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REG NO: 22BCT0353

StatKeyEval
A Statistical Framework for Dynamic Keyword Extraction, Evaluation, and Assessment Automation

Aim:

To implement an API for the available research paper models to give the answers for the short answers.

Research Paper:

Title: *Feature Engineering and Ensemble-Based Approach for Improving Automatic Short-Answer Grading Performance*

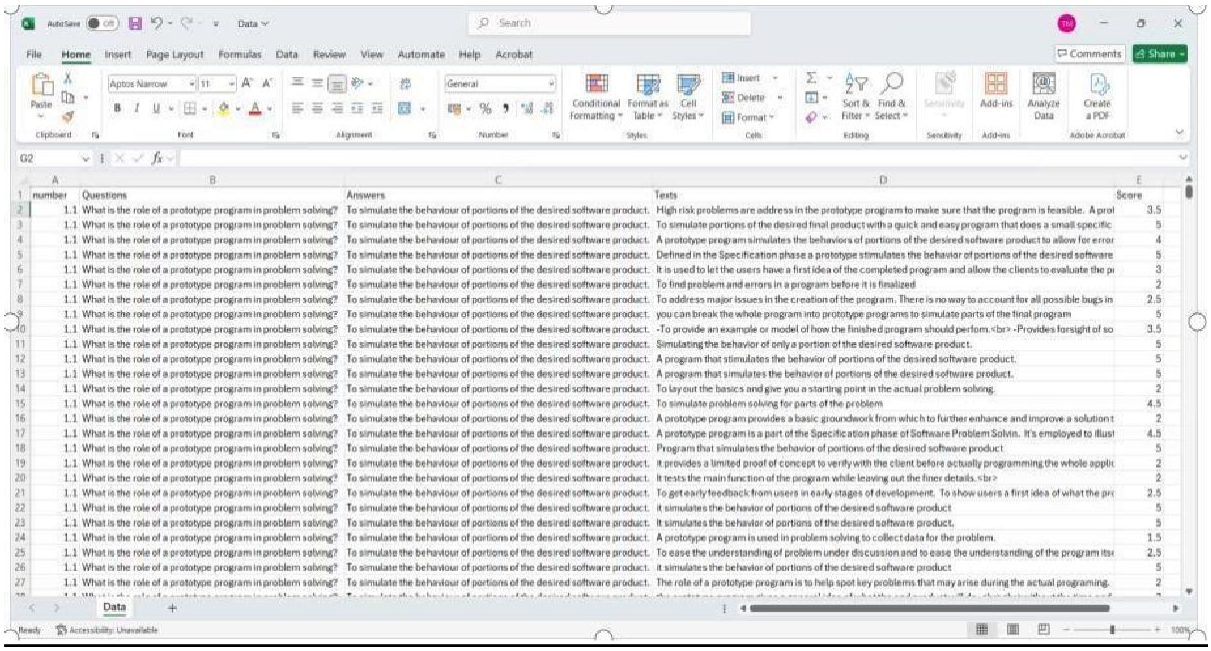
Authors: Archana Sahu and Plaban Kumar Bhowmick.

