

# Module Interface Specification for OAR

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# 1 Revision History

Date	Version	Notes
March 8, 2024	1.0	Initial Revision
March 15, 2024	1.1	Changes made according to Dr. Smith's Initial Comments
April 10, 2024	1.2	Changes made according to Comments from Primary and Secondary Reviewers
April 10, 2024	1.3	Changes made according to Dr. Smith's Detailed Comments

## 2 Symbols, Abbreviations and Acronyms

See SRS Documentation (Ceranic, 2024) at <https://github.com/cer-hunter/OAR-CAS741/blob/main/docs/SRS/SRS.pdf>

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### 3 Introduction

The following document details the Module Interface Specifications for the OAR (Optical Alphabet Recognition) program. This document specifies how each module interfaces with other parts of the program.

Complementary documents include the System Requirement Specifications and Module Guide. The full documentation and implementation can be found at <https://github.com/cer-hunter/OAR-CAS741>.

### 4 Notation

The structure of the MIS for modules comes from Hoffman and Strooper (1995), with the addition that template modules have been adapted from Ghezzi et al. (2003). The mathematical notation comes from Chapter 3 of Hoffman and Strooper (1995). For instance, the symbol  $:=$  is used for a multiple assignment statement and conditional rules follow the form  $(c_1 \Rightarrow r_1 | c_2 \Rightarrow r_2 | \dots | c_n \Rightarrow r_n)$ .

The following table summarizes the primitive data types used by OAR.

Data Type	Notation	Description
character	char	a single symbol or digit
integer	<b>Z</b>	a number without a fractional component in $(-\infty, \infty)$
positive integer	<b>Z</b> <sub>+</sub>	a positive integer ( <b>Z</b> ) in $(0, \infty)$
unsigned 8-bit integer	<b>U</b>	a number without a fractional component in $(0, 255)$
natural number	<b>N</b>	a number without a fractional component in $[1, \infty)$
real	<b>R</b>	any number in $(-\infty, \infty)$
positive real	<b>R</b> <sub>+</sub>	any real number ( <b>R</b> ) in $(0, \infty)$

The specification of OAR uses some derived data types: sequences, strings, tuples, and booleans. Sequences are lists filled with elements of the same data type. Strings are sequences of characters. Tuples contain a list of values, potentially of different types. Booleans can be represented in different ways but only have two possible values: true or false. In addition, OAR uses functions, which are defined by the data types of their inputs and outputs. Local functions are described by giving their type signature followed by their specification.

### 5 Module Decomposition

The following table is taken directly from the Module Guide document for this project.



Level 1	Level 2
Hardware-Hiding Module	
Behaviour-Hiding Module	Application Control Graphics Display Output Calculator Input Data Read Input Classifier OAR Model Data OAR Model Equations OAR Model Training OAR Model Testing
Software Decision Module	Confusion Matrix Input Processing Graphical User Interface

Table 1: Module Hierarchy

## 6 MIS of Application Control Module

### 6.1 Module

main

### 6.2 Uses

- Graphics Display Module Specification ([7](#))
- Output Module Specification

### 6.3 Syntax

#### 6.3.1 Exported Constants

None.

#### 6.3.2 Exported Access Programs

Name	In	Out	Exceptions
main	-	-	-

## 6.4 Semantics

### 6.4.1 State Variables

None.

### 6.4.2 Environment Variables

- Screen ( $\mathbf{Z}_+$  for width and height in pixels)

### 6.4.3 Assumptions

The GUI Display is running and displayed without issue.

### 6.4.4 Access Routine Semantics

main():

- transition: Connects the Output Calculator Module [8](#) to the Graphics Display module [7](#)

### 6.4.5 Local Functions

None.

