



# OCR for Mathematical Equations

Request for Proposal

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## 1 Objectives

The following request for proposal (RFP) outlines the requirements for developing solution for Optical Character Recognition (OCR) for Mathematical Equations, using deep learning.

All code should be original as much as possible and there should not be any license 3<sup>rd</sup> party liability or dependency.

- Intel will use this internally.
- This will be used by Software vendors.

## 2 OCR for Mathematical Equations Requirements

### 2.1 Responsibilities

Vendor Responsibilities
Develop deep learning algorithm solution package for - recognizing and digitizing steps of solving a mathematical equation written by freehand on a paper, validating the steps and final answer of the recognized handwritten lines by maintaining the context.
Solution needs to be developed for one type of equation.
Make the solution for one type of equation available in public without any cost.
Maintain a schedule on the progress
Intel Responsibilities
Perform acceptance testing on the solution and provide feedback/approval

### 2.2 RFP Proposal Requirements

The Proposal should include the following information as a minimum:

- The approach for developing the solution including specific deep learning techniques and frameworks that will be used
- Schedule including intermediate drops, licenses and waivers.
- Development Project Cost
- Payment Schedule
- Team list (including Qualifications/Geo/Experience)

### 2.3 Target Schedule

Table 2-1 Phase 2 Target Schedule

#	Description	Target Dates
1	Vendor selected	X
2	Vendor turn on (Contract Signed)	X + 1 week
3	Initial Release	X + 4 weeks
4	Final Release	X+ 6-8 weeks

## 2.4 OCR for Mathematical Equations Requirements

Vendor is responsible for delivering all the content specified below.

### 2.4.1 Detailed Requirements

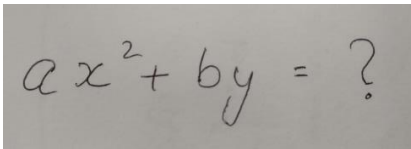
#### 2.4.1.1 Capturing and recognizing handwritten symbols

The handwriting will happen on a paper.

#### 2.4.1.2 Equation format

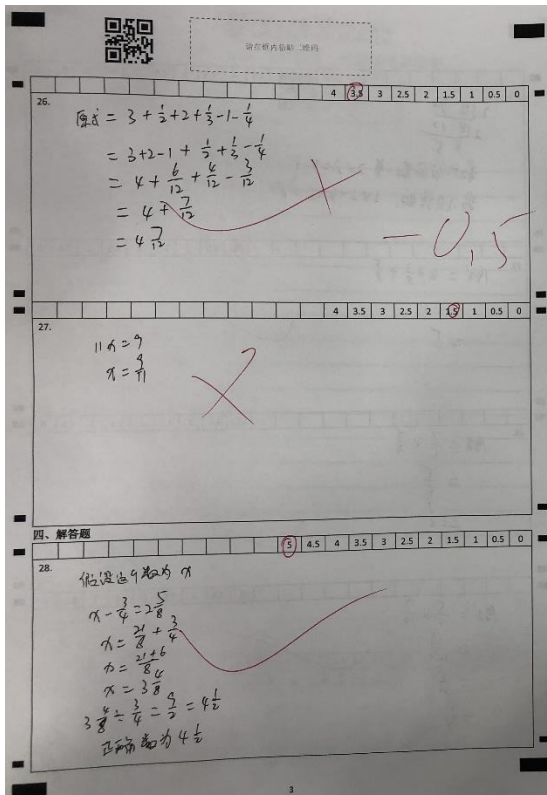
Following type of equation with any numeric values should be recognized and solved with steps.

**A binomial algebraic equation.**


$$ax^2 + by = ?$$

#### 2.4.1.3 Sample Input

This is only representation of an input worksheet. The actual equation in the sheet not to be considered.



The sample input worksheet shows three problems with handwritten calculations and a numeric keypad at the top of each section.

**Problem 26:**

$$\begin{aligned} \text{原式} &= 3 + \frac{1}{2} + 2 + \frac{1}{3} - 1 - \frac{1}{4} \\ &= 3 + 2 - 1 + \frac{1}{2} + \frac{1}{3} - \frac{1}{4} \\ &= 4 + \frac{6}{12} + \frac{4}{12} - \frac{3}{12} \\ &= 4 + \frac{7}{12} \\ &= 4\frac{7}{12} \end{aligned}$$

**Problem 27:**

$$\begin{aligned} 11x &= 9 \\ x &= \frac{9}{11} \end{aligned}$$

**Problem 28:**

$$\begin{aligned} \text{假设是 } 9 \text{ 则为 } x \\ x - \frac{3}{4} &= 2\frac{5}{8} \\ x &= \frac{21}{8} + \frac{3}{4} \\ &= \frac{21}{8} + \frac{6}{8} \\ x &= \frac{27}{8} \\ 3\frac{3}{8} \div \frac{3}{4} &= \frac{27}{8} \div \frac{3}{4} = 4\frac{1}{2} \\ \text{正确 应为 } 4\frac{1}{2} \end{aligned}$$

#### 2.4.1.4 Sample Output

Solve  $Ax^2 + By = ?$

A =

B =

x =

y =

Recognize

$3 \times 2^2 + 4 \times 3$   
 $3 \times 4 + 12$   
 $12 + 12$   
 $= 24$

$3 \times 2^2 + 4 \times 3$   
 $3 \times 4 + 8$   
 $12 + 8$   
 $20$

$3 \times 2^2 + 4 \times 3$   
 $3 \times 3 + 8$   
 $3 \times 11$   
 $24$

#### 2.4.1.5 Solving the mathematical Equation

The series of lines of recognized need to be in the same context and the next step and final answer of the most recent equation should be available to the user.

#### 2.4.2 Training Data set

Training dataset has to be created by the vendor.

### 2.5 Testing

The test process and test data set should be made available to Intel and should be free of any license.

### 2.6 Licensing/IP

There should not be any restrictions on Intel or Intel's customers using this solution.

### 2.7 Data Rights and Consent

Vendor is solely responsible for obtaining any and all consents from data subjects, if and as required under applicable law, for Intel to process the personal data. Vendor will provide to Intel the form of consent referenced in the preceding sentence as well as any published privacy policies and internal privacy policies and guidelines relating to the processing of the personal data by Vendor. If consent is not required under applicable law for Vendor to collect or otherwise process the personal data (including to enable a cross-border transfer of that data), Vendor will provide to Intel Vendor's basis for lawfully processing the personal data, including transferring it (cross-border) to Intel.

### 2.8 Acceptance Criteria

Intel will do an acceptance test using a set of test data set which will not be shared.

Inference should be on Intel Architecture.

Acceptance test will be done with images of handwritten equations on paper.

Following will be measured

- Intermediate steps are correctly recognized
- Final answer is correctly recognized.

An accuracy level of >90% should be achieved by the solution.

## 2.9 Support

The support period after the delivery of the final content for this project is 45 days after formal acceptance by Intel. Intel understands that the vendor will not provide ongoing support for the content after this period.

## 2.10 Deliverables

Following are identified minimum deliverables.

- Sample application in which take image input and provide image output with colored bounding boxes with Right or Wrong indication. Application should also generate detailed log file.
- Model files and weights.
- Training Files and Test Results
- User guide along with steps for integrating in a different application software.

All of this should be made available freely on github.

All parts of the solution should work on Intel Architecture.

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