

Divyansh Rawal

Techniques & Steps Used to remove overlapping and duplicate bounding boxes from this model:

This notebook focuses on improving document layout detection and reconstruction using YOLO models.

It enhances the overall accuracy and structure interpretation of document elements like text blocks, tables, figures, titles and footers.

➤ Overlapping Box Correction

Resolved cases where different layout elements (e.g., Text and Table) shared overlapping regions.

Used class-priority and confidence thresholds to correctly assign the dominant label.

➤ Misclassification Fixes

Addressed common model misclassifications (e.g., detecting “text” inside figures or titles as separate entities).

Applied heuristic rules and confidence-based re-labeling to improve class precision.

➤ Nested Boxes Handling

Fixed nested box issues (e.g., “text inside table” or “caption inside figure”) through structural hierarchy logic.

Ensured proper containment relationships between parent (table, figure) and child (text, caption) elements.

➤ Bounding Box Reconstruction

Implemented logic to merge fragmented or partially overlapping boxes belonging to the same element.

Produces cleaner, contiguous region detection for text blocks and tables.

Added interactive bounding box visualization for before-and-after comparisons.

1. Initial Prediction

➤ Function: `perform_prediction()`

- Runs the YOLOv10 model on the page image to generate raw detection results with bounding boxes, class labels, and confidence scores.

2. Extract Bounding Boxes

- Function: `extract_bboxes()`
- Converts YOLO's tensor output into a list of dictionaries with keys:
- "bbox": [x1, y1, x2, y2] "label" (class name) "confidence" (probability score).

3. Pre-filter by Confidence

- Step: `boxes = [b for b in boxes if b["confidence"] >= pre_conf_thresh]`
- Removes low-confidence predictions before any merging/deduplication.

4. Class-wise Non-Maximum Suppression (NMS)

- Function: `nms_classwise()`
- Removes redundant overlapping boxes within the same class using IoU threshold (default 0.3).
- Keeps the highest confidence box, suppresses weaker overlapping ones.

5. Merge Nearby Text Boxes

- Function: `merge_text_boxes()`
- Groups multiple text fragments (boxes with "label"=="Text") that have small overlaps ($\text{IoU} \geq 0.1$).
- Produces larger merged text regions by expanding bounding boxes to cover combined area.
- Keeps the highest confidence score among merged boxes.

6. Cross-Class Conflict Resolution

- Function: `resolve_cross_class_conflicts()`
- Handles cases where two different classes overlap nearly perfectly ($\text{IoU} \geq 0.9999$).
- Keeps only one box using: Higher confidence, or, if equal confidence → uses a class priority ranking : (Text > Table > Picture > Section-header > List-item > Caption).

➤ Visualization Enhancements

Added interactive bounding box visualization for before-and-after comparisons.

Displays corrected layout structure using matplotlib and cv2 overlays.

Added Visualization function

Which Loops over all bounding boxes (boxes), which contain:

- 1) bbox: coordinates [x1, y1, x2, y2]
- 2) label: class name (e.g., Text, Picture, Table)
- 3) Confidence: model's confidence score
- 4) Draws a rectangle around each detected object.

Output: Visualization of the sample images and their before and after bounding boxes number (yolo detection) in JSON format.

Image 1:

Section-header 0.81

The Cobra And The Ants

Copyright@ Bedtimeshortstories.com

Text 0.95

Once upon a time, a huge King Cobra lived in a dense forest. He ate all kinds of creatures like lizards, frogs, bird eggs and other small animals and insects. All night long, he hunted for food. And as soon as the sun rises, he would hide in his hole to sleep.

Text 0.89

The Cobra was very lazy and he soon grew fat. As he grew fat, it became difficult for the Cobra to move in and out of his old hole. So, he found himself a new hole which was a huge tree. The only problem was that the tree had a group of ants there at its root.

Picture 0.97



Text 0.81

So, the Cobra went to the anthill and ordered them to live somewhere else as he was considered to be the King of the forest. The other animals that were around them were very frightened. But the ants did not pay any attention to his threats at all.

