IRRanalysis

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part 1 kappa by criteria

```
latchman <- read_excel("Latchman_Rubric Scoring Sheet 2025.xlsx", sheet = 1)
kva      <- read_excel("Rubric Scoring Sheet 2025 kva UF.xlsx", sheet = 1)
ly       <- read_excel("Rubric Scoring Sheet 2025 LY UF.xlsx", sheet = 1)
wagner   <- read_excel("Wagner_Rubric Scoring Sheet 2025.xlsx", sheet = 1)
```

```
clean_rater <- function(df) {
  df_clean <- df[1:12, -(1:2)]
  df_clean <- df_clean %>%
    mutate_all(as.character) %>%
    mutate_all(toupper)
  return(df_clean)
}

latchman_clean <- clean_rater(latchman)
kva_clean      <- clean_rater(kva)
ly_clean       <- clean_rater(ly)
wagner_clean   <- clean_rater(wagner)
#tail(latchman)
```

```
normalize_score <- function(x) {
  x <- toupper(trimws(x))  # remove whitespace and make uppercase

  if (x %in% c("N/A", "NA")) {
    return(NA)
  } else if (grepl("^Y(\\b|\\W)", x)) {
    return("Y")
  } else if (grepl("^N(\\b|\\W)", x)) {
    return("N")
  } else {
    return(NA)  # comments like "A IS DIFFERENT..." will be treated as NA
  }
}
```

```
latchman_normalized <- latchman_clean %>%
  mutate(across(everything(), ~sapply(., normalize_score)))
kva_normalized <- kva_clean %>%
  mutate(across(everything(), ~sapply(., normalize_score)))
ly_normalized <- ly_clean %>%
```

```
  mutate(across(everything(), ~sapply(., normalize_score)))
wagner_normalized <- wagner_clean %>%
  mutate(across(everything(), ~sapply(., normalize_score)))
#tail(latchman_normalized)
```

```
reshape_rater <- function(df, rater_name) {
  df <- df %>%
    filter(rowSums(!is.na(.)) > 1) %>%  # Drop rows that are all NA or mostly empty
    mutate(Criterion = 1:nrow(.)) %>%
    pivot_longer(
      cols = -Criterion,
      names_to = "Question",
      values_to = "Score"
    ) %>%
    mutate(Rater = rater_name)
  return(df)
}

latchman_long <- reshape_rater(latchman_normalized, "Latchman")
kva_long      <- reshape_rater(kva_normalized, "KVA")
ly_long       <- reshape_rater(ly_normalized, "LY")
wagner_long   <- reshape_rater(wagner_normalized, "Wagner")
#tail(latchman_long)
```

```
all_ratings <- bind_rows(latchman_long, kva_long, ly_long, wagner_long)
all_ratings
```

```
## # A tibble: 1,440 x 4
##    Criterion Question Score Rater
##        <int> <chr>    <chr> <chr>
##  1         1 Q1       N     Latchman
##  2         1 Q2       Y     Latchman
##  3         1 Q3       Y     Latchman
##  4         1 Q4       N     Latchman
##  5         1 Q5       N     Latchman
##  6         1 Q6       Y     Latchman
##  7         1 Q7       Y     Latchman
##  8         1 Q8       Y     Latchman
##  9         1 Q9       Y     Latchman
## 10         1 Q10      Y     Latchman
## # i 1,430 more rows
```

```
# Initialize results dataframe
kappa_results <- data.frame(
  Criterion = 1:12,
  Subjects = NA,
  Kappa = NA,
  z = NA,
  p_value = NA
)

for (i in 1:12) {
```

```
  # Reshape data for this criterion
  crit <- all_ratings %>%
    filter(Criterion == i) %>%
    pivot_wider(names_from = Rater, values_from = Score) %>%
    select(-Question)

  # Drop Criterion column
  crit_clean <- crit %>%
    select(-Criterion)

  # Filter rows with at least 2 non-NA scores
  crit_matrix <- as.matrix(crit_clean[rowSums(!is.na(crit_clean)) >= 2, ])

  # Only run kappa if matrix is valid
  if (nrow(crit_matrix) >= 2) {
    result <- tryCatch(
      kappam.light(crit_matrix),
      error = function(e) NULL
    )

    if (!is.null(result)) {
      kappa_results$Subjects[i] <- result$subjects
      kappa_results$Kappa[i] <- result$value
      kappa_results$z[i] <- result$statistic
      kappa_results$p_value[i] <- result$p.value
    }
  }
}

print(kappa_results)
```

```
##    Criterion Subjects        Kappa             z   p_value
## 1          1       30  0.246976365  0.1854160407 0.8529027
## 2          2       30 -0.036062378 -0.0004747116 0.9996212
## 3          3       27  0.421330140  0.0674526523 0.9462214
## 4          4       23          NaN           NaN       NaN
## 5          5        4  0.666666667  0.3666793988 0.7138582
## 6          6       25          NaN           NaN       NaN
## 7          7       28  0.825000000  0.0168402534 0.9865641
## 8          8       21  0.097725086  0.0262910017 0.9790252
## 9          9       26  0.679639581  0.1058405191 0.9157089
## 10        10        4 -0.222222222 -0.0594503949 0.9525934
## 11        11       26          NaN           NaN       NaN
## 12        12       26  0.008623853  0.0002015462 0.9998392
```

```
for (i in 1:12) {
  cat("\n=== Criterion", i, "===\n")

  df <- all_ratings %>%
    filter(Criterion == i) %>%
    pivot_wider(names_from = Rater, values_from = Score) %>%
    select(-Question, -Criterion)
```

