HuMaIN: Human- and Machine-Intelligent Network software elements

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Introduction and Motivation

Big Data scientists in all communities spend the majority of their **time and effort** collecting, integrating, curating, transforming, and assessing quality before actually performing discovery analysis.

Data is often in **non-structured** form, **not compatible** with analytics tools.

Two main approaches to deal with these challenges:

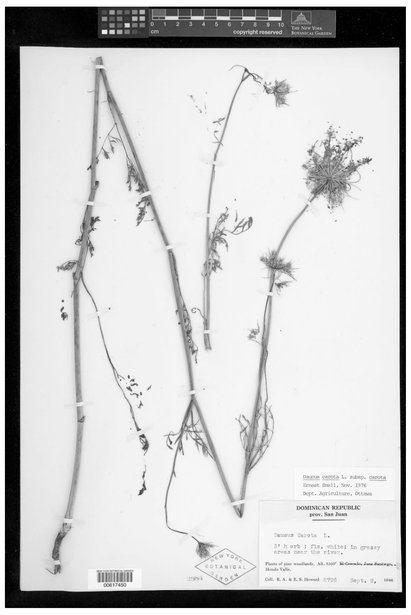
- ❑ **Crowdsourcing** (Human-Intelligent processes)
- ❑ **Machine Learning** (Machine-Intelligent processes)

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

Implementing crowdsourcing or machine learning solution use to demand a lot of **time** and **resources**.

The vision of the Human- and Machine-Intelligent Network (**HuMaIN**) project is to accelerate scientific digitization through fundamental advances in the **integration and mutual cooperation between human and machine processing** in order to handle practical hurdles and bottlenecks present in data digitization.

During the project, the information extraction process from the scientific data collected by the **Integrated Digitized Biocollections (iDigBio)** project will be used as a **motivating example**: https://www.idigbio.org/.



OCR

0 1 2 3 4 5 6 7 8 9 10
cm copyright reserved
The New York
Botanical Garden

Daucus carota L. subsp. carota
Ernest Small, Nov. 1976
Dept. Agriculture, Ottawa

DOMINICAN REPUBLIC
prov. San Juan

Daucus Carota L.

3' herb ; fls. white; in grassy
areas near the river.

Plants of pine woodlands. Alt. 3500' El Cercado,
Juan Santiago, Hondo Valle.

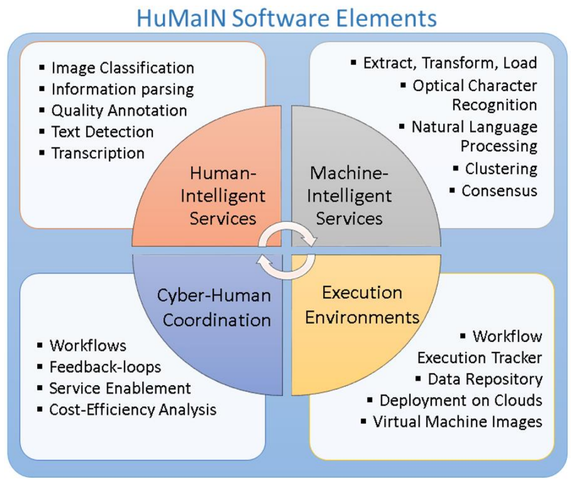
Coll. R. A. & E. S. Howard 8726 Sept. 2, 1946

NEW YORK
BOTANICAL
GARDEN

NEW YORK BOTANICAL GARDEN
00617450

2984

Fields extraction → DB



Goals

- ❖ Research and development of HuMaIN software elements in four main areas:
  - ❑ **Human-Intelligent services**
  - ❑ **Machine-Intelligent services**
  - ❑ **Cyber-Human Coordination**
  - ❑ **Execution Environments**
- ❖ Providing a **platform** for reusing the HuMaIN software elements as RESTful **services** in other projects.

Experimental Progress and Results

- ❖ The hardware platform, software, and web site for the HuMaIN Software Elements project was **setup**: http://humain.acis.ufl.edu
- ❖ **OCRopy** (https://github.com/tmbdev/ocropy) is being tested as the OCR software for the HuMaIN project
  - ❑ Several **scripts** have been created to automatize the process, detecting the language of the text, and extracting some fields: date, country.
  - ❑ **Cropping** the text area of the image improves importantly the quality of the OCR result.
- ❖ These first tries of the OCR process made us decide beginning by the **5th step of the Development Plan**:
  - ❑ Human-only and machine-only workflows were setup for digitizing the label of scientific data from the iDigBio project.
  - ❑ 2 Hybrid workflows were also prepared and we expect to demonstrate these perform better than the human-only or machine-only approaches.
  - ❑ Anybody can **help us** to complete the crowdsourcing tasks at: http://humain.acis.ufl.edu/app.html

Development Plan and Deliverables

1. **Machine-Intelligent Components**
   - ❑ Adding an interface to OCRopy tool to manage training sets for different fonts
   - ❑ Expose OCRopy to a set of alternative methods to deal with noise
   - ❑ Selecting and integrating Carrot² clustering algorithms and parameters
2. **Human-Intelligent Components**
   - ❑ Create a set of Javascript sensors to detect the number, time, and sequence of user interactions
   - ❑ Extending PyBossa to support configurable and reusable microtasks
3. **Machine-Intelligent Services Enablement**
   - ❑ Implementing the 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 with management of batches of tasks and user qualification
   - ❑ Set of complex tasks making use of multiple developed micro-tasks
   - ❑ Evaluation of alternative human-intelligent workflows using sensors from step 2
5. **Workflows with Human- and Machine-Intelligent Services**
   - ❑ Build a workflow with only machine-intelligent services (image binarization, OCR, and NLP)
   - ❑ Build a workflow with only human-intelligent services (image selection, text interpretation, and transcription)
   - ❑ Build a workflow where human- and machine-intelligent services improve machine-only and human-only processes.
6. **Feedback-loops between Human- and Machine-Intelligent Services**
   - ❑ Online feedback loop workflow with CrowdConsensus controlling a multi-step text interpretation workflow.
   - ❑ Online feedback loop workflow with OCR errors triggering need for additional training sets.
   - ❑ Online feedback loop 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-effect comparative analysis of 1. and 7.
   - ❑ Surveys with selected customers of HuMaIN.

Challenges

- ❖ OCR (Optical Character Recognition): Text mixed with other elements (cropping), different fonts and sizes, handwritten text, different languages, underlined text, overlapped text, OCR performance.
- ❖ Information extraction: Data cleaning, multiple formats, incomplete data, natural language processing, field value standardization, consensus, processes efficiency, data completion, deduplication, ambiguity, spelling errors, dictionaries, abbreviations / data truncation.

Future Work

- ❖ The 5th step of the Development Plan will be completed
- ❖ Based on the gained experience, we are going to continue with steps 2 and 1 of the Development Plan, making these software components reusable and the improving the workflows, environment, and efficiency.

Summary and Conclusions

- ❖ Human- or machine-only approaches for information extraction have weaknesses that the integration of human- and machine-intelligent processes can improve.
- ❖ Information extraction is a complex problem with imperfect solutions that can rescue the knowledge buried in not digitized formats.
- ❖ HuMaIN project will provide a platform of services to reuse the human- and machine-intelligent processes in other areas of knowledge.

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