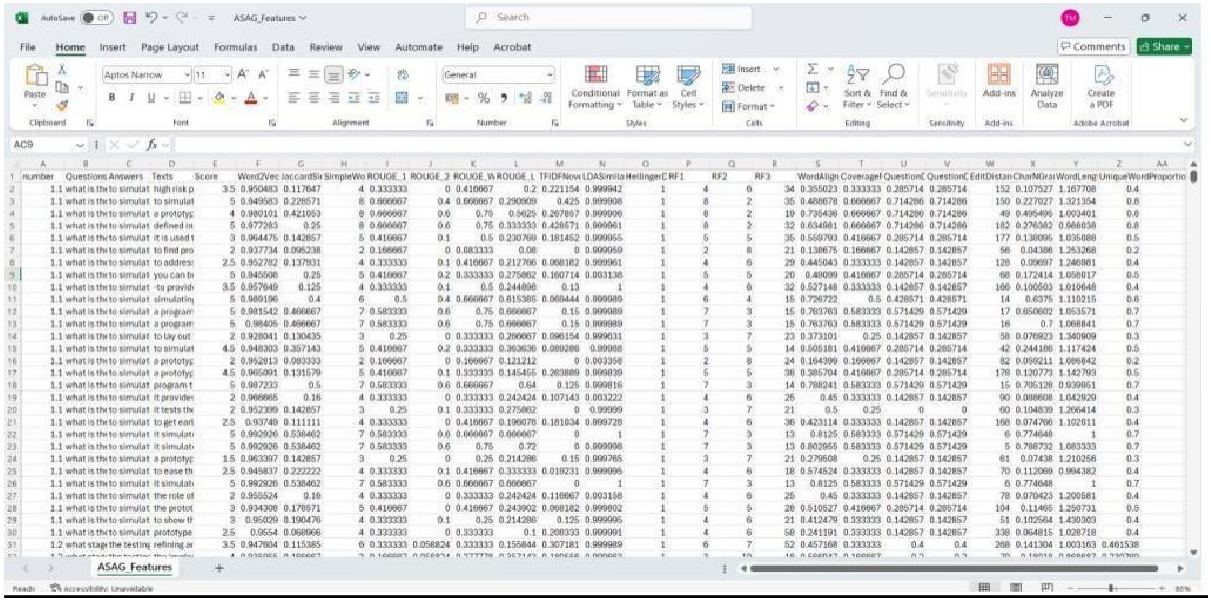
Conference/Journal: Educational Data Mining Conference (2018)

Datasets:

1. UNT Dataset
2. SciEntsBank Dataset
3. Beetle Dataset

.





Statistical Function for Keyword Extraction

$$\text{Relevance}(W) = \log\left(1 + \text{FreqRatio}(W)\right)^{\alpha} \times [1 + \text{InverseDistance}(W)]^{\beta} \times \text{Specificity}(W)^{\gamma}$$

Where:

- Relevance(W) is the final importance score for word W in the lexical extraction process

- FreqRatio(W) is the ratio of word W's frequency in relevant contexts to its frequency in irrelevant contexts plus a smoothing constant δ: frequency in relevant / (frequency in irrelevant + δ)
- InverseDistance(W) is the reciprocal of the average distance to other key terms plus 1: 1/(average distance to other key terms + 1)
- Specificity(W) is a measure of word uniqueness calculated as log(total corpus words / document frequency of W)
- α, β, and γ are tunable exponential parameters that control the influence of each component (typical values: α=0.5, β=0.7, γ=0.4)

Statistical Function for Keyword Mutation

$$\text{ExpandMetric}(K_1, K_2) = [\text{SymbioticOverlap}(K_1, K_2) \times \text{LogisticDecay}(|K_1|, |K_2|)] \times \left[1 + \log\left(1 + \text{SemanticDensity}(K_1 \cap K_2)\right)\right]$$

Where: • ExpandMetric(K_1, K_2) is the final expansion benefit score between keyword sets K_1 and K_2

- SymbioticOverlap(K_1, K_2) is the quadratic overlap measure calculated as $|K_1 \cap K_2|^2 / (|K_1| \times |K_2|)$
- LogisticDecay($|K_1|$, $|K_2|$) is a balanced size similarity function calculated as $2/(1 + \exp(|abs(|K_1| - |K_2|)|/\lambda))$, where λ is a scaling parameter
- SemanticDensity($K_1 \cap K_2$) is the sum of co-occurrence frequencies for all word pairs in the intersection
- $|K_1|$ and $|K_2|$ are the cardinalities (sizes) of the keyword sets
- log is the natural logarithm function
- exp is the exponential function

Statistical Functions for Score calculation

$$\text{AdjustedMetric}(R) = M \times \left[1 - e^{-R/\tau}\right] \times \left[1 + \beta \times \sin\left(\frac{\pi \times R}{2M}\right)\right]$$

Where:

- AdjustedMetric(R) is the final calibrated value after quantization to the nearest 0.5
- R is the original raw measurement
- M is the maximum threshold value
- τ is a scaling coefficient governing the saturation rate
- β is a modulation parameter controlling oscillation intensity
- e is the base of the natural logarithm

