Text Extraction From PDF

Problem Statement

Accurate metadata extraction from born-digital academic PDFs depends on first obtaining a complete, correctly ordered textual representation of each document's contents. This task is complicated by:

- **Heterogeneous publisher templates:** (e.g., IEEE, Springer) that differ in font usage, heading conventions, and artifact placement.
- **Variable page layouts:** single-column, multi-column, or hybrid—that break naive top-to-bottom reading order.
- **Parser-specific limitations:** in handling encoded characters, ligatures, figures, footnotes, and incremental updates inside the PDF file structure.

The immediate goal is therefore to identify which open-source parsing library - **PyMuPDF**, **pypdfium2**, **pdfminer.six**, or **PyPDF2** delivers the highest fidelity text extraction on *first pages* of arXiv papers representing diverse layouts and styles.

"Highest fidelity" will be quantified against a manually verified ground-truth transcript using four automated text-similarity measures:

1. **Character Error Rate (CER)** – percentage of character insertions, deletions, and substitutions.
2. **Word Error Rate (WER)** – percentage of word-level insertions, deletions, and substitutions.
3. **BLEU Score** – n-gram precision–based overlap between extracted text and reference.
4. **ROUGE-L** – longest-common-subsequence recall and precision, capturing sentence-level ordering.

Data

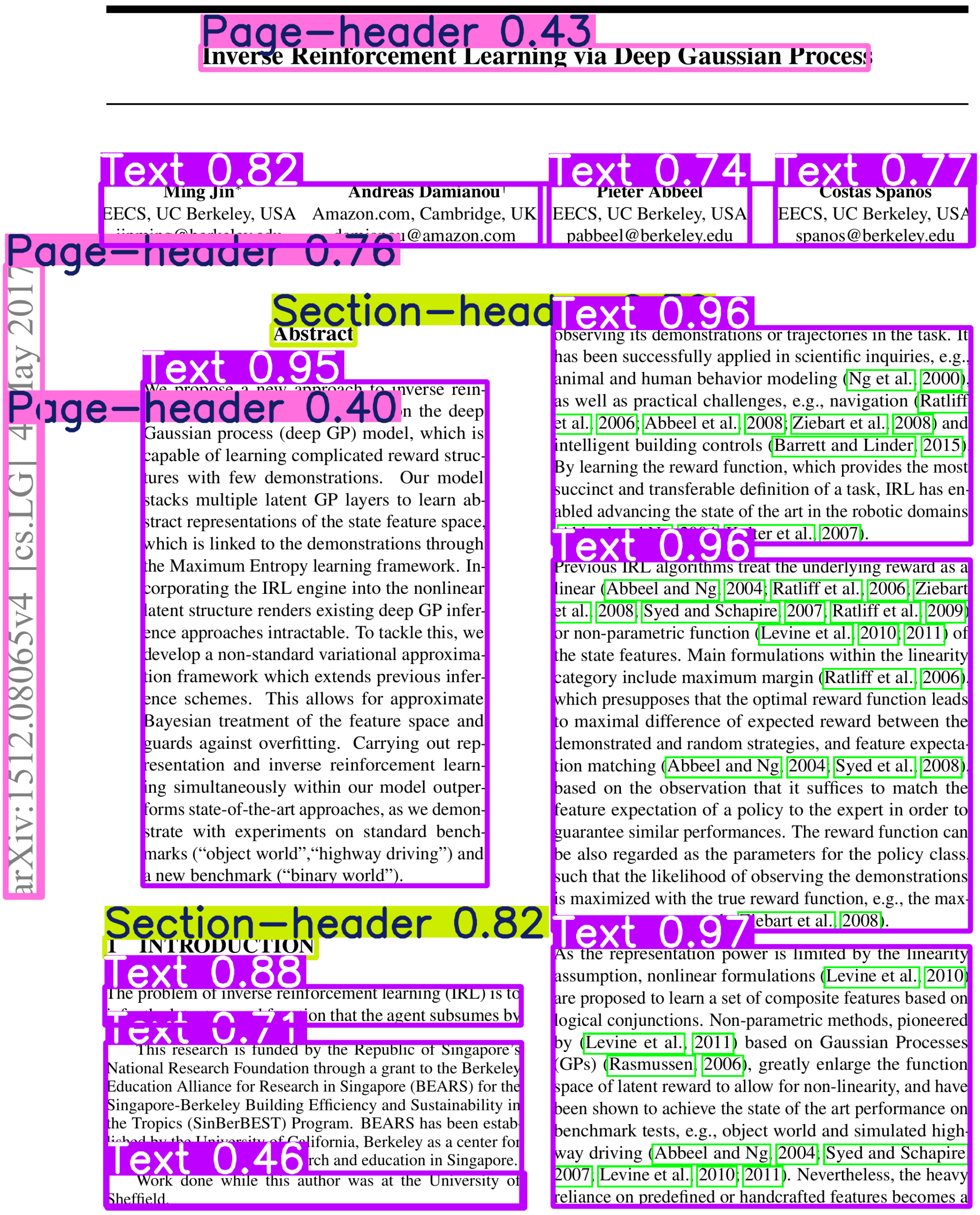
Aspect	Detail
Source dataset	**DocBank**—token-level annotations (bounding box, font, text) for arXiv papers published 2014-2018.
Rationale	*Born-digital academic PDFs* with ground-truth tokens; diverse layouts and publisher styles.
Selection method	1. Queried arXiv API for 5 disciplines (CS, Stats, Math, EESS, Econ). 2. Cross-referenced results with DocBank to keep only papers with existing annotations. 3. Downloaded PDFs + annotations for **101 papers** (distribution: CS 31, Stat 22, Math 18, EESS 18, Econ 12).
Reading-order ground truth	1. **YOLOv12** segments each page into logical blocks. 2. Group DocBank tokens by detected segments. 3. Feed segments + unassigned tokens into **LayoutReader** (LayoutLM-based seq2seq) to predict inter-segment reading order. 4. Concatenate ordered tokens to obtain full reference text per page.