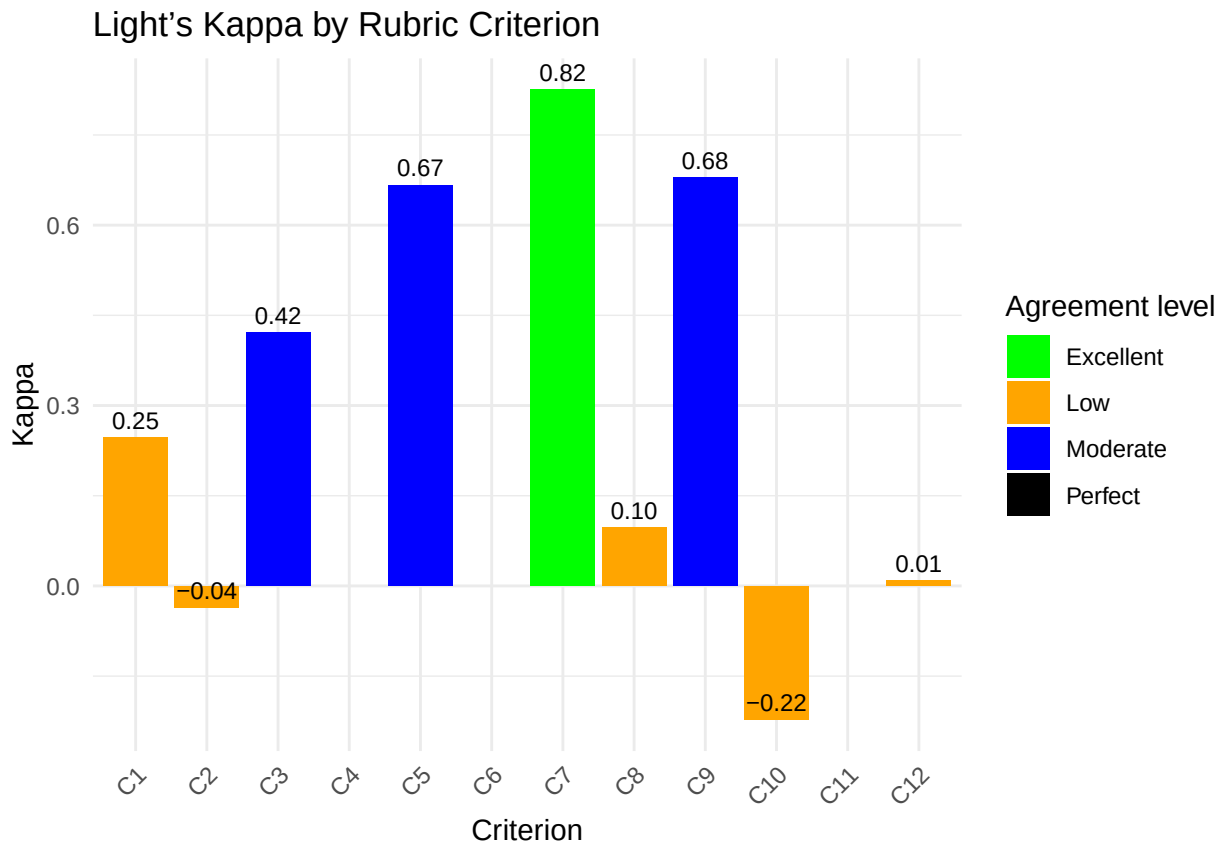
```r
  df[df == "N/A"] <- NA
  df_filtered <- df[rowSums(!is.na(df)) >= 2, ]

  if (nrow(df_filtered) == 0) {
    cat("No usable rows after filtering.\n")
  } else {
    print(table(apply(df_filtered, 1, paste, collapse = "-")))
  }
}
```

```
##
## === Criterion 1 ===
##
## N-N-N-N N-Y-N-N N-Y-N-Y Y-Y-N-N Y-Y-N-Y Y-Y-Y-Y
##       1       2       5       1      10      11
##
## === Criterion 2 ===
##
## N-Y-Y-Y Y-N-Y-Y Y-Y-Y-N Y-Y-Y-Y
##       3       1       3      23
##
## === Criterion 3 ===
##
##  N-N-N-Y N-NA-N-Y  N-Y-N-N Y-NA-Y-Y  Y-Y-N-Y  Y-Y-Y-Y
##        1        1        3        2        3       20
##
## === Criterion 4 ===
##
## N-NA-N-Y  N-Y-N-Y  N-Y-Y-Y Y-NA-N-Y Y-NA-Y-N Y-NA-Y-Y  Y-Y-N-Y  Y-Y-Y-Y
##        1        1        1        2        2        2        4       17
##
## === Criterion 5 ===
##
## N-N-N-N N-Y-N-Y Y-Y-Y-Y
##       1       1       2
##
## === Criterion 6 ===
##
##   Y-N-N-Y Y-NA-Y-NA  Y-NA-Y-Y   Y-Y-Y-Y
##         1         2         3        24
##
## === Criterion 7 ===
##
##  N-N-N-N  N-N-Y-N Y-NA-Y-Y  Y-Y-Y-Y
##        1        1        2       26
##
## === Criterion 8 ===
##
## N-NA-N-N N-NA-Y-Y  N-Y-N-N N-Y-Y-NA  N-Y-Y-Y Y-NA-N-N Y-NA-N-Y Y-NA-Y-Y
##        1        1        1        1        1        1        1        1
##  Y-Y-N-N  Y-Y-N-Y  Y-Y-Y-N Y-Y-Y-NA  Y-Y-Y-Y
##        3        5        1        1       10
##
```

```