- sin is the sine function

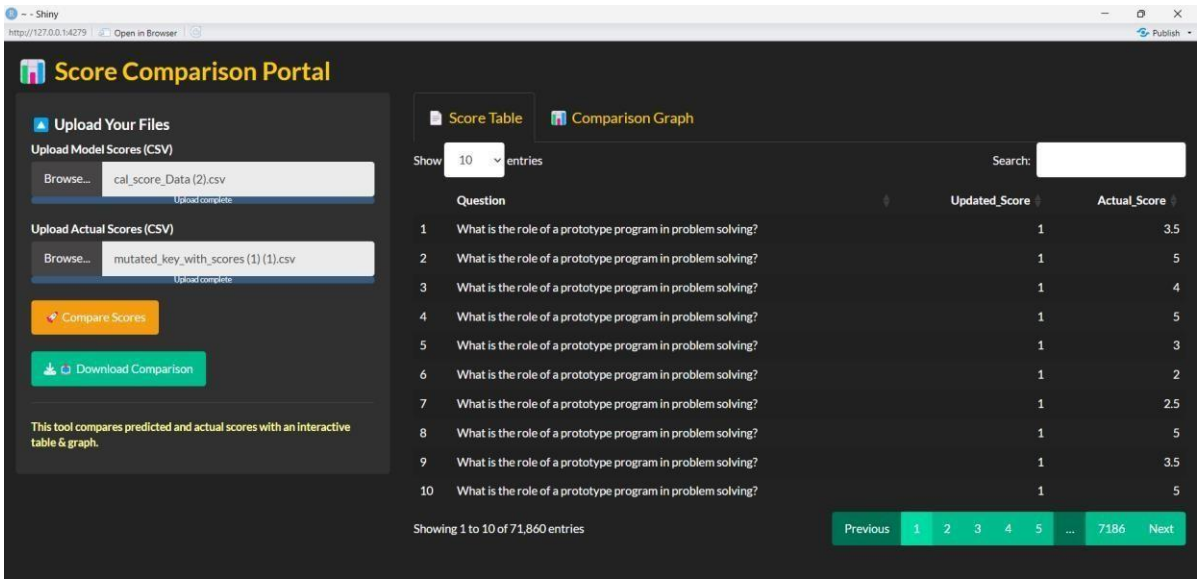
Code for Performance Graph:

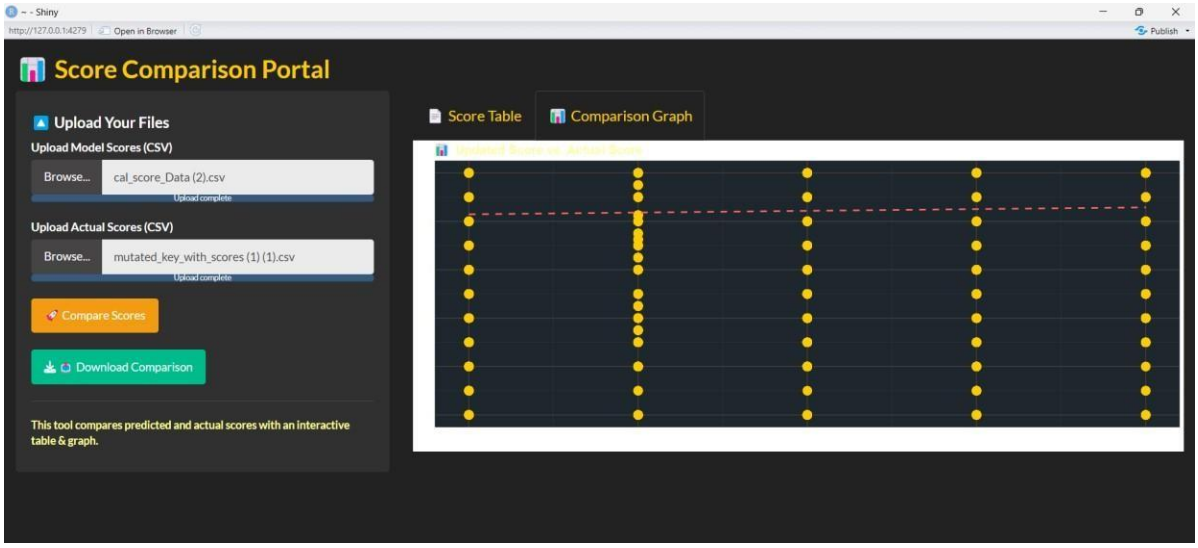
Code:

```
# Load necessary libraries if (!require("shiny"))
install.packages("shiny") if (!require("ggplot2"))
install.packages("ggplot2") if (!require("DT"))
install.packages("DT") if (!require("readr"))
install.packages("readr") if (!require("dplyr"))
install.packages("dplyr") if (!require("Metrics"))
install.packages("Metrics")

library(shiny)
library(ggplot2)
library(DT) library(readr)
library(dplyr)
library(Metrics)

# Define UI ui
<- fluidPage(
  titlePanel("Score Comparison Portal"),
sidebarLayout(     sidebarPanel(
     fileInput("file_model", "Upload Model Scores (CSV)", accept = c(".csv")),
fileInput("file_existing", "Upload Actual Scores (CSV)", accept = c(".csv")),
actionButton("compare_btn", "Compare Scores")
   ),
   mainPanel(       tabsetPanel(         tabPanel("Score
Table", DTOutput("score_table")),
      tabPanel("Comparison Graph", plotOutput("comparison_plot"))
    )
   )
  )
)
# Define Server logic
server <- function(input, output, session)
  { results <- reactiveValues(data = NULL)

  observeEvent(input$compare_btn,
{ req(input$file_model, input$file_existing)

   model_data <- read_csv(input$file_model$datapath) %>% select(Questions, Calculated_Score)
existing_data <- read_csv(input$file_existing$datapath) %>% select(Questions, Score)
```

```
  colnames(model_data) <- c("Question", "Updated_Score")
colnames(existing_data) <- c("Question", "Actual_Score")

  comparison_data <- model_data %>%
    inner_join(existing_data, by = "Question")

  results$data <- comparison_data
 })

 # Render Data Table
output$score_table <-
renderDT({ req(results$data)
  datatable(results$data, options = list(pageLength = 10))
 })

 # Render Comparison Graph  output$comparison_plot <-
renderPlot({ req(results$data)  ggplot(results$data, aes(x = Updated_Score, y =
Actual_Score))
+      geom_point(color = "blue", size = 3) +      geom_smooth(method = "lm", se =
FALSE, color = "red", linetype = "dashed") +      labs(title = "Comparison: Updated
Score vs. Actual Score",           x = "Updated Score (Calculated)", y = "Actual
Score") +      theme_minimal()
 })
}

# Run the app
shinyApp(ui = ui, server = server)
```

Output:





INPUT FILE LINK:

https://drive.google.com/file/d/1o8GJwpX2duVMxNAOZK6cKh0kc3n6wees/view?usp=sharing

https://drive.google.com/file/d/10r2z1S11ffp_wGnfYmyEvKfw1LFH717s/view?usp=sharing

OUTPUT FILE LINK:

https://drive.google.com/file/d/1m7MykvAg7lEBvyVSePob4iA-XNBGhO6Q/view?usp=sharing

CODE FOR API: try to build upon with this code: if (!require("shiny")) install.packages("shiny") if (!require("tm")) install.packages("tm") if (!require("dplyr")) install.packages("dplyr") if (!require("readr")) install.packages("readr") if (!require("DT")) install.packages("DT")

library(shiny) library(tm)

library(dplyr)

library(readr) library(DT)