## 7 MIS of Graphics Display

### 7.1 Module

display

### 7.2 Uses

- Hardware-Hiding Module
- Input Data Read Module ([9](#))
- Output Calculator Module ([8](#))
- Graphical User interface (GUI) Module ([17](#))

### 7.3 Syntax

#### 7.3.1 Exported Constants

- GUI\_BOXSIZE: A value ( $\mathbf{Z}_+$ ) describing both width and height (in pixels) used for the image display "box" (currently always a square)

### 7.3.2 Exported Access Programs

Name	In	Out	Exceptions
display	inputImage ( $\mathbf{U}^{m \times n}$ ), resultLabel (String), resultConf (String)	displayWindow ( $\mathbf{Z}_+^{m \times n}$ ), event han- dlers	guiException

## 7.4 Semantics

### 7.4.1 State Variables

- inputImage ( $\mathbf{U}^{m \times n}$ ): The processed input image and given by the Output Calculator Module 8
- resultLabel (String): The label output as given by the Output Calculator Module 8 as a string.
- resultConf ( $\mathbf{R}$ ): The confidence probability output as given by the Output Calculator Module 8 as a string.

### 7.4.2 Environment Variables

- Keyboard ( $\mathbf{Z}_+$  for keycodes describing the key pressed)
- Mouse (Boolean for click state and  $\mathbf{Z}_+$  for cursor position)
- Screen ( $\mathbf{Z}_+$  for width and height in pixels)
- displayWindow ( $\mathbf{Z}_+$  for width and height in pixels) for the application interface
- inputButton (String for a file location) to provide an input image from the file system

### 7.4.3 Assumptions

- The file system is able to read and provide the image file as specified by the user through an OS file-open dialog. Otherwise if the file is not found, denied access or cancelled, no changes should occur.
- The OS is able to provide basic text or number input user controls with some basic built-in validation, and is able to handle events from Human Interface Devices (HIDs such as mouse, keyboard or touchscreen).

#### 7.4.4 Access Routine Semantics

`display()`:

- transition: Sets up user control event handlers (i.e., mouse clicks or drag, button presses, text input change, ...) as needed for the user input. Calls the Input Data Read Module 9 to accept a base image and Output Calculator Module 8 to classify the input image. The input image and output results are then pushed to the `displayWindow`.
- exception: `guiException` when `ValueError` is raised by the program, or incorrect user input.

#### 7.4.5 Local Functions

None.

## 8 MIS of Output Calculator Module

### 8.1 Module

`output`

### 8.2 Uses

- Input Classifier Module Specification (10)

### 8.3 Syntax

#### 8.3.1 Exported Constants

- `DEC_FIXED`: Used for fixed decimal number length rounding (ex. "5.8923" at fixed length "2" results in "5.89")

#### 8.3.2 Exported Access Programs

Name	In	Out	Exceptions
output	baseImage ( $\mathbf{Z}^{m,n}$ )	displayImage resultLabel resultConf (String)	( $\mathbf{U}^{m \times n}$ ), - (String),

### 8.4 Semantics

#### 8.4.1 State Variables

- `labelData (tuple)`:= outputs from `classify(displayImage)` containing the label (string), and confidence ( $\mathbf{R}_+$ ) in the prediction

#### 8.4.2 Environment Variables

None.

#### 8.4.3 Assumptions

The input image is valid.

#### 8.4.4 Access Routine Semantics

output():

- output: resultLabel, resultConf := labelData (String)  
displayImage := input(baseImage)

#### 8.4.5 Local Functions

None.

## 9 MIS of Input Data Read Module

### 9.1 Module

input

### 9.2 Uses

- Input Processing Module Specification ([16](#))

### 9.3 Syntax

#### 9.3.1 Exported Constants

None.

#### 9.3.2 Exported Access Programs

Name	In	Out	Exceptions
input	inputPath (String)	inputImage ( $\mathbf{I}_{x,y}$ )	ValueError

## 9.4 Semantics

### 9.4.1 State Variables

- **maxSize**: A value ( $\mathbf{Z}_+$ ) describing both width and height (in pixels) for maximum acceptable size of the input image (currently a square).
- **minSize**: A value ( $\mathbf{Z}_+$ ) describing both width and height (in pixels) for minimum acceptable size of the input image (currently a square).
- **modelSize**: The required size of the input image matrix to be used by the classification model  $\mathbf{I}_{x,y}$ .

