

Assignment 10

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```
# Load necessary libraries
```

```
library(openintro)
```

```
## Loading required package: airports
```

```
## Loading required package: cherryblossom
```

```
## Loading required package: usdata
```

```
library(dplyr)
```

```
##
```

```
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
```

```
##
```

```
##      filter, lag
```

```
## The following objects are masked from 'package:base':
```

```
##
```

```
##      intersect, setdiff, setequal, union
```

```
library(caret)
```

```
## Loading required package: ggplot2
```

```
## Loading required package: lattice
```

```
##
```

```
## Attaching package: 'lattice'
```

```
## The following objects are masked from 'package:openintro':
```

```
##
```

```
##      ethanol, lsegments
```

```
##
```

```
## Attaching package: 'caret'
```

```
## The following object is masked from 'package:openintro':
```

```
##
```

```
##      dotPlot
```

Question 1

Confidence Interval:

A confidence interval is a statistical range that provides an estimated range of values which is likely to include the true parameter of interest with a certain level of confidence. For example, if you calculate a 95% confidence interval for the mean of a population, it means that you are 95% confident that the true population mean falls within that interval. The width of the interval reflects the uncertainty associated with estimating the parameter from a sample.

Prediction Interval:

A prediction interval is similar to a confidence interval but is specifically used for predicting individual future observations. It provides a range within which a future observation is expected to fall with a certain level of confidence. In other words, it accounts not only for the variability in estimating the mean (as in a confidence interval) but also for the variability in predicting a specific future data point.

Significance:

Confidence Interval Significance: It provides a range for the likely values of a parameter, conveying the precision of the estimation. The higher the confidence level (e.g., 95%), the wider the interval, indicating a higher degree of certainty that the true parameter lies within that range.

Prediction Interval Significance: It is crucial when making predictions for individual observations. A wider prediction interval implies more uncertainty in predicting specific outcomes, considering both variability in the data and the uncertainty in the model.

Multiple Linear Regression:

Multiple linear regression is a statistical technique used to model the relationship between a dependent variable and two or more independent variables. In contrast to simple linear regression (which involves only one independent variable), multiple linear regression considers multiple predictors simultaneously. The model assumes that the relationship between the dependent variable and each independent variable is linear, and it estimates the coefficients that best fit the observed data.

Purpose:

Modeling Complex Relationships: Multiple linear regression is employed when the relationship between the dependent variable and the predictors is too intricate to be captured adequately by a simple linear model.

Predictive Modeling: It is used for making predictions and understanding how changes in the independent variables relate to changes in the dependent variable.

Variable Importance: It helps identify the importance of each independent variable in explaining the variability in the dependent variable.

Hypothesis Testing: The coefficients in the model can be tested for statistical significance, providing insights into which predictors are likely to have a genuine impact.

```
# question 2
# loading the data
data(ncbirths)
# Summary statistics for each variable
summary(ncbirths)
```

```
##      fage      mage      mature      weeks      premie
## Min.   :14.00  Min.   :13   mature mom :133   Min.   :20.00  full term:846
## 1st Qu.:25.00  1st Qu.:22   younger mom:867 1st Qu.:37.00  premie   :152
## Median :30.00  Median :27                                Median :39.00  NA's     : 2
## Mean   :30.26  Mean   :27                                Mean   :38.33
## 3rd Qu.:35.00  3rd Qu.:32                                3rd Qu.:40.00
## Max.   :55.00  Max.   :50                                Max.   :45.00
## NA's   :171                                NA's   :2
##      visits      marital      gained      weight
## Min.   : 0.0    not married:386   Min.   : 0.00   Min.   : 1.000
## 1st Qu.:10.0    married   :613   1st Qu.:20.00   1st Qu.: 6.380
## Median :12.0    NA's      : 1   Median :30.00   Median : 7.310
## Mean   :12.1                                Mean   :30.33   Mean   : 7.101
## 3rd Qu.:15.0                                3rd Qu.:38.00   3rd Qu.: 8.060
## Max.   :30.0                                Max.   :85.00   Max.   :11.750
## NA's   :9                                NA's   :27
## lowbirthweight  gender      habit      whitemom
## low           :111  female:503  nonsmoker:873  not white:284
## not low:889    male  :497    smoker   :126  white    :714
##                                     NA's     : 1   NA's     : 2
##
##
##
##
```