Text 0.85

Soon, they swarmed all over the body of the Cobra, stinging and biting him. Their sting caused unbearable pain to the Cobra. He wriggled with pain and tried to keep ants away from his body but he could not do so. After some time, the ants went away from the Cobra. The Cobra laid there hurt and wounded.

Text 0.82

The Cobra was crying in pain. All the animals who were afraid of him could only pity him. The ants taught King Cobra a great lesson.

...

```
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  }
]
```

Output is truncated. View as a [scrollable element](#) or open in a [text editor](#). Adjust cell output [settings...](#)

Image 2 -

practice questions. save and upload it to the blackboard.

List-Item 0.00

Q1. Create a database that includes the following three tables:
Students, courses, and register.

Section-Header 0.75

Table 0.93

studentID	studentName	studentAddress
10	Omar Saeed	Dubai
11	Khadija Ahmad	Dubai
12	Alya Ali	Abu Dhabi
13	Khalid Mohamed	Abu Dhabi

Table 0.91

code	title	credits
2	English 1	2
5	Math 1	2
6	Ethics	4
8	database	4

Table 0.94

Registration#	studentID	code
1	10	2
2	11	5
3	10	6
4	11	2
5	10	5
6	11	6

```
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Post cross-class: Counter({'Table': 3, 'Section-header': 1, 'List-item': 1, 'Text': 1})
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      51.36980438232422,
      553.947998046875,
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      9.474678993225098,
      ...
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    ]
  }
]
```

Image 3 -

The following data were collected by a group of students as they tested four different types of plastics

Plastic	Acetone	Flame test	Heat	Crease color
1	No effect	Green color	Softens	None
2	Softened	No change	No change	White
3	No effect	Red color	Softens	None
4	No effect	Green color	Softens	none

Which plastic would be unsafe to use to store products that contain acetone?

a. 1
b. 2
c. 3
d. 4

```
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Post text merge: Counter({'List-item': 1, 'Table': 1, 'Text': 1})
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Post deduplication: Counter({'List-item': 1, 'Text': 1, 'Table': 1})
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      ...
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]
```

Image 4:

Text 0.97

clever and unscrupulous man began to take advantage of this sense of fear and helplessness. He suggested that these setbacks were really caused by the work of spies inside the United States.

Text 0.97

The Rise of Senator Joe McCarthy In February 1950, a little-known senator from Wisconsin made a speech in Wheeling, West Virginia. The senator, **Joseph R. McCarthy**, charged that the State Department was infested with communist agents. He waved a piece of paper, which, he said, contained the names of State Department employees who were secretly communists.

Text 0.98

The reason why we find ourselves in a position of [weakness] is not because the enemy has sent men to invade our shores, but rather because of the traitorous actions of those who have had all the benefits that the wealthiest nation on earth has had to offer—the finest homes, the finest college educations, and the finest jobs in Government we can give. . .

... I have here in my hand a list of 205 [individuals] that were known to the Secretary of State as being members of the Communist Party and who nevertheless are still working and shaping the policy of the State Department.

Speech by McCarthy, February 9, 1950

Text 0.95

The charge provoked a furor. When challenged to give specific names, McCarthy said he had meant that there were "205 bad security risks" in the department. Then he claimed that 57 employees were communists. Over the next months, the numbers on his list changed. McCarthy never did produce the list of communists. Still, with the outbreak of the Korean War in June 1950, McCarthy's accusations grabbed the attention of the

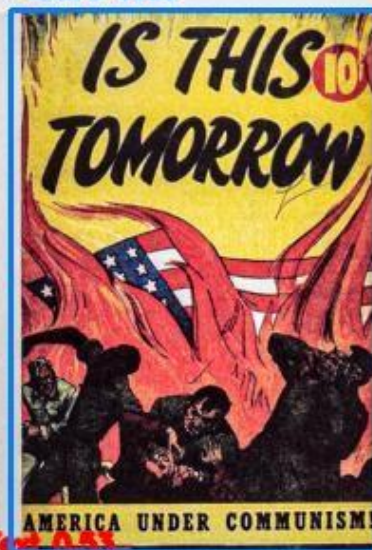
Text 0.97

At the time of the above speech, McCarthy was finishing his first term in the Senate. He had accomplished very little in that term and was looking for a popular issue on which to focus his 1952 reelection campaign. Anticommunism seemed to be just the issue. McCarthy was easily reelected to a second term.