## === Criterion 9 ===
##
##  N-N-N-N  N-N-N-Y  Y-Y-N-Y  Y-Y-Y-N Y-Y-Y-NA  Y-Y-Y-Y
##        2        1        2        1        4       20
##
## === Criterion 10 ===
##
##  N-NA-N-Y  N-NA-Y-Y   N-Y-Y-Y  NA-N-N-N NA-NA-Y-Y  NA-Y-Y-Y  Y-NA-N-Y  Y-NA-Y-Y
##         1         1         1         1         6         2         3         2
##   Y-Y-N-Y   Y-Y-Y-N
##         2         1
##
## === Criterion 11 ===
##
## Y-NA-Y-NA   Y-Y-N-Y   Y-Y-Y-N  Y-Y-Y-NA   Y-Y-Y-Y
##         2         2         1         2        23
##
## === Criterion 12 ===
##
##   N-Y-N-Y Y-NA-Y-NA   Y-Y-N-Y   Y-Y-Y-N  Y-Y-Y-NA   Y-Y-Y-Y
##         1         2         7         1         2        17
```

```r
plot_data <- kappa_results %>%
  mutate(
    Criterion = paste0("C", Criterion),
    Criterion = factor(Criterion, levels = paste0("C", 1:12)),
    Label = ifelse(is.nan(Kappa), "Perfect\nagreement", sprintf("%.2f", round(Kappa, 2))),
    Fill = case_when(
      is.nan(Kappa) ~ "Perfect",
      Kappa >= 0.75 ~ "Excellent",
      Kappa >= 0.4  ~ "Moderate",
      !is.na(Kappa) ~ "Low",
      TRUE ~ "Missing"
    )
  )

ggplot(plot_data, aes(x = Criterion, y = Kappa, fill = Fill)) +
  geom_col(na.rm = TRUE) +
  geom_text(aes(label = Label), vjust = -0.5, size = 3) +
  scale_fill_manual(
    values = c(
      "Perfect" = "black",
      "Excellent" = "green",
      "Moderate" = "blue",
      "Low" = "orange",
      "Missing" = "gray"
    )
  ) +
  labs(
    title = "Light's Kappa by Rubric Criterion",
    y = "Kappa",
    x = "Criterion",
    fill = "Agreement level"
  ) +
```

```
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```



part 2: One Kappa per Question (All Criteria Combined)