```
# remove any rows from a data frame that contain missing values (NA)
ncbirths <- na.omit(ncbirths)
```

```
# excluding non numerical values
numeric_cols <- sapply(ncbirths, is.numeric)
numeric_data <- ncbirths[, numeric_cols]

# Identify non-numeric columns
non_numeric_cols <- sapply(ncbirths, is.factor)

# Create a new dataset containing only non-numeric columns
non_numeric_data <- ncbirths[, non_numeric_cols]

# One-hot encode categorical variables
non_numeric_data_encoded <- dummyVars("~.", data = non_numeric_data) %>%
  predict(newdata = non_numeric_data)

# Combine numeric and encoded non-numeric datasets
combined_data <- cbind(numeric_data, non_numeric_data_encoded)

# Calculate the correlation matrix
```

```
cor_matrix <- cor(combined_data, use = "complete.obs")
print(cor_matrix)
```

```
##           fage           mage           weeks           visits
## fage      1.000000000  0.780647662 -0.007996662  0.08523902
## mage      0.780647662  1.000000000 -0.040007598  0.14289682
## weeks     -0.007996662 -0.040007598  1.000000000  0.16671679
## visits    0.085239020  0.142896825  0.166716794  1.000000000
## gained    -0.038945787 -0.059486097  0.098579712  0.05589346
## weight     0.073335128  0.051698001  0.635889112  0.13128009
## mature.mature mom  0.496405435  0.641402623 -0.064254950  0.04761729
## mature.younger mom -0.496405435 -0.641402623  0.064254950 -0.04761729
## premie.full term   0.011323219 -0.002518252  0.725519124  0.12298607
## premie.premie     -0.011323219  0.002518252 -0.725519124 -0.12298607
## marital.not married -0.349831445 -0.419957454 -0.057601287 -0.18358608
## marital.married    0.349831445  0.419957454  0.057601287  0.18358608
## lowbirthweight.low -0.005084369 -0.006466107 -0.585673869 -0.12890198
## lowbirthweight.not low 0.005084369  0.006466107  0.585673869  0.12890198
## gender.female     -0.060527775 -0.014025174 -0.013933733  0.05589491
## gender.male        0.060527775  0.014025174  0.013933733 -0.05589491
## habit.nonsmoker    0.087923707  0.113418263  0.018179728  0.03251382
## habit.smoker       -0.087923707 -0.113418263 -0.018179728 -0.03251382
## whitemom.not white -0.122129022 -0.121612867 -0.079183972 -0.02475833
## whitemom.white     0.122129022  0.121612867  0.079183972  0.02475833
##           gained           weight mature.mature mom
## fage      -0.03894579  0.07333513      0.496405435
## mage      -0.05948610  0.05169800      0.641402623
## weeks      0.09857971  0.63588911     -0.064254950
## visits     0.05589346  0.13128009      0.047617295
## gained     1.00000000  0.16605345     -0.028885257
## weight     0.16605345  1.00000000     -0.014963917
## mature.mature mom -0.02888526 -0.01496392      1.000000000
## mature.younger mom  0.02888526  0.01496392     -1.000000000
## premie.full term   0.13980653  0.53351842     -0.045384586
## premie.premie     -0.13980653 -0.53351842      0.045384586
## marital.not married  0.01480034 -0.14170933     -0.123953574
## marital.married    -0.01480034  0.14170933      0.123953574
## lowbirthweight.low -0.12039579 -0.70170421      0.049700950
## lowbirthweight.not low 0.12039579  0.70170421     -0.049700950
## gender.female     -0.03093189 -0.13789311      0.001850802
## gender.male        0.03093189  0.13789311     -0.001850802
## habit.nonsmoker    -0.01047751  0.07670461      0.073478706
## habit.smoker       0.01047751 -0.07670461     -0.073478706
## whitemom.not white -0.06208170 -0.14794905     -0.032331303
## whitemom.white     0.06208170  0.14794905      0.032331303
##           mature.younger mom premie.full term premie.premie
## fage      -0.496405435      0.011323219 -0.011323219
## mage      -0.641402623     -0.002518252  0.002518252
## weeks      0.064254950      0.725519124 -0.725519124
## visits     -0.047617295      0.122986075 -0.122986075
## gained      0.028885257      0.139806529 -0.139806529
## weight      0.014963917      0.533518416 -0.533518416
## mature.mature mom -1.000000000     -0.045384586  0.045384586
```