Basic functions extract_keywords <- function(text) { text

<- tolower(text) words <- unlist(strsplit(gsub("[[:punct:]]",

```
" ", text), "\\s+"))   words <- words[words != ""]     stopwords <- c("the", "and",
"a", "an", "in", "on", "at", "to", "for", "of", "with",
"is", "are", "was", "were", "be", "been", "being", "have", "has", "had",
              "do", "does", "did", "can", "could", "will", "would", "should", "may",
              "might", "must", "shall", "this", "that", "these", "those", "it", "its",
              "they", "them", "their", "we", "us", "our", "i", "me", "my", "you", "your")
words <- words[!words %in% stopwords]   words <- words[nchar(words) > 1]
words <- words[!grepl("^\\d+$", words)]   return(unique(words))
}

calculate_score <- function(answer_keywords, student_keywords)
{  jaccard_sim <- length(intersect(answer_keywords, student_keywords)) /
length(union(answer_keywords, student_keywords))   raw_score <- jaccard_sim
* 5   wpcs_score <- min(raw_score * 1.05, 5)   wpcs_score
<- round(wpcs_score * 2) / 2
return(list(      raw_score = raw_score,
wpcs_score = wpcs_score,
similarity = jaccard_sim
  ))
}

SCM <- function(corpus, answer_keywords, student_keywords, threshold = 0.3) {   if (length(corpus)
== 0 || length(answer_keywords) == 0 || length(student_keywords) == 0)
{ return(list(mutation_candidates = list(), similarity_score = 0))
  }
  corpus <- lapply(corpus, function(x) if(length(x) == 0) c("") else x)
candidates <- setdiff(student_keywords, answer_keywords)    if
(length(candidates) == 0) {      return(list(mutation_candidates = list(),
similarity_score = 0))
```

```
  }
  candidate_freq <- sapply(candidates, function(word)
{ sum(sapply(corpus, function(doc) word %in% doc))
  })
  candidate_rel_freq <- candidate_freq / length(corpus)     mutation_candidates
<- list()    for (i in
1:length(candidates)) {      word <- candidates[i]      freq
<- candidate_rel_freq[i]      if (freq >= threshold)
{       mutation_candidates[[word]] <- list(          word
= word,          score = freq,          uniqueness = 1 - freq
     )
   }
  }
  if (length(mutation_candidates) > 0) {      sorted_candidates
<-                                  mutation_candidates[order(
sapply(mutation_candidates,          function(x)          x$score),
decreasing = TRUE
   )]
  } else {      sorted_candidates
<- list()
  }
  jaccard_sim <- length(intersect(answer_keywords, student_keywords)) /
length(union(answer_keywords, student_keywords))
return(list(      mutation_candidates =
sorted_candidates,      similarity_score = jaccard_sim
  ))
}
```

```
update_keywords <- function(question_data) {    answer_keywords <-
unlist(strsplit(question_data$Answer_Keywords[1], ", "))    all_text_keywords <-
lapply(question_data$Text_Keywords, function(x) {      if (is.na(x) || x == "")
return(character(0))       unlist(strsplit(x, ", "))
 })
 all_student_keywords <- unique(unlist(all_text_keywords))     threshold <- 0.65     scm_result
<- SCM(all_text_keywords, answer_keywords, all_student_keywords, threshold)
mutation_candidates <- scm_result$mutation_candidates    new_keywords <-
names(mutation_candidates)      return(list(      new_keywords = paste(new_keywords,
collapse = ", "),     similarity_score = scm_result$similarity_score
 ))
}

process_batch <- function(data) {   if ("Score" %in% colnames(data) &&
!"WPCS_Score" %in% colnames(data)) {     data <- data %>%
                                              mutate( Score =
       as.numeric(Score),
       WPCS_Score = pmin(Score * 1.05, 5),
       WPCS_Score = round(WPCS_Score * 2) / 2
     )
 }
 if (all(c("Questions", "Answer_Keywords", "Text_Keywords") %in% colnames(data)))
{ result <- data %>%    group_by(Questions) %>%       group_modify(~{         mutation_result
<- update_keywords(.x)
       .x$New_Keywords <- mutation_result$new_keywords
       .x$Similarity_Score <- mutation_result$similarity_score
       .x$Combined_Keywords <- ifelse(.x$New_Keywords != "",
paste(.x$Answer_Keywords, .x$New_Keywords, sep = ", "),
```

```
                                .x$Answer_Keywords)
return(.x)       }) %>%       ungroup()     return(result)
  }
return(data)
}

# Ultra simple UI ui <-
fluidPage( titlePanel("Keyword Analysis"),

  # Single Analysis Tab   h3("Single
Analysis"),

  textInput("question", "Question"),   textAreaInput("model_answer", "Model
Answer"),   textInput("manual_keywords", "Model Answer Keywords (comma-
separated)"),   textAreaInput("student_answer", "Student Answer"),   actionButton("analyze_btn",
"Analyze"),

hr(),

  h4("Results:"),  verbatimTextOutput("score_output"),
verbatimTextOutput("keywords_output"),   hr(),

  # Batch Processing Tab   h3("Batch
Processing"),

  fileInput("file_upload", "Upload CSV File"),   checkboxInput("header",
"File has header", TRUE),   actionButton("process_btn", "Process"),
downloadButton("download_results", "Download"),
```