```
# test on q1
q1_data <- all_ratings %>%
  filter(Question == "Q1") %>%
  pivot_wider(names_from = Rater, values_from = Score) %>%
  select(-Question, -Criterion)

q1_data[q1_data == "N/A"] <- NA

# Keep only criteria (rows) with at least 2 valid scores
q1_filtered <- q1_data[rowSums(!is.na(q1_data)) >= 2, ]

if (nrow(q1_filtered) >= 2) {
  q1_matrix <- as.matrix(q1_filtered)
  kappa_q1 <- kappam.light(q1_matrix)
  print(kappa_q1)
} else {
  print("Not enough usable criteria to compute kappa for Question 1.")
}
```

```
##  Light's Kappa for m Raters
##
##  Subjects = 10
##    Raters = 4
##     Kappa = 0.572
##
##         z = 0.189
##   p-value = 0.85
```

```
light_kappa_by_question <- data.frame(
  Question = character(),
  Subjects = integer(),
  Raters = integer(),
  Kappa = numeric(),
  Z = numeric(),
  P_value = numeric(),
  stringsAsFactors = FALSE
)

for (q in paste0("Q", 1:30)) {
  q_data <- all_ratings %>%
    filter(Question == q) %>%
    pivot_wider(names_from = Rater, values_from = Score) %>%
    select(-Question, -Criterion)

  q_data[q_data == "N/A"] <- NA

  q_filtered <- q_data[rowSums(!is.na(q_data)) >= 2, ]

  if (nrow(q_filtered) >= 2) {
    q_matrix <- as.matrix(q_filtered)
    result <- tryCatch({
      kappa <- kappam.light(q_matrix)
      data.frame(
        Question = q,
        Subjects = kappa$subjects,
        Raters = kappa$raters,
        Kappa = kappa$value,
        Z = kappa$statistic,
        P_value = kappa$p.value
      )
    }, error = function(e) {
      data.frame(
        Question = q,
        Subjects = nrow(q_filtered),
        Raters = ncol(q_filtered),
        Kappa = NA,
        Z = NA,
        P_value = NA
      )
    })
  } else {
    result <- data.frame(
      Question = q,
```

