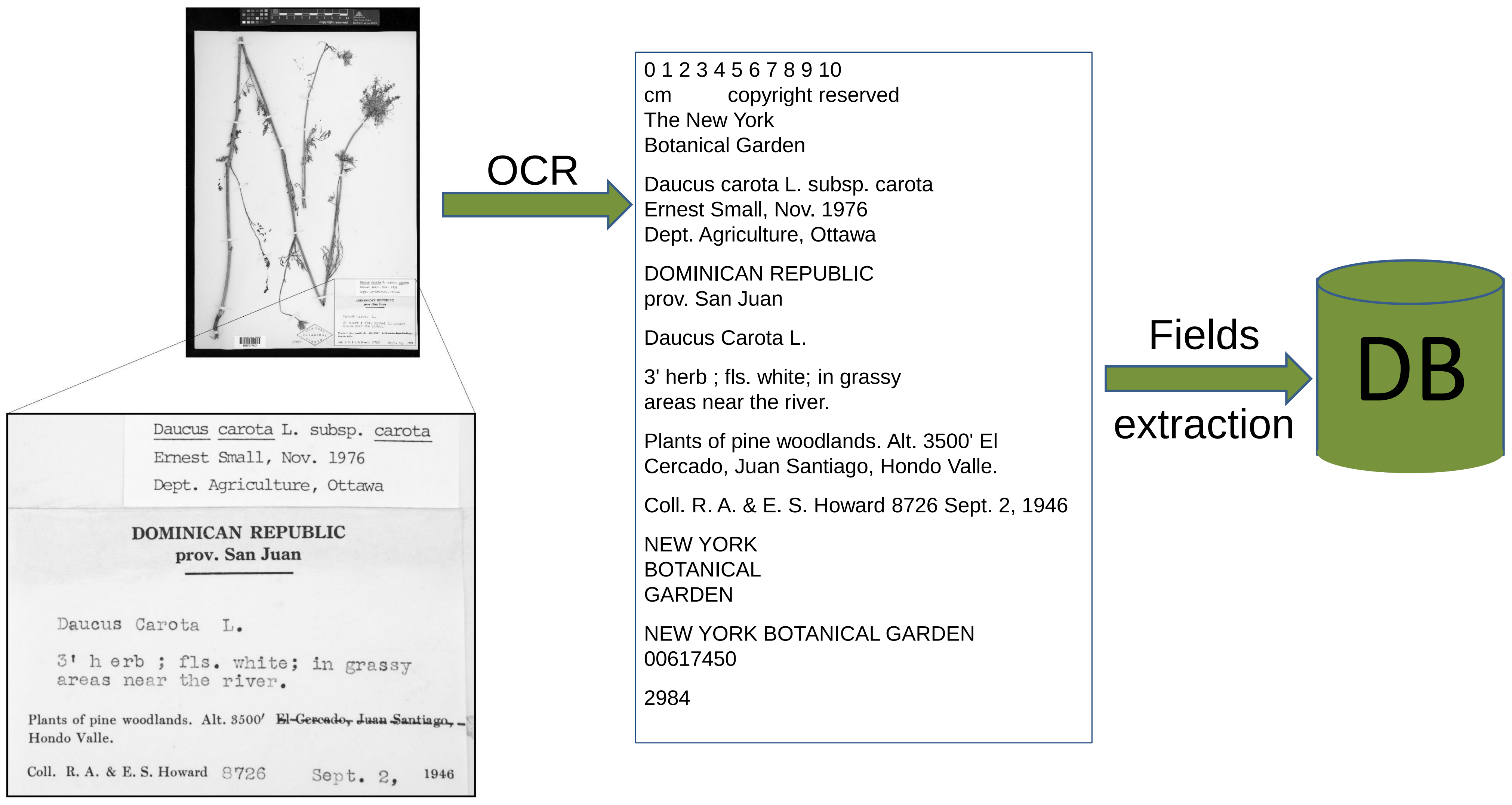
❑ **Machine Learning** (Machine-Intelligent processes)

Each method has its strengths and weaknesses. However, very little has been done to combine and **simultaneously** take advantage of both types of solutions.

The goal of the Human- and Machine-Intelligent Network (**HuMaIN**) project is to accelerate scientific digitization through the **integration and synergistic cooperation of human and machine processing** in order to overcome hurdles and bottlenecks found in data digitization.