### 9.4.2 Environment Variables

- **baseImage**: The base input image in the form of a .BMP .JPG or .PNG file.

### 9.4.3 Assumptions

The `inputPath` location for the `baseImage` is valid, readable and accessible.

### 9.4.4 Access Routine Semantics

`input(inputPath):`

- **output**: `inputImage := preprocess(baseImage)`
- **exception**: `ValueError` if the size of the base image is outside of the range of `minSize` to `maxSize`, `ValueError` if the file type of the `baseImage` is not supported by the OAR Program (according to R1)

### 9.4.5 Local Functions

None.

## 10 MIS of Input Classifier Module

### 10.1 Module

`classify`

### 10.2 Uses

- OAR Model Data Module Specification (11)
- OAR Model Equations Module Specification (12)

## 10.3 Syntax

### 10.3.1 Exported Constants

**LABELS**:= (A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z)

### 10.3.2 Exported Access Programs

Name	In	Out	Exceptions
classify	inputImage ( $\mathbf{U}^{m \times n}$ ), oarModel ( $\mathbf{R}^{m \times n}$ )	resultLabel (String), confPercent ( $\mathbf{R}_+$ )	-

## 10.4 Semantics

### 10.4.1 State Variables

- **weight**: the weight portion of the **oarModel** input as  $\mathbf{M}_{x,y}$  for each label.
- **bias**: the bias portion of the **oarModel** input as  $\mathbf{R}$  for each label.
- **predictionMatrix**:  $\mathbf{M}_{x,y}$ , where each entry is the output of **predict**(inputImage, weight, bias), corresponding to each label
- **bestPrediction**:  $\max(\text{predictionMatrix}) \leq 1$

### 10.4.2 Environment Variables

None.

### 10.4.3 Assumptions

The input image is valid.

### 10.4.4 Access Routine Semantics

**classify**(inputImage):

- **output**: **confPercent** := **bestPrediction**, **resultLabel**:= the letter in the list of **LABELS** corresponding to the index of **bestPrediction** in the **predictionMatrix**

### 10.4.5 Local Functions

None.

## 11 MIS of OAR Model Data Module

### 11.1 Module

model

### 11.2 Uses

- OAR Model Testing Module Specification ([14](#))

### 11.3 Syntax

#### 11.3.1 Exported Constants

None.

#### 11.3.2 Exported Access Programs

Name	In	Out	Exceptions
model	-	-	-

### 11.4 Semantics

#### 11.4.1 State Variables

- **oarModel**: Data structure designed to store the matrix of weights and biases associated with the trained OAR classification model as a tuple of  $\mathbf{M}_{x,y}$  and  $\mathbf{R}$ .
- **performance**: Data structure designed to store the matrix of performance values associated with each label of the trained OAR classification model as a  $\mathbf{M}_{x,y}$ .

#### 11.4.2 Environment Variables

None.

#### 11.4.3 Assumptions

None.

#### 11.4.4 Access Routine Semantics

model():

- **transition**: This module is a simple tuple ( $\mathbf{R}^{m \times n}$  and  $\mathbf{R}$ ) data structure for storing the OAR classification model weights and biases and corresponding performance matrix.



### 11.4.5 Local Functions

None.

## 12 MIS of OAR Model Equations Module

### 12.1 Module

oarUtils

### 12.2 Uses

None.

### 12.3 Syntax

#### 12.3.1 Exported Constants

None.