```
      Subjects = nrow(q_filtered),
      Raters = ifelse(nrow(q_data) > 0, ncol(q_data), NA),
      Kappa = NA,
      Z = NA,
      P_value = NA
    )
  }

  light_kappa_by_question <- rbind(light_kappa_by_question, result)
}

print(light_kappa_by_question)
```

```
##    Question Subjects Raters      Kappa           Z   P_value
## 1        Q1       10      4 0.57236842 0.189019680 0.8500774
## 2        Q2        9      4        NaN         NaN       NaN
## 3        Q3       10      4 0.12301587 0.035215915 0.9719076
## 4        Q4        9      4 0.14835874 0.043249103 0.9655030
## 5        Q5       10      4 0.04715219 0.007644911 0.9939003
## 6        Q6       10      4        NaN         NaN       NaN
## 7        Q7        6      4 1.00000000 0.128778425 0.8975330
## 8        Q8       10      4         NA          NA        NA
## 9        Q9       11      4        NaN         NaN       NaN
## 10      Q10       11      4         NA          NA        NA
## 11      Q11       10      4 0.20256410 0.040081440 0.9680282
## 12      Q12        9      4        NaN         NaN       NaN
## 13      Q13       11      4         NA          NA        NA
## 14      Q14        9      4 0.50000000 0.011947288 0.9904677
## 15      Q15       10      4        NaN         NaN       NaN
## 16      Q16        7      4 0.26819990 0.092573330 0.9262425
## 17      Q17        8      4        NaN         NaN       NaN
## 18      Q18        8      4        NaN         NaN       NaN
## 19      Q19       11      4         NA          NA        NA
## 20      Q20       11      4         NA          NA        NA
## 21      Q21       10      4 0.69696970 0.416892317 0.6767572
## 22      Q22       10      4        NaN         NaN       NaN
## 23      Q23       10      4        NaN         NaN       NaN
## 24      Q24        9      4 0.26242236 0.023858471 0.9809655
## 25      Q25       11      4         NA          NA        NA
## 26      Q26       10      4 0.30392157 0.018603484 0.9851574
## 27      Q27       11      4        NaN         NaN       NaN
## 28      Q28        6      4 0.10000000 0.005978606 0.9952298
## 29      Q29        9      4 0.73913043 0.114587357 0.9087722
## 30      Q30       10      4 0.40000000 0.083839999 0.9331836
```

Wide format

```
df <- all_ratings %>%
  pivot_wider(
    names_from = Rater,
    values_from = Score
```

```
  )
head(df)
```

```
## # A tibble: 6 x 6
##   Criterion Question Latchman KVA   LY    Wagner
##       <int> <chr>    <chr>    <chr> <chr> <chr>
## 1         1 Q1       N        N     N     N
## 2         1 Q2       Y        Y     Y     Y
## 3         1 Q3       Y        Y     N     Y
## 4         1 Q4       N        Y     N     Y
## 5         1 Q5       N        Y     N     Y
## 6         1 Q6       Y        Y     N     Y
```