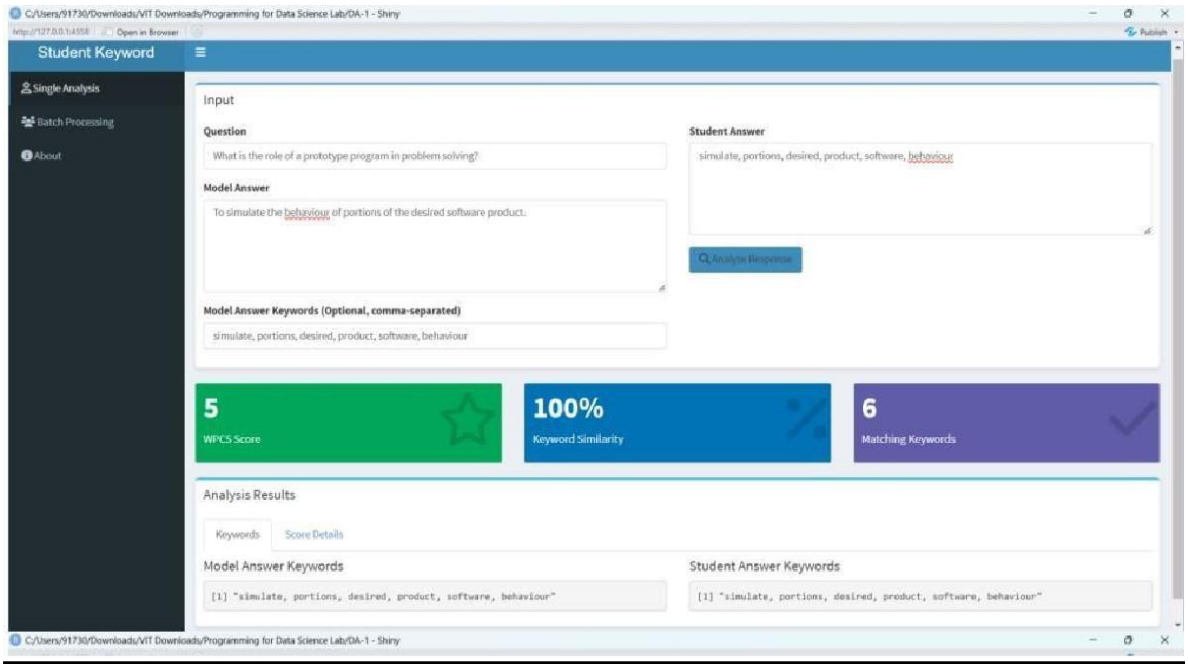
```
hr(),

  DTOutput("results_table"),  verbatimTextOutput("batch_stats")
)
# Server logic server <- function(input,
output, session) {  results <-
reactiveValues( model_keywords = NULL,
student_keywords = NULL,     score =
NULL,     batch_data = NULL,
processed_data = NULL
  )

  observeEvent(input$analyze_btn,
{ req(input$model_answer,
input$student_answer)

   if (input$manual_keywords != "") {       model_kw <-
unlist(strsplit(input$manual_keywords, ", "))       model_kw <- trimws(model_kw)
   } else {
     model_kw <- extract_keywords(input$model_answer)
   }

   student_kw <- extract_keywords(input$student_answer)       score_result
<- calculate_score(model_kw, student_kw)

   results$model_keywords <- model_kw      results$student_keywords
<- student_kw      results$score
<- score_result
```