#### 12.3.2 Exported Access Programs

Name	In	Out	Exceptions
sigmoid	sigIn ( $\mathbf{R}$ )	sigOut ( $\mathbf{R}$ )	-
logLossFunc	trueVal ( $\mathbf{R}$ ), predVal ( $\mathbf{R}$ )	logLoss ( $\mathbf{R}$ )	ValueError
predict	inputImage ( $\mathbf{U}^{m \times n}$ ), weight ( $\mathbf{R}^{m \times n}$ ), bias ( $\mathbf{R}$ )	predVal ( $\mathbf{R}$ )	ValueError
gradientW	inputImage ( $\mathbf{U}^{m \times n}$ ), trueVal ( $\mathbf{R}$ ), weight ( $\mathbf{R}^{m \times n}$ ), bias ( $\mathbf{R}$ ), regParam ( $\mathbf{R}$ ), trainSize ( $\mathbf{Z}_+$ )	gradW ( $\mathbf{R}$ )	ValueError
gradientB	inputImage ( $\mathbf{U}^{m \times n}$ ), trueVal ( $\mathbf{R}$ ), weight ( $\mathbf{R}^{m \times n}$ ), bias ( $\mathbf{R}$ )	gradB ( $\mathbf{R}$ )	-

### 12.4 Semantics

#### 12.4.1 State Variables

None.

#### 12.4.2 Environment Variables

None.

### 12.4.3 Assumptions

The input image is valid.

### 12.4.4 Access Routine Semantics

`sigmoid(sigIn)`:

- output: `sigOut` :=  $\frac{1}{1+e^{-\text{sigIn}}}$

`logLossFunc(trueVal, predVal)`:

- output: `logLoss` := `trueVal` · `log(predVal)` + (1 – `trueVal`) · `log(1 – predVal)`
- exception: `ValueError` if `predVal` or 1 – `predVal` is negative

`predict(inputImage, weight, bias)`:

- output: `sigIn` := `weight`<sup>T</sup> · `inputImage` + `bias`, `predVal` := `sigmoid(sigIn)`
- exception: `ValueError` if `inputImage` and `weight` are matrices of the same size

`gradientW(inputImage, trueVal, weight, bias, regParam, trainSize)`:

- transition: `predVal` := `predict(inputImage, weight, bias)`
- output: `gradW` := `inputImage` · (`trueVal` – `predVal`) –  $\frac{\text{regParam}}{\text{trainSize}} \cdot \text{weight}^2$
- exception: `ValueError` if `trainSize` is 0

`gradientB(inputImage, trueVal, weight, bias)`:

- transition: `predVal` := `predict(inputImage, weight, bias)`
- output: `gradB` := `trueVal` – `predVal`

### 12.4.5 Local Functions

None.

## 13 MIS of OAR Model Training Module

### 13.1 Module

`train`

### 13.2 Uses

- OAR Model Equations Module Specification ([12](#))

## 13.3 Syntax

### 13.3.1 Exported Constants

- REG\_PARAM: The regularization parameter used during model training as  $\mathbf{R}_+$ .
- ALPHA: The learning rate parameter used during model training as  $\mathbf{R}_+$ .

### 13.3.2 Exported Access Programs

Name	In	Out	Exceptions
train	trainData ( $\mathbf{U}^{m \times n}$ ), trainLabels ( $\mathbf{Z}_+^{m \times n}$ ), weightBiasMatrix (tuple of $\mathbf{R}^{m \times n}$ and $\mathbf{R}$ ), trainSize ( $\mathbf{Z}_+$ )	weightBiasMatrix (tuple of $\mathbf{R}^{m \times n}$ and $\mathbf{R}$ )	-

## 13.4 Semantics

### 13.4.1 State Variables

- weight: the weight portion of the weightBiasMatrix input as  $\mathbf{R}^{m \times n}$  for each label.
- bias: the bias portion of the weightBiasMatrix input as  $\mathbf{R}$  for each label.
- gradW:= gradientW(trainData, trainLabels, REG\_PARAM, trainSize)
- gradB:= gradientB(trainData, trainLabels, weight, bias)

### 13.4.2 Environment Variables

None.