```
kappam.light(df %>% select(Latchman:Wagner))
```

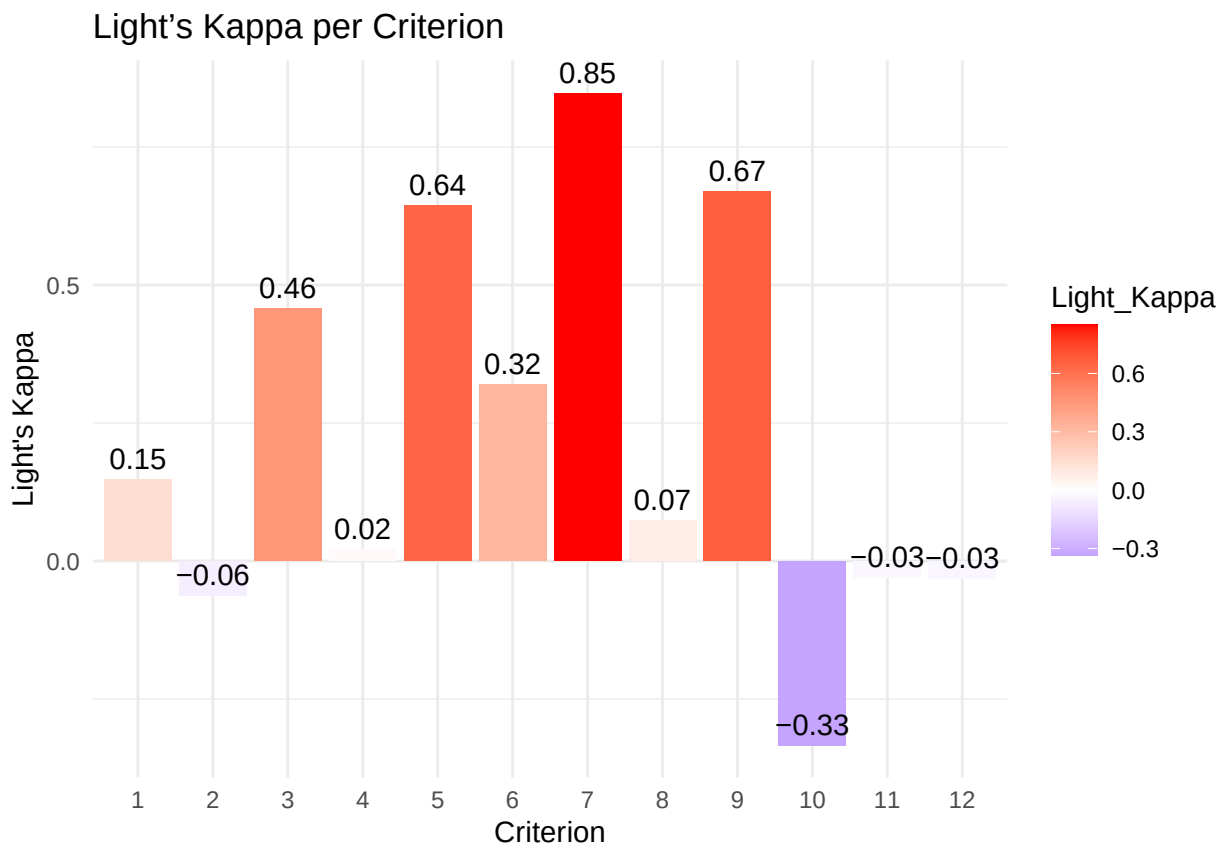
```
##  Light's Kappa for m Raters
##
##  Subjects = 270
##    Raters = 4
##     Kappa = 0.321
##
##         z = 0.0939
##   p-value = 0.925
```

```
# Compute Light's Kappa for each Criterion
df_kappa_criterion <- df %>%
  group_split(Criterion) %>%
  map_dfr(function(group_df) {
    ratings <- group_df %>% select(Latchman:Wagner)
    crit <- unique(group_df$Criterion)

    if (nrow(ratings) < 2) {
      return(tibble(Criterion = crit, Light_Kappa = NA))
    }

    kappa_value <- tryCatch(
      kappam.fleiss(ratings)$value,
      error = function(e) NA
    )

    tibble(Criterion = crit, Light_Kappa = kappa_value)
  })


df_kappa_criterion
```

```
## # A tibble: 12 x 2
##    Criterion Light_Kappa
##        <int>       <dbl>
##  1         1      0.148
##  2         2     -0.0619
##  3         3      0.458
```

```
##  4          4       0.0207
##  5          5       0.644
##  6          6       0.320
##  7          7       0.848
##  8          8       0.0735
##  9          9       0.670
## 10         10      -0.333
## 11         11      -0.0297
## 12         12      -0.0326
```