Text 0.93

The Methods of McCarthyism In the following four years, McCarthy put forward his own brand

Picture 0.88



Text 0.93

>> The charges from McCarthy and others that communists were working from within to overthrow the American government helped spread panic through popular culture.

Text 0.98

of anticommunism—so much so that the term **McCarthyism** became a catchword for extreme, reckless charges. By making irresponsible allegations, McCarthy did more to discredit legitimate concerns about domestic communism than any other single American. Between 1950 and 1954, McCarthy was perhaps the most powerful politician in the United States. Piling baseless accusations on top of charges that could not be proved, McCarthy became chairman of an investigations subcommittee. Merely being accused by McCarthy caused people to lose their jobs and destroyed their reputations. He attacked ruthlessly. When one case faded, he introduced a new one.

Text 0.98

Confident because of his increasing power, McCarthy took on larger targets. He attacked former Secretary of State George Marshall, a national hero and author of the Marshall Plan. Even other senators came to fear McCarthy. They worried that he would brand them as communist sympathizers.

Text 0.97

McCarthy Loses Support In 1954, McCarthy went after the United States Army, claiming that it, too, was full of communists. Army leaders responded that McCarthy's attacks were personally motivated.

```

..
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```

Image 5 -

Text 0.91

postwar, they embraced traditional ideals of family life and community.

Text 0.97

The "ideal" American family during World War II, many women—including married women with children—had gone off to work in factories. In 1943, women made up 25 percent of the workers in the wartime auto industry. With the war's end, however, most of the women who had entered the workforce returned to being homemakers. Now, a more traditional image of the family took hold, one in which women stayed home and men served as "breadwinners." Women who wanted a career outside the home faced social Text 0.97 to rethink their decisions.

During the 1950s, the ideal family was one in which men worked and supported their families and women stayed home and reared their children. In the popular magazines of the postwar era, social scientists and other opinion makers described the nuclear family as a household consisting of a mother and father and their children, as the backbone of American society. For the nuclear family to function smoothly, experts claimed, women had to accept their role as homemakers. Television shows and movies made similar assertions. For example, in the 1956 Hollywood movie *The Tender Trap*, actress Debbie Reynolds declared, "A woman isn't a woman unless she's been married and had children."

Picture 0.93



Women in the 1950s were encouraged to return to traditional family roles by staying home to raise families.

Text 0.98

As the 1950s progressed, however, more women were willing to challenge the view that a woman could not have a career outside the home. By 1960, women held one third of the nation's jobs. Approximately half of these women workers were married.

Text 0.92

Baby Boom Increases Focus on Children More so than in the past, family life revolved around children. Not surprisingly, the best-selling book of the era was

Text 0.96

Benjamin Spock's *Common Sense Book of Baby and Child Care*. Parents bought and read his book because they wanted expert advice on how to raise their children. Spock emphasized the importance of nurturing children, from their earliest days as infants through their teen years. Mothers, Spock suggested, should not worry about spoiling their children because children could not get too much comfort and love. Some criticized Spock for promoting what they called a "permissive culture." Nevertheless, Spock's book Text 0.96 extremely popular for several decades.

Another sign of the degree to which family life revolved around children was the amount of money parents spent on their children. Some parents defended their spending by arguing that such spending guaranteed against the recurrence of another

Text 0.95

As baby boomers became teens, their impact on the economy and American culture became even more noticeable. While as children they received toys, such as Davy Crockett caps and Barbie dolls, as teens they purchased very expensive items. As *LIFE* magazine observed:

Text 0.95

The time is past when a boy's chief possession was his bike and a girl's party wardrobe consisted of a fancy dress worn with a string of dime-store pearls. . . . Today's teenagers surround themselves with a fantastic array of garish and often expensive baubles and amusements. They own 10 million phonographs, over a million TV sets, 13 Text 0.95 cameras.

Text 0.95 August 31, 1956

Section-Header 0.96

Text 0.97 Ham Contributes to a Religious Revival

The 1950s also witnessed a revival of religion in the United States. Organized religious groups became more powerful and more houses of worship were built. Regular church attendance rose from about 50 million in

Text 0.95

1940s about 80 million in 1958. The increased number of churches and synagogues in suburban communities across the country helped to strengthen community life. The evangelist Billy Graham attracted millions Text 0.95 revivals that he held around the nation.

Roman Catholic bishop Fulton Sheen effectively used television to reach audiences estimated at 30 million a week. During the 1950s, Congress added the words "In God We Trust" to the dollar bill and "under God" to the Pledge of Allegiance. These additions were aimed at making clear the contrast between the centrality of religion in American society and the atheist basis of communist societies.

Text 0.96

Specific Needs Lead to Medical Innovations

During the 1950s, American families benefited from numerous advances in medicine. By 1952, Dr. Jonas Salk was refining a vaccine against polio, the disease that had struck down Franklin Roosevelt and that, in 1952 alone, had crippled tens of thousands and killed 14,000, mostly children. By 1960, the widespread distribution of Salk's new vaccine and an oral vaccine developed by Albert Sabin had nearly eliminated the

Text 0.96

At the same time, antibiotics, such as penicillin Text 0.92, shortened one

The antibiotics helped control numerous infectious diseases caused by bacteria, such as whooping cough and tuberculosis. As a result of these medical advances and a better understanding of the importance of diet, children born after 1946 had a longer life expectancy than those born before 1946.

Text 0.95

CONNECT How did the focus on children and teenagers help Text 0.95 prosperity during the 1950s?

Section-Header 0.96

Educational Opportunities

Text 0.96 Priorities

As the economy grew, so too did opportunities for Americans to attain higher education. A more educated work force boosted economic productivity. In 1940, only about 15 percent of college-age Americans attended college. By the early 1960s, however, close to 40 percent did. The percentage of Americans who completed high school also rose sharply. "The astonishing growth of education in the late 1940s (and thereafter)," wrote historian James Patterson, "seemed yet another sign that the American Dream was well and alive."

Section-Header 0.97

Text 0.97 Spending Shapes Education Priorities

New priorities meant that students had expanded opportunities. In Texas, for example, the state

Picture 0.93



Text 0.96

In 1954, Dr. Jonas Salk created a polio vaccine. His vaccine was ordered for all American children and was eventually used around the globe to virtually eradicate polio.

Picture 0.96



Text 0.96

A combination of more educational opportunities and a large baby-boom population contributed to full classrooms across the nation.