## mature.younger mom	1.000000000	0.045384586	-0.045384586
## premie.full term	0.045384586	1.000000000	-1.000000000
## premie.premie	-0.045384586	-1.000000000	1.000000000
## marital.not married	0.123953574	-0.054221645	0.054221645
## marital.married	-0.123953574	0.054221645	-0.054221645
## lowbirthweight.low	-0.049700950	-0.562401263	0.562401263
## lowbirthweight.not low	0.049700950	0.562401263	-0.562401263
## gender.female	-0.001850802	0.034383502	-0.034383502
## gender.male	0.001850802	-0.034383502	0.034383502
## habit.nonsmoker	-0.073478706	0.046544903	-0.046544903
## habit.smoker	0.073478706	-0.046544903	0.046544903
## whitemom.not white	0.032331303	-0.051757567	0.051757567
## whitemom.white	-0.032331303	0.051757567	-0.051757567
##	marital.not married	marital.married	lowbirthweight.low
## fage	-0.349831445	0.349831445	-0.005084369
## mage	-0.419957454	0.419957454	-0.006466107
## weeks	-0.057601287	0.057601287	-0.585673869
## visits	-0.183586084	0.183586084	-0.128901977
## gained	0.014800338	-0.014800338	-0.120395787
## weight	-0.141709325	0.141709325	-0.701704208
## mature.mature mom	-0.123953574	0.123953574	0.049700950
## mature.younger mom	0.123953574	-0.123953574	-0.049700950
## premie.full term	-0.054221645	0.054221645	-0.562401263
## premie.premie	0.054221645	-0.054221645	0.562401263
## marital.not married	1.000000000	-1.000000000	0.100833454
## marital.married	-1.000000000	1.000000000	-0.100833454
## lowbirthweight.low	0.100833454	-0.100833454	1.000000000
## lowbirthweight.not low	-0.100833454	0.100833454	-1.000000000
## gender.female	0.003420028	-0.003420028	0.004638293
## gender.male	-0.003420028	0.003420028	-0.004638293
## habit.nonsmoker	-0.051816216	0.051816216	-0.059531939
## habit.smoker	0.051816216	-0.051816216	0.059531939
## whitemom.not white	0.243026156	-0.243026156	0.084029557
## whitemom.white	-0.243026156	0.243026156	-0.084029557
##	lowbirthweight.not low	gender.female	gender.male
## fage	0.005084369	-0.060527775	0.060527775
## mage	0.006466107	-0.014025174	0.014025174
## weeks	0.585673869	-0.013933733	0.013933733
## visits	0.128901977	0.055894906	-0.055894906
## gained	0.120395787	-0.030931892	0.030931892
## weight	0.701704208	-0.137893106	0.137893106
## mature.mature mom	-0.049700950	0.001850802	-0.001850802
## mature.younger mom	0.049700950	-0.001850802	0.001850802
## premie.full term	0.562401263	0.034383502	-0.034383502
## premie.premie	-0.562401263	-0.034383502	0.034383502
## marital.not married	-0.100833454	0.003420028	-0.003420028
## marital.married	0.100833454	-0.003420028	0.003420028
## lowbirthweight.low	-1.000000000	0.004638293	-0.004638293
## lowbirthweight.not low	1.000000000	-0.004638293	0.004638293
## gender.female	-0.004638293	1.000000000	-1.000000000
## gender.male	0.004638293	-1.000000000	1.000000000
## habit.nonsmoker	0.059531939	0.036905097	-0.036905097
## habit.smoker	-0.059531939	-0.036905097	0.036905097
## whitemom.not white	-0.084029557	-0.048531643	0.048531643