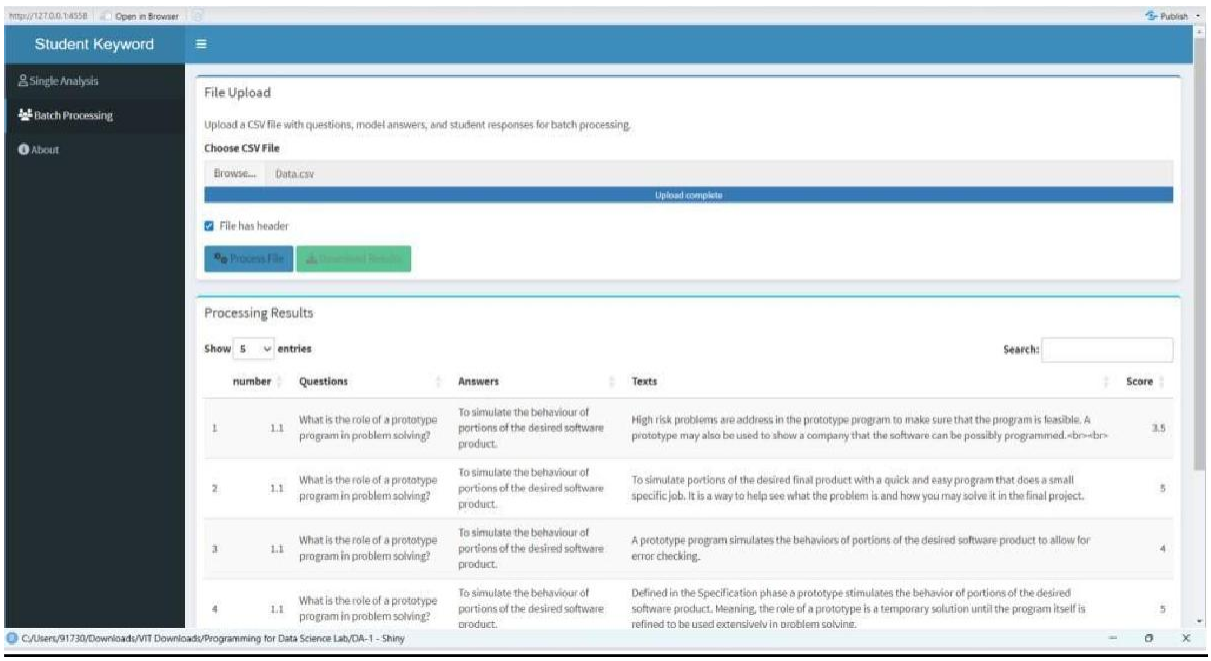
```
    output$score_output <- renderPrint({       cat("WPCS Score: ", results$score$wpcs_score,
"/5.0\n", sep = "")       cat("Similarity: ", round(results$score$similarity * 100, 2), "%\n", sep
= "")       cat("Matching: ", length(intersect(results$model_keywords,
results$student_keywords)),
          " out of ", length(union(results$model_keywords, results$student_keywords)), "\n", sep="")
    })

    output$keywords_output <- renderPrint({       cat("Model
Answer Keywords:\n")       cat(paste(results$model_keywords,
collapse = ", "), "\n\n")       cat("Student Answer  Keywords:\n")
                        cat(paste(results$student_keywords,
collapse = ", "))

    })
  })

  observeEvent(input$file_upload,
{ req(input$file_upload)

    tryCatch({       batch_data <- read_csv(input$file_upload$datapath, col_names = input$header)
results$batch_data <- batch_data

      output$results_table <-
renderDT({ datatable(results$batch_data, options =
list(pageLength = 5))
      })
    }, error = function(e) {       showNotification("Error reading
file", type = "error")
    })
```

```
  })

  observeEvent(input$process_btn,
{ req(results$batch_data)

    processed_data <- process_batch(results$batch_data)       results$processed_data
<- processed_data

    output$results_table <-
renderDT({ datatable(results$processed_data, options =
list(pageLength = 5))
    })

    output$batch_stats <- renderPrint({        if
("WPCS_Score" %in% colnames(processed_data)) {         cat("Records:
", nrow(processed_data), "\n")


        if ("Score" %in% colnames(processed_data)) {           cat("Average Score: ",
round(mean(processed_data$Score, na.rm = TRUE), 2), "\n")           cat("Average WPCS: ",
round(mean(processed_data$WPCS_Score, na.rm = TRUE), 2), "\n")
        }
        if ("Similarity_Score" %in% colnames(processed_data)) {
          cat("Average Similarity: ", round(mean(processed_data$Similarity_Score, na.rm = TRUE) *
100, 2), "%\n")
        }
      } else {         cat("Data
loaded")
}

    })
```