```
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```

Image 6:

Section—header 0.56

Table 1: Discussion Rubric

Table 0.95

Criteria	Exemplary Performance	Satisfactory Performance	Needs Improvement
Participation	Makes an original post and replies to at least two other classmates in the discussion.	Makes an original post and replies to one other classmate in the discussion.	Makes an original post but doesn't reply to others within the discussion.
Relevance	The posting directly addresses key issues, questions, or problems related to the text and the discussion activity. The posing applies course concepts well.	The posting addresses key issues, questions, or problems related to the text and the discussion activity, but in some cases, only indirectly. It does not always apply course concepts fully.	The posting does not directly address the question or problem posed by the discussion activity.
Insight	The posting offers original or thoughtful insight, analysis, or observation that demonstrates a strong grasp of concepts and ideas pertaining to the discussion topic.	The posting does offer some insight, analysis, or observation to the topic but may not demonstrate a full understanding or knowledge of concepts and ideas pertaining to the discussion topic.	The posting does not offer any significant insight, analysis, or observation related to the topic. No knowledge or understanding is demonstrated regarding concepts and ideas pertaining to the discussion topic.
Support	The posting supports all claims and opinions with either rational argument or evidence.	The posting generally supports claims and opinions with evidence or argument but may leave some gaps where unsupported opinions still appear.	The posting does not support its claims with either evidence or argument. The posting contains largely unsupported opinion.