### 13.4.3 Assumptions

None.

### 13.4.4 Access Routine Semantics

train(trainData, trainLabels, weightBiasMatrix, trainSize):

- transition: weight:= weight + ALPHA·gradW, bias:= bias + ALPHA·gradB
- output: weightBiasMatrix:= (weight,bias)

### 13.4.5 Local Functions

None.

## 14 MIS of OAR Model Testing Module

### 14.1 Module

test

### 14.2 Uses

- OAR Model Data Module Specification ([12](#))
- OAR Model Equations Module Specification ([12](#))
- OAR Model Training Module Specification ([13](#))
- Metrics Module Specification ([15](#))

### 14.3 Syntax

#### 14.3.1 Exported Constants

- EPOCHS: The the number of times the model training regression algorithm is ran as  $\mathbf{Z}_+$ .
- LABELS:= (A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z) (tuple of Strings)
- TRAIN\_SIZE: The size of the training data used during model training as  $\mathbf{Z}_+$ .
- TEST\_SIZE: The size of the testing data used during model training as  $\mathbf{Z}_+$ .

#### 14.3.2 Exported Access Programs

Name	In	Out	Exceptions
test	-	oarModel (tuple of $\mathbf{R}^{m \times n}$ and $\mathbf{R}$ ), performance (tuple of $\mathbf{R}^{m \times n}$ and $\mathbf{U}^{m \times n}$ )	-

## 14.4 Semantics

### 14.4.1 State Variables

- **dataSize**: The size of the input image matrix used during model training as  $\mathbf{Z}_+$ .
- **dataSet**: The set of pre-processed images and their associated labels that will be used for training the classification model as a tuple of  $\mathbf{I}_{x,y}$  and  $\mathbf{Z}_+$ .
- **weight**: the weight portion of the **weightBiasMatrix** input as  $\mathbf{R}^{m \times n}$  for each label.
- **bias**: the bias portion of the **weightBiasMatrix** input as  $\mathbf{R}$  for each label.
- **predictionData**: matrix which tracks the predictions made for each test image as  $\mathbf{R}_+^{m \times n}$ .

### 14.4.2 Environment Variables

None.

### 14.4.3 Assumptions

None.

### 14.4.4 Access Routine Semantics

**test()**:

- **transition**: **weightBiasMatrix** :=  $\mathbf{R}^{m \times n}$  of randomized values from 0 to 1, **train**(**trainData**, **trainLabels**, **weightBiasMatrix**, **trainSize**)
- **output**: **oarModel** := **weightBiasMatrix**, **performance** := **confMatrix**(**predictionData**, **trainLabels**), **loss**(**trainLoss**).

### 14.4.5 Local Functions

- **splitDataSet**(**dataSet**):
  - **output**: Takes the **dataSet** as an input and splits it into distinct parts for training and testing the classification model. The following values are output:
    - \* **trainData** := The part of the **dataSet** used to train the model as  $\mathbf{U}^{m \times n}$ .
    - \* **trainLabels** := The part of the **dataSet** corresponding to the true labels of the **trainData** as  $\mathbf{Z}_+^{m \times n}$ .
    - \* **testData** := The part of the **dataSet** used to test the model as  $\mathbf{U}^{m \times n}$ .
    - \* **testLabels** := The part of the **dataSet** corresponding to the true labels of the **testData** as  $\mathbf{Z}_+^{m \times n}$ .

## 15 MIS of Metrics Module

### 15.1 Module

metrics

### 15.2 Uses

None.

### 15.3 Syntax

#### 15.3.1 Exported Constants

None.