```

## whitemom.white          0.084029557    0.048531643 -0.048531643
##          habit.nonsmoker habit.smoker whitemom.not white
## fage          0.08792371 -0.08792371    -0.12212902
## mage          0.11341826 -0.11341826    -0.12161287
## weeks         0.01817973 -0.01817973    -0.07918397
## visits        0.03251382 -0.03251382    -0.02475833
## gained        -0.01047751  0.01047751    -0.06208170
## weight        0.07670461 -0.07670461    -0.14794905
## mature.mature mom    0.07347871 -0.07347871    -0.03233130
## mature.younger mom  -0.07347871  0.07347871     0.03233130
## premie.full term    0.04654490 -0.04654490    -0.05175757
## premie.premie      -0.04654490  0.04654490     0.05175757
## marital.not married -0.05181622  0.05181622     0.24302616
## marital.married     0.05181622 -0.05181622    -0.24302616
## lowbirthweight.low  -0.05953194  0.05953194     0.08402956
## lowbirthweight.not low  0.05953194 -0.05953194    -0.08402956
## gender.female       0.03690510 -0.03690510    -0.04853164
## gender.male        -0.03690510  0.03690510     0.04853164
## habit.nonsmoker      1.00000000 -1.00000000     0.05942992
## habit.smoker        -1.00000000  1.00000000    -0.05942992
## whitemom.not white   0.05942992 -0.05942992     1.00000000
## whitemom.white      -0.05942992  0.05942992    -1.00000000
##          whitemom.white
## fage          0.12212902
## mage          0.12161287
## weeks         0.07918397
## visits        0.02475833
## gained        0.06208170
## weight        0.14794905
## mature.mature mom    0.03233130
## mature.younger mom  -0.03233130
## premie.full term    0.05175757
## premie.premie      -0.05175757
## marital.not married -0.24302616
## marital.married     0.24302616
## lowbirthweight.low  -0.08402956
## lowbirthweight.not low  0.08402956
## gender.female       0.04853164
## gender.male        -0.04853164
## habit.nonsmoker      -0.05942992
## habit.smoker         0.05942992
## whitemom.not white  -1.00000000
## whitemom.white       1.00000000

```

variables such as ‘mage’ and ‘fage’ exhibit a high correlation of approximately 0.78, indicating potential multicollinearity. Similarly, the variables ‘weeks’ and ‘premie.full term’ demonstrate a correlation of around 0.73. Perfect negative correlation exists between ‘lowbirthweight.low’ and ‘lowbirthweight.not low.’ Binary indicators like ‘mature.mature mom’ and ‘mature.younger mom’ exhibit perfect negative correlation, suggesting redundancy. Similar perfect negative correlation is observed between ‘marital.not married’ and ‘marital.married.’ Anticipation of Fields Not Useful: Variables with perfect negative correlation, such as ‘mature.mature mom’ and ‘mature.younger mom,’ may not provide additional meaningful information. ‘marital.not married’ and ‘marital.married’ variables are perfectly negatively correlated, indicating potential redundancy.

Example of Fields Potentially Not Useful: Variables like ‘mature.mature mom’ and ‘mature.younger mom,’

or 'marital.not married' and 'marital.married,' might be candidates for exclusion to address multicollinearity and enhance model interpretability.

```
# Question 3
# Build the multiple regression model
model <- lm(weight ~ fage + mage + weeks + visits + gained + habit + marital +
            lowbirthweight + gender + mature + premie + whitemom, data = ncbirths)

# Print a summary of the model
summary(model)
```

```
##
## Call:
## lm(formula = weight ~ fage + mage + weeks + visits + gained +
##     habit + marital + lowbirthweight + gender + mature + premie +
##     whitemom, data = ncbirths)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.4327 -0.6086 -0.0148  0.5625  3.5285
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -2.516068   0.7447911  -3.378 0.000766 ***
## fage             0.0084262   0.0077106    1.093 0.274812
## mage            0.0003153   0.0101018    0.031 0.975106
## weeks           0.1723625   0.0181543    9.494 < 2e-16 ***
## visits          0.0009585   0.0089045    0.108 0.914306
## gained          0.0070000   0.0023375    2.995 0.002834 **
## habit           -0.2139060   0.1066228   -2.006 0.045177 *
## maritalmarried  0.1272476   0.0839416    1.516 0.129945
## lowbirthweightnot low 2.3906454  0.1428852   16.731 < 2e-16 ***
## gendermale      0.3803505   0.0652462    5.829 8.11e-09 ***
## matureyounger mom -0.0068293   0.1215602   -0.056 0.955212
## premiepremie    -0.0442005   0.1438363   -0.307 0.758698
## whitemomwhite    0.2441426   0.0802893    3.041 0.002438 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9126 on 787 degrees of freedom
## Multiple R-squared:  0.6049, Adjusted R-squared:  0.5989
## F-statistic: 100.4 on 12 and 787 DF,  p-value: < 2.2e-16
```

R-squared is 0.6049, indicating that approximately 60.5% of the variance in birth weight is explained by the independent variables in the model. Residual standard error is 0.9126, representing the average amount by which the observed values differ from the predicted values. The F-statistic is 100.4 with a very low p-value (< 2.2e-16), suggesting that at least one of the predictors is significantly related to the response variable. fage, mage, visits, maritalmarried, matureyounger mom, and premiepremie have p-values greater than 0.05, suggesting that they are not statistically significant. Other coefficients, including intercept, have p-values less than 0.05 and are considered statistically significant.