```r
# Plot

ggplot(df_kappa_criterion, aes(x = factor(Criterion), y = Light_Kappa, fill = Light_Kappa)) +
  geom_col() +
  geom_text(aes(label = round(Light_Kappa, 2)), vjust = -0.5) +
  scale_fill_gradient2(low = "blue", mid = "white", high = "red", midpoint = 0) +
  labs(
    title = "Light's Kappa per Criterion",
    x = "Criterion",
    y = "Light's Kappa"
  ) +
  theme_minimal()
```

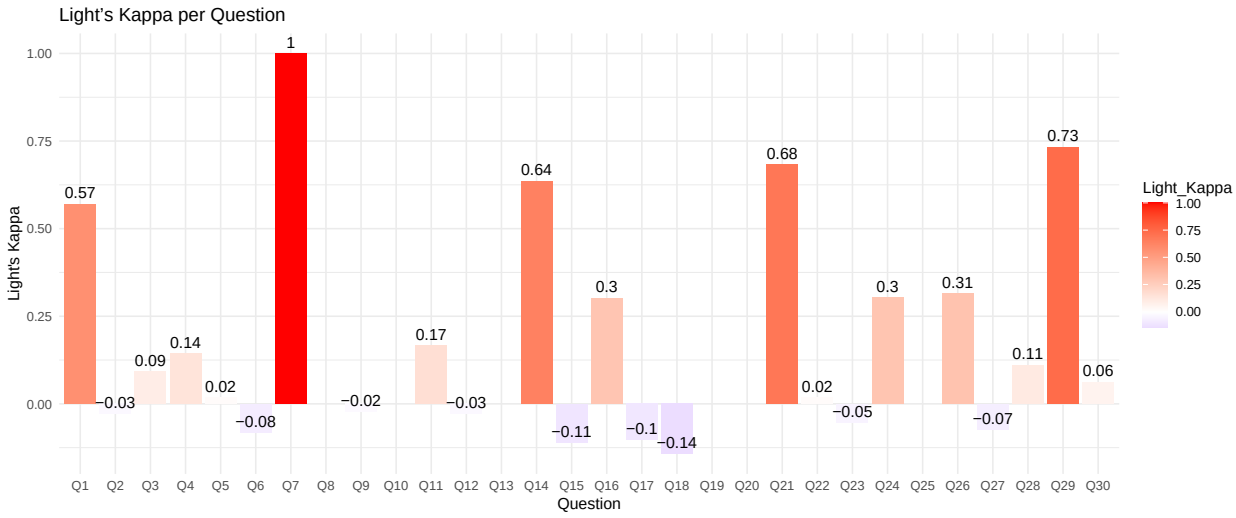



```r
# Compute Light's Kappa for each Question
df_kappa_question <- df %>%
```

```
  group_split(Question) %>%
  map_dfr(function(group_df) {
    ratings <- group_df %>% select(Latchman:Wagner)
    ques <- unique(group_df$Question)

    if (nrow(ratings) < 2) {
      # only one question = not enough for kappam.fleiss
      return(tibble(Question = ques, Light_Kappa = NA))
    }

    kappa_value <- tryCatch(
      kappam.fleiss(ratings)$value,
      error = function(e) NA
    )

    tibble(Question = ques, Light_Kappa = kappa_value)
  })

df_kappa_question
```

```
## # A tibble: 30 x 2
##    Question Light_Kappa
##    <chr>          <dbl>
##  1 Q1             0.570
##  2 Q10          NaN
##  3 Q11            0.167
##  4 Q12           -0.0286
##  5 Q13          NaN
##  6 Q14            0.636
##  7 Q15           -0.111
##  8 Q16            0.302
##  9 Q17           -0.103
## 10 Q18           -0.143
## # i 20 more rows
```

```
# Plot
df_kappa_question <- df_kappa_question %>%
  mutate(Question = factor(Question, levels = paste0("Q", 1:30)))

ggplot(df_kappa_question, aes(x = factor(Question), y = Light_Kappa, fill = Light_Kappa)) +
  geom_col() +
  geom_text(aes(label = round(Light_Kappa, 2)), vjust = -0.5) +
  scale_fill_gradient2(low = "blue", mid = "white", high = "red", midpoint = 0) +
  labs(
    title = "Light's Kappa per Question",
    x = "Question",
    y = "Light's Kappa"
  ) +
  theme_minimal()
```


Light's Kappa per Question
Lights Kappa
1.00
0.75
0.50
0.25
0.00
0.57
−0.03
0.09
0.14
0.02
−0.08
1
−0.02
0.17
−0.03
0.64
−0.11
0.3
−0.1
−0.14
0.68
0.02
−0.05
0.3
0.31
−0.07
0.11
0.73
0.06
Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28 Q29 Q30
Question
Light_Kappa
1.00
0.75
0.50
0.25
0.00