HuMaIN: Human- and Machine-Intelligent Network of Software Elements

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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:

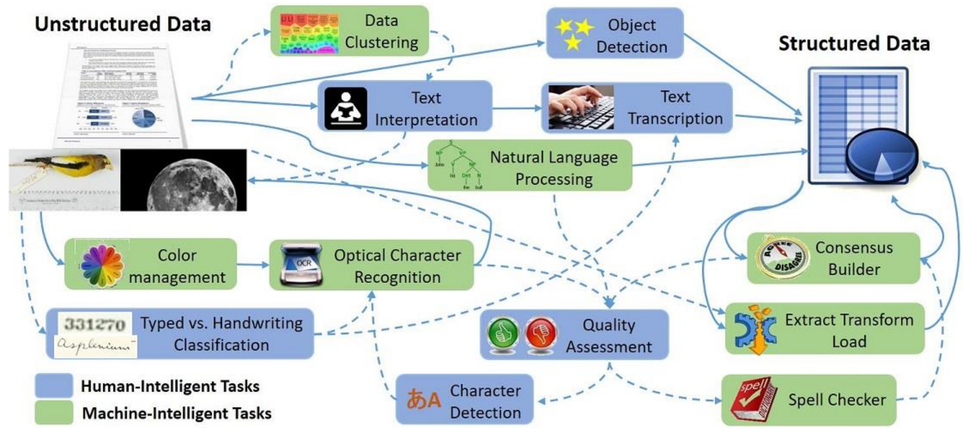
❑ **Crowdsourcing** (Human-Intelligent processes)

❑ **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 information extraction challenges present in the **Integrated Digitized Biocollections (iDigBio**, https://www.idigbio.org**)** project are used as a **motivating use case**.



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**.

Progress and Results

❖ Devised, developed and demonstrated hybrid human- and machine-intelligent approaches to digitize labels from biocollections specimens.

❖ Ongoing Studies and Experiments:
- ❖ Task Complexity in Crowdsourcing
- ❖ Self-aware Data Extraction

❖ Web applications and data processing tools developed to support crowdsourcing and machine intelligent processes.

https://github.com/acislab/HuMaIN_Collaborative_Data_Extraction

❖ Paper presented at the 2016 IEEE 12th International Conference on eScience: Cooperative Human-Machine Data Extraction from Biological Collections.

Cooperative Human-Machine Data Extraction

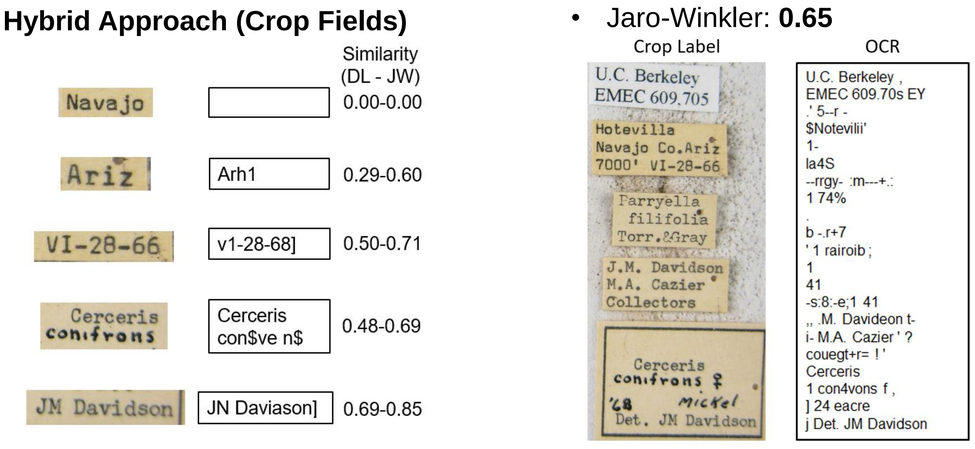
❖ **Cooperative Human-Machine Data Extraction from Biological Collections**

0. Human-only approach:
Extracted from the paper "Reaching Consensus in Crowdsourced Transcription of Biocollections Information", A. Matsunaga, A. Mast, and J. A.B. Fortes.
- Consensus found 86.7% of times with accuracy of 91.1% => **79%** correct