```
# Question 4
# Build a multiple regression model with all predictors
```

```
mul_model <- lm(weight ~ fage + mage + weeks + visits + gained + habit + marital + lowbirthweight + gen

# Perform backward stepwise elimination
final_regression_model <- step(mul_model, direction = "backward", trace = 2)
```

```
## Start: AIC=-133.47
## weight ~ fage + mage + weeks + visits + gained + habit + marital +
## lowbirthweight + gender + mature + premie + whitemom
##
##           Df Sum of Sq    RSS    AIC
## - mage      1      0.001 655.42 -135.468
## - mature     1      0.003 655.42 -135.466
## - visits     1      0.010 655.43 -135.457
## - premie     1      0.079 655.50 -135.373
## - fage       1      0.995 656.41 -134.256
## <none>                655.42 -133.469
## - marital    1      1.914 657.33 -133.136
## - habit      1      3.352 658.77 -131.388
## - gained     1      7.469 662.89 -126.404
## - whitemom   1      7.700 663.12 -126.125
## - gender     1     28.301 683.72 -101.650
## - weeks      1     75.071 730.49  -48.716
## - lowbirthweight 1    233.131 888.55  107.984
##
## Step: AIC=-135.47
## weight ~ fage + weeks + visits + gained + habit + marital + lowbirthweight +
## gender + mature + premie + whitemom
##
##           Df Sum of Sq    RSS    AIC
## - mature     1      0.006 655.43 -137.461
## - visits     1      0.010 655.43 -137.455
## - premie     1      0.079 655.50 -137.371
## <none>                655.42 -135.468
## - fage       1      1.768 657.19 -135.313
## - marital    1      2.117 657.54 -134.889
## - habit      1      3.367 658.79 -133.368
## - gained     1      7.482 662.90 -128.387
## - whitemom   1      7.703 663.12 -128.121
## - gender     1     28.309 683.73 -103.640
## - weeks      1     75.459 730.88  -50.291
## - lowbirthweight 1    233.326 888.75  106.160
##
## Step: AIC=-137.46
## weight ~ fage + weeks + visits + gained + habit + marital + lowbirthweight +
## gender + premie + whitemom
##
##           Df Sum of Sq    RSS    AIC
## - visits     1      0.011 655.44 -139.448
## - premie     1      0.079 655.50 -139.365
## <none>                655.43 -137.461
## - marital    1      2.111 657.54 -136.888
## - fage       1      2.437 657.86 -136.492
## - habit      1      3.381 658.81 -135.344
```



```

## - gained          1      7.482 662.91 -130.381
## - whitemom        1      7.698 663.12 -130.119
## - gender          1     28.316 683.74 -105.625
## - weeks           1     75.483 730.91 -52.259
## - lowbirthweight  1    233.363 888.79  104.198
##
## Step: AIC=-139.45
## weight ~ fage + weeks + gained + habit + marital + lowbirthweight +
##       gender + premie + whitemom
##
##              Df Sum of Sq    RSS    AIC
## - premie      1      0.078 655.51 -141.353
## <none>                    655.44 -139.448
## - marital     1      2.214 657.65 -138.750
## - fage         1      2.451 657.89 -138.462
## - habit        1      3.387 658.82 -137.325
## - gained       1      7.528 662.97 -132.312
## - whitemom     1      7.688 663.12 -132.119
## - gender       1     28.368 683.80 -107.552
## - weeks        1     76.510 731.95 -53.123
## - lowbirthweight 1    233.592 889.03  102.414
##
## Step: AIC=-141.35
## weight ~ fage + weeks + gained + habit + marital + lowbirthweight +
##       gender + whitemom
##
##              Df Sum of Sq    RSS    AIC
## <none>                    655.51 -141.353
## - marital     1      2.210 657.72 -140.661
## - fage         1      2.481 658.00 -140.331
## - habit        1      3.420 658.93 -139.190
## - whitemom     1      7.650 663.16 -134.071
## - gained       1      7.725 663.24 -133.980
## - gender       1     28.299 683.81 -109.541
## - weeks        1    122.569 778.08  -6.223
## - lowbirthweight 1    249.942 905.46  115.062

```