Image 7:

Table 0.91

Data Set	Column 1	Column 2	Column 3	Column 4	Column 5
Row 1	248120	128469	187918	571239	186161
Row 2	64811	158615	475537	261461	249846
Row 3	568484	786210	189358	187997	148768
Row 4	458648	186489	189687	123456	518498

Image 8:

Table 0.94

Authors		
AuthorId	AuthorName	AuthorBirthdate
1	John Grisham	February 8, 1955
2	Stephen King	September 21, 1947
3	J.K. Rowling	July 31, 1965

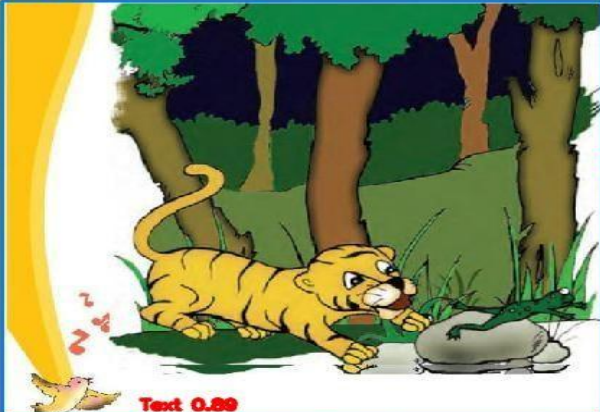
Table 0.94

Books			
BookId	AuthorId	BookTitle	ReleaseYear
1	2	The Shining	1977
2	2	It	1986
3	3	Harry Potter and the Sorcerer's Stone	1997

```
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```


Image 9:

Picture 0.62



Text 0.95

If he went too far away, the mother tiger called him with a low, quiet grunt. The tiger cub came back, but he did not like to stay near his mother in the jungle at night.

Text 0.63

One night the mother tiger was tired and closed her eyes. The tiger cub saw a tiny frog, hopping along the ground. The tiger cub pounced, but the frog hopped away. He chased the frog and caught it, and turned to show

Text 0.89


his mother. But she was not in sight. Instead he saw a tiger, bigger than his mother, near him in the jungle.

Text 0.93

The tiger's green eyes glistened as he watched the tiger cub. The tiger cub was frightened. He could not hide or run. He let the frog hop away. The tiger crept up closer to the little tiger cub.

Text 0.91

But a roar filled the jungle, the roar of the mother tiger! She faced the other tiger and he went away. The mother tiger liked to roar, a loud, big tiger roar, to tell



Text 0.94

all the other animals in the jungle that she was there. All the other animals in the jungle kept far, far away.

Page-footer 0.75

70

Page-footer 0.73

2019-20

```

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```

Image 10 -

date	Item_id	price	units_sold
7/27/2017	12947239	12.99	204
7/27/2017	49273623	12.00	150
7/27/2017	40238274	10.60	276
7/26/2017	12947239	10.50	405
7/26/2017	49273623	21.00	70
7/25/2017	1111111	13.00	87