The data collected in the **Integrated Digitized Biocollections (iDigBio)** project is used as a use case or **motivating example** for information extraction. https://www.idigbio.org





Daucus carota L. subsp. carota
Ernest Small, Nov. 1976
Dept. Agriculture, Ottawa
DOMINICAN REPUBLIC
prov. San Juan
Daucus Carota L.
3' h erb ; fls. white; in grassy
areas near the river.
Plants of pine woodlands. Alt. 3500' ~~El Cercado, Juan Santiago,~~
Hondo Valle.
Coll. R. A. & E. S. Howard 8726 Sept. 2, 1946

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The New York
Botanical Garden

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Development Plan and Deliverables

1. **Machine-Intelligent Components**
   - ❑ Interface to OCRopy tool to manage training sets for different fonts
   - ❑ Set of alternative methods for OCRopy to deal with noise
   - ❑ Selecting and integrating Carrot^2 clustering algorithms and parameters
2. **Human-Intelligent Components**
   - ❑ Javascript sensors to detect the number, time, and sequence of user interactions
   - ❑ PyBossa extension to support configurable and reusable microtasks
3. **Machine-Intelligent Services Enablement**
   - ❑ Automatic generation of RESTful services using CLAWS (Command-Line Application Wrapper service)
   - ❑ Extending PyBossa to support configurable and reusable microtasks
4. **Human-Intelligent Services Enablement**
   - ❑ PyBossa extension to allow management of batches of tasks and user qualification
   - ❑ Enabling complex tasks by composing micro-tasks developed by this project
   - ❑ Evaluation of alternative human-intelligent workflows using sensors from step 2
5. **Building workflows with Human- and Machine-Intelligent Services**
   - ❑ Using only machine-intelligent services (image binarization, OCR, and NLP)
   - ❑ Using only human-intelligent services (image selection, text interpretation, and transcription)
   - ❑ Using both human- and machine-intelligent services that improve machine-only and human-only processes
6. **Online feedback-loops between Human- and Machine-Intelligent Services**
   - ❑ Workflow with CrowdConsensus controlling a multi-step text interpretation workflow
   - ❑ Workflow with OCR errors triggering need for additional training sets
   - ❑ Workflow with chain of user expertise controlling the need for assessment of a worker
7. **Execution Environments**
   - ❑ Dedicated private compute-and-storage cloud for HuMaIN research and development.
   - ❑ Middleware to support workflows and feedback loops
   - ❑ Tutorials and how-to documents
8. **Cyber-Human System Cost Efficiency**
   - ❑ Cost-efficiency comparative analysis of 1. and 7.
   - ❑ Surveys of selected users of HuMaIN

Goals

❖ Research and development of HuMaIN software elements in four main areas:

- ❑ **Human-Intelligent services**
- ❑ **Machine-Intelligent services**
- ❑ **Cyber-Human Coordination**
- ❑ **Execution Environments**

❖ **Platform** for reusing the HuMaIN software elements as RESTful **services**.

Challenges

❖ OCR (Optical Character Recognition): Text mixed with other elements (cropping required), different fonts and sizes, handwritten text, different languages, underlined text, overlapped text, OCR performance.

❖ Information extraction: Data cleaning, multiple formats, incomplete data, data completion, natural language processing, field value standardization, consensus, process efficiency, deduplication, ambiguity, spelling errors, dictionaries, abbreviations / data truncation.

Progress and Results

❖ Hardware platform, system software, and web site:

http://humain.acis.ufl.edu

❖ **OCRopy** (https://github.com/tmbdev/ocropy) tested and selected as the OCR software for the HuMaIN project

- ❑ **Scripts** to automate the OCR process, detection of the text language, and fields extraction (date, country).
- ❑ **Cropping** the text area of the image improves the OCR result.
- ❑ Without training or cropping the text areas, **OCRopy identifies only 42% of the characters** of images hosted by iDigBio.

❖ Started the **5th step of the Development Plan** to address observed OCR limitations:

- ❑ Human-only and machine-only workflows were setup for digitizing the label of scientific data from the iDigBio project.
- ❑ Two hybrid workflows prepared to demonstrate that these perform better than the human-only or machine-only approaches.
- ❑ Public access to developed crowdsourcing tasks and progress at: **http://humain.acis.ufl.edu/app.html**

Summary and Conclusions

❖ Discovering information in non-digital records via digitization and information extraction remains a challenging problem with imperfect solutions.

❖ Combined human and machine approaches address weaknesses found when independently applying each of these approaches.

❖ Long term goal of HuMaIN project is to provide a platform of reusable services for combined human- and machine-intelligent to improve the processing of digitized biocollections.

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