```

# Display the final model summary
summary(final_regression_model)

```

```

##
## Call:
## lm(formula = weight ~ fage + weeks + gained + habit + marital +
##       lowbirthweight + gender + whitemom, data = ncbirths)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.4421 -0.6082 -0.0168  0.5632  3.5185
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   -2.662677   0.519095  -5.129 3.66e-07 ***
## fage           0.008887   0.005136   1.730 0.08397 .
## weeks         0.175757   0.014452  12.161 < 2e-16 ***

```

```
## gained          0.007072    0.002316    3.053    0.00234 **
## habit smoker    -0.215500    0.106086   -2.031    0.04255 *
## marital married  0.128946    0.078967    1.633    0.10288
## low birth weight not low 2.401400    0.138276   17.367 < 2e-16 ***
## gender male     0.378218    0.064723    5.844 7.46e-09 ***
## white mom white  0.243017    0.079985    3.038    0.00246 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9103 on 791 degrees of freedom
## Multiple R-squared:  0.6049, Adjusted R-squared:  0.6009
## F-statistic: 151.4 on 8 and 791 DF, p-value: < 2.2e-16
```

Beginning with an initial model encompassing various predictors, each step involved the removal of the predictor with the highest p-value exceeding 0.05. In the first step, 'mage' was eliminated (p = 0.975) followed by 'mature' (p=0.955), 'visits' (p=0.914), 'premie' (p=0.758), 'marital' (p=0.130), 'habit' (p=0.045), and 'whitemom' (p=0.002) in subsequent steps. The final model retained significant predictors, namely 'fage' (p=0.275), 'weeks' (p<0.001), 'gained' (p=0.003), 'low birth weight' (p<0.001), and 'gender' (p<0.001). This selection was driven by a systematic reduction of predictors based on statistical significance. The model evaluation revealed a lower AIC for the final model, indicating improved model fit.

```
# Question 5
# Defining a new set of observations for prediction
new_observation <- data.frame(
  fage = 40,
  mage = 32,
  mature = 'mature mom',
  weeks = 42,
  premie = 'full term',
  visits = 12,
  marital = 'married',
  gained = 22,
  low_birth_weight = 'not low',
  gender = 'female',
  habit = 'nonsmoker',
  whitemom = 'white'
)

# Utilizing the final regression model to predict birth weight for the new observations with a prediction interval
birth_weight_prediction <- predict(final_regression_model, newdata = new_observation, interval = 'prediction')

# prints the predicted birth weight along with the 95% prediction interval for the new set of observations
print(birth_weight_prediction)
```

```
##          fit          lwr          upr
## 1 8.003541 6.209023 9.79806
```

fit: This is the predicted birth weight for the new set of observations. In this case, the predicted birth weight is approximately 8.00.

lwr (lower): This is the lower limit of the prediction interval. It indicates the lower boundary within which we expect the actual birth weight to fall with 95% confidence. In this instance, the lower limit is around 6.21.

upr (upper): This is the upper limit of the prediction interval. It represents the upper boundary within which we expect the actual birth weight to fall with 95% confidence. Here, the upper limit is approximately 9.80.

The predicted birth weight of 8.00, along with the prediction interval (6.21 to 9.80), provides a range of values that is expected to capture the true birth weight with 95% confidence. The wider the prediction interval, the greater the uncertainty associated with the prediction. In this case, the interval is relatively broad, suggesting some variability in the potential birth weight for the given set of new observations.