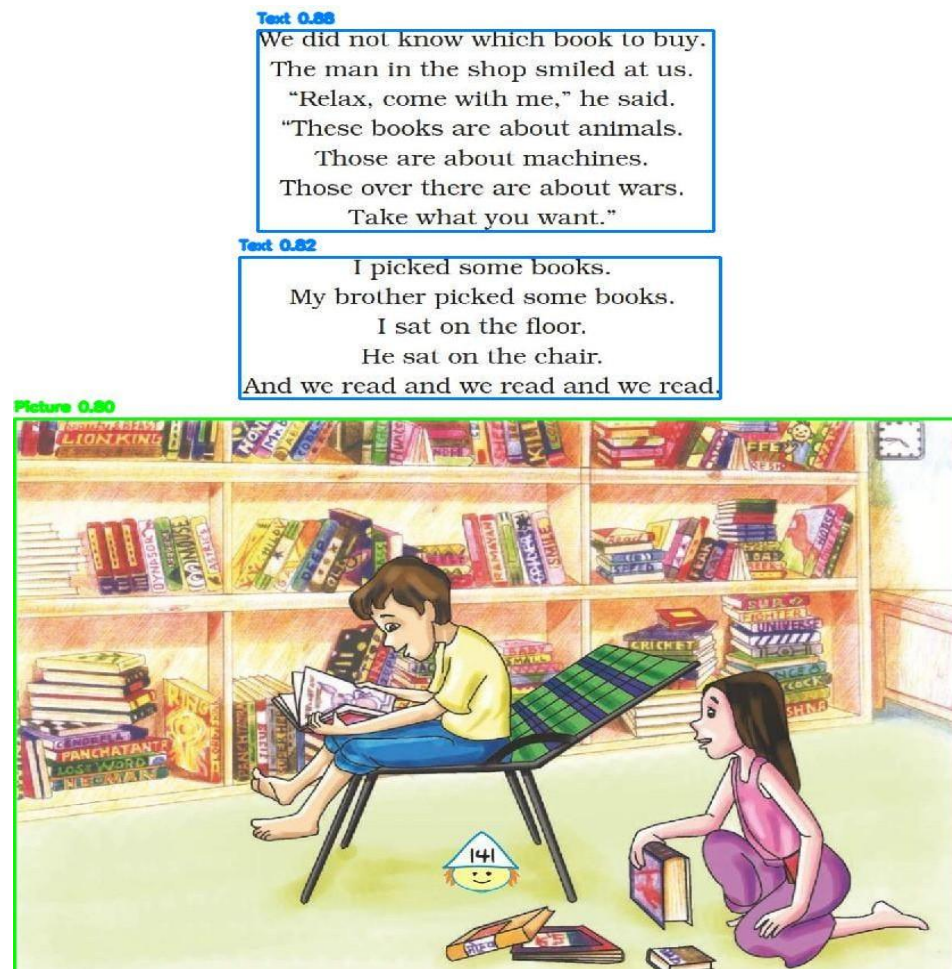
Item_id	name	is_veg	avg_price
12947239	Spaghetti	no	10.50
49273623	Steak	no	15.00
40238274	Eggplant parm	yes	9.50
371743817	Mac and Cheese	yes	6.50
3718373	Chicken	no	10.30


```

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Speed: 13.6ms preprocess, 1346.5ms inference, 0.0ms postprocess per image at shape (1, 3, 416, 1024)
Before: {'Table': 20} total: 20
Post pre-filter: Counter({'Table': 20})
Post NMS: Counter({'Table': 2})
Post text merge: Counter({'Table': 2})
Post cross-class: Counter({'Table': 2})
Post deduplication: Counter({'Table': 2})
After: {'Table': 2} total: 2
[
  {
    "bbox": [
      0.0017092825146391988,
      1.5751674175262451,
      204.4264678955078,
      173.57769775390625
    ],
    "label": "Table",
    "confidence": 0.91970294713974
  },
  {
    "bbox": [
      223.0729522705078,
      1.2985602617263794,
      ...
    ],
    "label": "Table",
    "confidence": 0.899629533290863
  }
]

```

Image 11:



```

0: 1024x864 10 Pictures, 20 Texts, 4245.3ms
Speed: 22.5ms preprocess, 4245.3ms inference, 4.0ms postprocess per image at shape (1, 3, 1024, 864)
Before: {'Text': 20, 'Picture': 10} total: 30
Post pre-filter: Counter({'Text': 20, 'Picture': 10})
Post NMS: Counter({'Text': 2, 'Picture': 1})
Post text merge: Counter({'Text': 2, 'Picture': 1})
Post cross-class: Counter({'Text': 2, 'Picture': 1})
Post deduplication: Counter({'Text': 2, 'Picture': 1})
After: {'Text': 2, 'Picture': 1} total: 3
[
  {
    "bbox": [
      215.4816131591797,
      89.23631286621094,
      616.1595458984375,
      298.645263671875
    ],
    "label": "Text",
    "confidence": 0.8803678750991821
  },
  {
    "bbox": [
      199.835693359375,
      325.8321228027344,
      ...
      "label": "Picture",
      "confidence": 0.7999792695045471
    ]
  }
]

```