#### 15.3.2 Exported Access Programs

Name	In	Out	Exceptions
confMatrix	predictionData ( $\mathbf{R}_+^{m \times n}$ ), trainLabels ( $\mathbf{Z}_+^{m \times n}$ )	confusionMatrix ( $\mathbf{U}^{m \times n}$ ), matrixData ( $\mathbf{Z}_+^{m \times n}$ )	-
loss	trainLoss ( $\mathbf{R}^{m \times n}$ )	lossGraph ( $\mathbf{U}^{m \times n}$ )	-

### 15.4 Semantics

#### 15.4.1 State Variables

None.

#### 15.4.2 Environment Variables

None.

#### 15.4.3 Assumptions

None.

#### 15.4.4 Access Routine Semantics

confMatrix(predictionData, trainLabels):

- output: matrixData:= ( $\sum \text{predictionData} == \text{True} \ \& \ \text{trainLabels} == \text{True}, \sum \text{predictionData} == \text{True} \ \& \ \text{trainLabels} == \text{False}, \sum \text{predictionData} == \text{False} \ \& \ \text{trainLabels} == \text{True}, \sum \text{predictionData} == \text{False} \ \& \ \text{trainLabels} == \text{False}$ )  
confMatrix:= The graphical representation of matrixData

`loss(trainLoss):`

- output: `lossGraph:= trainLoss` as a graphical representation over some number of epochs ( $\mathbf{Z}_+$ ).

#### 15.4.5 Local Functions

None.

## 16 MIS of Input Processing Module

### 16.1 Module

`preprocess`

### 16.2 Uses

None.

### 16.3 Syntax

#### 16.3.1 Exported Constants

None.

#### 16.3.2 Exported Access Programs

Name	In	Out	Exceptions
<code>preprocess</code>	<code>baseImage</code> ( $\mathbf{Z}^{m \times n}$ )	<code>inputImage</code> ( $\mathbf{U}^{m \times n}$ )	-

### 16.4 Semantics

#### 16.4.1 State Variables

None.

#### 16.4.2 Environment Variables

None.

#### 16.4.3 Assumptions

The format and parameters of the base image was already verified to be within the requirements.

### 16.4.4 Access Routine Semantics

`preprocess(baseImage)`:

- output: Performs transformations on the `baseImage` using functions provided by the sci-kit learn library, such that the resulting `inputImage` as  $(\mathbf{U}^{m \times n})$ , is normalized to be able to be used by the classification model.

### 16.4.5 Local Functions

None.

## 17 MIS of Graphical User Interface

### 17.1 Module

`gui`

### 17.2 Uses

None.

### 17.3 Syntax

#### 17.3.1 Exported Constants

None.

#### 17.3.2 Exported Access Programs

Name	In	Out	Exceptions
<code>gui</code>	None	None	-

### 17.4 Semantics

#### 17.4.1 State Variables

None.

#### 17.4.2 Environment Variables

- Keyboard ( $\mathbf{Z}_+$  for keycodes describing the key pressed)
- Mouse (Boolean for click state and  $\mathbf{Z}_+$  for cursor position)
- Screen ( $\mathbf{Z}_+$  for width and height in pixels)



- Button (String for a file location) to provide an input image from the file system

### **17.4.3 Assumptions**

None.

### **17.4.4 Access Routine Semantics**

`gui()`:

- transition: Provides methods from the TKinter Library to build and deploy a GUI to Graphics Display Module [7](#)

### **17.4.5 Local Functions**

None.

## References

- Hunter Ceranic. System requirements specification. <https://github.com/cer-hunter/OAR-CAS741/blob/main/docs/SRS/SRS.pdf>, 2024.
- Carlo Ghezzi, Mehdi Jazayeri, and Dino Mandrioli. *Fundamentals of Software Engineering*. Prentice Hall, Upper Saddle River, NJ, USA, 2nd edition, 2003.
- Daniel M. Hoffman and Paul A. Strooper. *Software Design, Automated Testing, and Maintenance: A Practical Approach*. International Thomson Computer Press, New York, NY, USA, 1995. URL <http://citeseer.ist.psu.edu/428727.html>.