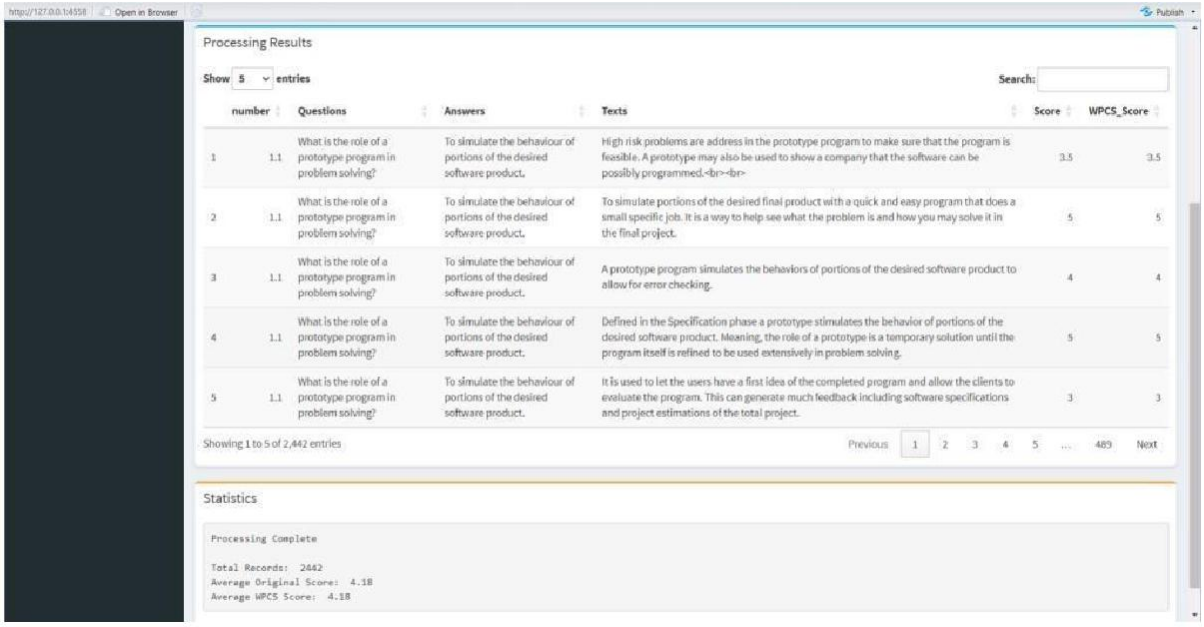
```
  })


  output$download_results <-
downloadHandler( filename = function() {
      "results.csv"
    },      content =
function(file) {
write_csv(results$processed_data,  file)
    }
  )
}

shinyApp(ui = ui, server = server)
```

RESULT:




Student Keyword
Single Analysis
Batch Processing
About
File Upload
Upload a CSV file with questions, model answers, and student responses for batch processing.
Choose CSV File
Browse...
Data.csv
Upload complete
File has header
Process File
Processing Results
Show 5 entries
Search:
number
Questions
Answers
Texts
Score
1 1.1 What is the role of a prototype program in problem solving? To simulate the behaviour of portions of the desired software product. High risk problems are address in the prototype program to make sure that the program is feasible. A prototype may also be used to show a company that the software can be possibly programmed.

 3.5
2 1.1 What is the role of a prototype program in problem solving? To simulate the behaviour of portions of the desired software product. To simulate portions of the desired final product with a quick and easy program that does a small specific job. It is a way to help see what the problem is and how you may solve it in the final project. 5
3 1.1 What is the role of a prototype program in problem solving? To simulate the behaviour of portions of the desired software product. A prototype program simulates the behaviors of portions of the desired software product to allow for error checking. 4
4 1.1 What is the role of a prototype program in problem solving? To simulate the behaviour of portions of the desired software product. Defined in the Specification phase a prototype stimulates the behavior of portions of the desired software product. Meaning, the role of a prototype is a temporary solution until the program itself is refined to be used extensively in problem solving. 5
C:/Users/91730/Downloads/VIT Downloads/Programming for Data Science Lab/DA-1 - Shiny


Processing Results
Show 5 entries
Search:
number
Questions
Answers
Texts
Score
WPCS_Score
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5 1.1 What is the role of a prototype program in problem solving? To simulate the behaviour of portions of the desired software product. It is used to let the users have a first idea of the completed program and allow the clients to evaluate the program. This can generate much feedback including software specifications and project estimations of the total project. 3 3
Showing 1 to 5 of 2,442 entries
Previous 1 2 3 4 5 ... 489 Next
Statistics
Processing Complete
Total Records: 2442
Average Original Score: 4.18
Average WPCS Score: 4.18