1. Machine-only Approach:
OCR the whole image with OCRopus and Tesseract. Obtained similarity:
- Damerau-Levenshtein: **0.36**
- Jaro-Winkler: **0.59**

2. Hybrid Approach (Crop Label):
- Damerau-Levenshtein: **0.49**
- Jaro-Winkler: **0.65**

3. Hybrid Approach (Crop Fields)



Average similarity and improvement with respect to A1

	Entomology	Bryophyte	Lichen
1. Machine-only	0.27	0.38	0.64
2. Hybrid (Crop Label)	**0.52 – 93%**	0.61 – 61%	**0.66 – 3%**
3. Hybrid (Crop Fields)	0.43 – 59%	**0.67 – 76%**	0.64 – 0%

- Hybrid approaches improve similarity with respect to the machine-only approach (1) up to a factor of 1.93.
- No improvement for Lichens, because their images contain only text (a Label)
- Cropping fields eliminate the need of NLP, adding interpretation.

Time, Cost, and Similarity

Approach	Human + Machine (Time in years)	Cost ($ in Millions)	Recognition rate or Similarity
0. Human-only	17123 + 0 (17123)	1500.00	**0.79**
1. Machine-only	0 + 1202 (1202)	**3.61**	0.43
2. Hybrid (Crop Label)	580 + 422 (**1002**)	52.10	0.60
3. Hybrid (Crop Fields)	6342 + 1218 (7560)	559.21	0.58

Task Complexity in Crowdsourcing (in progress)

❖ **Participate at: http://humain.acis.ufl.edu/complexity**

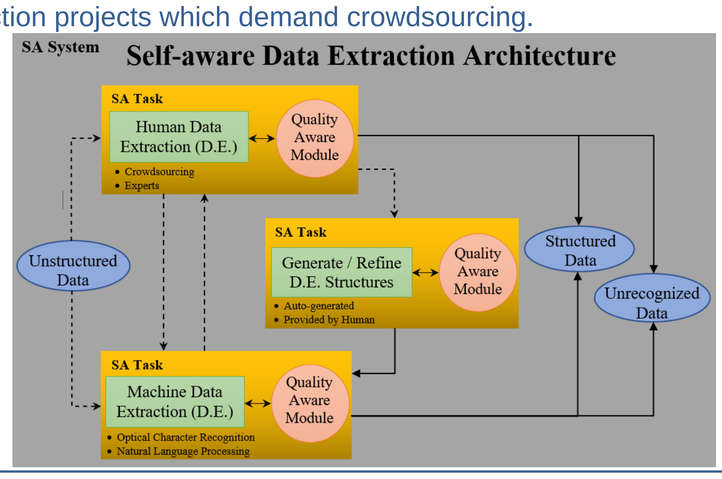
❖ **Goals:**
- Finding what task size generates the best quality and completion rate.
- Studying three types of interfaces: transcribing, selecting, and cropping, and their perceived complexity, productivity, and friendliness.

❖ **Experiments progress:**
- 16 volunteers of the Florida Museum of Natural History participated in the experiments
- 6 members of the ACIS Lab evaluated and took part in the experiments
- 10 volunteers used the cropping webapp during the 2016 WeDigBio Transcription Blitz.
- New participants will be paid for completing one hour experiment's sessions.
- A Zooniverse project was created and has collected data from hundreds of volunteers: Participate at **https://www.zooniverse.org/projects/ialzuru/humain**

Self-aware Data Extraction (in progress)

❖ **Participate in our data collection process, at: http://humain.acis.ufl.edu/aware**

❖ **Goals:**
- Designing Data Extraction processes able to self-evaluate and take smart decisions.
- Reducing the amount of crowdsourcing required and therefore, the time and cost of data extraction projects which demand crowdsourcing.



Summary and Conclusions

❖ The combined execution of human- and machine-intelligent techniques addresses weaknesses found in crowdsourcing-only or machine-only 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.

❖ Self-aware machine intelligence will have the ability to determine when it is necessary to engage human intelligence. This is part of ongoing work.

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