DocBank Annotations

> token | boundingbox ((x0, y0), (x1, y1)) - > (x0, y0, x1, y1) | color (R, G, B) | font | label

```
Inverse 201 111 275 134 0    0    0    RQRKXE+NimbusRomNo9L-Medi    title
Reinforcement    280 111 428 134 0    0    0    RQRKXE+NimbusRomNo9L-Medi    title
```

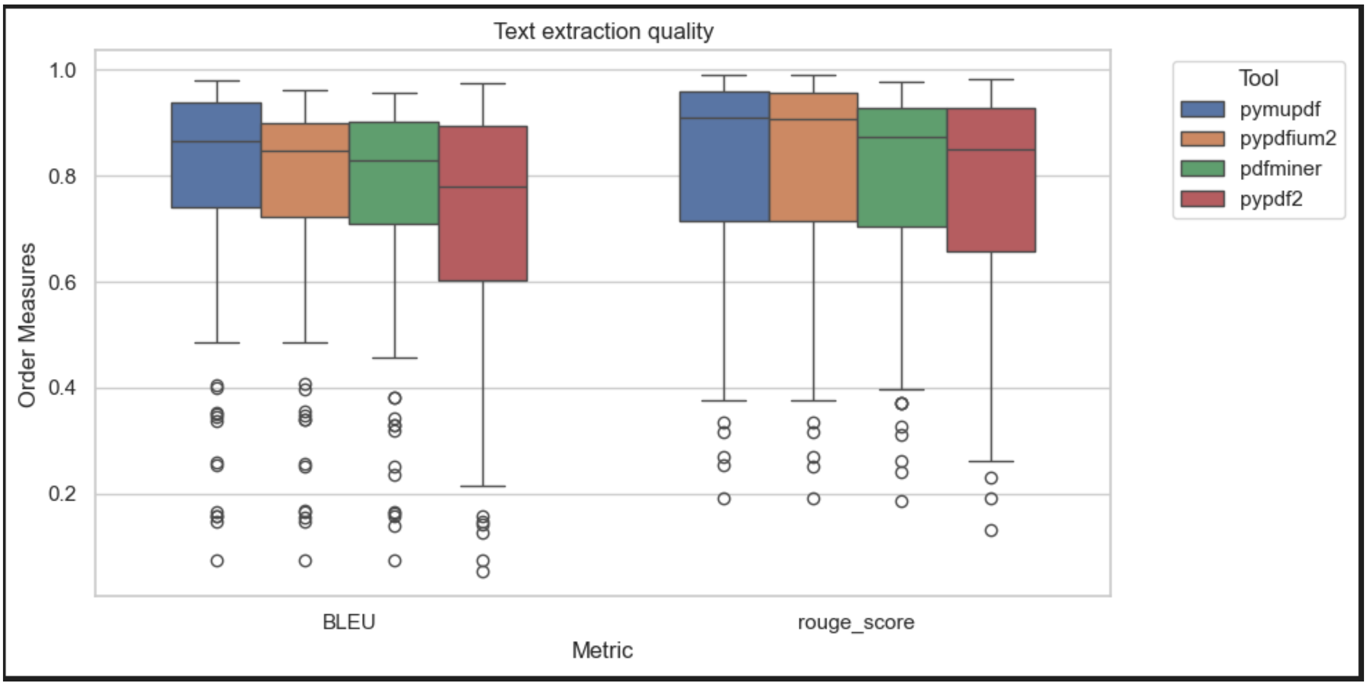
Example output from YOLO



Results

PyMuPdf

- avg_BLEU=0.7817
- avg_rouge_score=0.8086



PyMuPdf

- avg_CER=0.2805
- avg_WER=0.3544