



M1.4 Regresión Lineal Múltiple

Integrantes

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Realizar las transformaciones adecuadas a las variables predictoras.

Estandarización en Minitab (**Restar la media y Dividir entre la desviaciones estándar**)

| C11 | C12 | C13 | C14 |
|----------------------|---------------------|---------------------|---------------------|
| Factor Coagulación_1 | Índice pronóstico_1 | Función de enzima_1 | Función de hígado_1 |
| 0.57498 | -0.04738 | 0.43629 | -0.06786 |
| -0.54769 | -0.22589 | -0.28054 | -0.95290 |
| 1.06615 | -0.34489 | 0.53187 | -0.49546 |
| 0.43465 | 0.60714 | -1.47526 | -0.64463 |
| 1.34682 | 0.13113 | 2.06112 | 1.63261 |
| -0.05652 | -1.47544 | 0.00619 | -1.23134 |
| -0.12669 | -0.99942 | -0.42391 | -0.74407 |
| -1.53003 | 0.30963 | 0.43629 | -0.08775 |
| 0.08381 | 0.25013 | 1.00976 | -0.15736 |
| -1.53003 | 0.78565 | 1.05755 | -0.25680 |
| 0.29431 | 1.26167 | 0.53187 | 1.46356 |
| 0.57498 | -0.70191 | -1.37968 | -0.79379 |
| -0.05652 | 1.97570 | 2.01333 | 1.28456 |
| -0.05652 | 1.20217 | 0.77082 | 1.28456 |
| 1.27665 | -0.04738 | -0.23275 | 0.73763 |
| 1.06615 | 0.66665 | -0.18496 | -0.25680 |
| 0.08381 | 1.32117 | -2.09652 | 0.31997 |
| -1.53003 | -0.70191 | -1.47526 | -1.10206 |
| 0.99598 | 0.30963 | 0.10177 | 0.89673 |
| -0.19686 | -0.34489 | 0.72303 | 0.35974 |
| -0.47753 | -0.64240 | 0.19735 | 0.19069 |
| -1.74053 | 1.20217 | -0.90179 | -1.52967 |
| 0.57498 | -2.18946 | -0.18496 | -0.55513 |
| -0.05652 | 0.25013 | 0.67524 | 0.73763 |

| C15 |
|----------|
| Edad_1 |
| -0.00720 |
| -0.95758 |
| 0.42479 |
| -0.18000 |
| -0.43919 |
| 1.28877 |
| -0.09360 |
| 1.63436 |
| 0.68399 |
| -0.18000 |
| -1.13038 |
| 0.59759 |
| 1.11598 |
| 0.16560 |
| 0.68399 |
| 1.20237 |
| -1.21677 |
| -0.95758 |
| 0.77038 |

Estandarización por Excel, considerando que Min es mejor para todas las variables

| min | min | min | min | min |
|-----------------------|----------------------|----------------------|----------------------|------------|
| Factor Coagulación | Índice pronóstico | Función de enzima | Función de hígado | Edad |
| 0.00764736 | 0.00824782 | 0.00736905 | 0.00816269 | 0.00876649 |
| 0.01004654 | 0.0086672 | 0.00904383 | 0.0124361 | 0.0112391 |
| 0.00692396 | 0.00897132 | 0.00719148 | 0.00978767 | 0.00796954 |
| 0.00788267 | 0.007005 | 0.01455837 | 0.0105181 | 0.00913177 |
| 0.00656889 | 0.00786716 | 0.00519037 | 0.0049166 | 0.00974055 |
| 0.00883402 | 0.01345698 | 0.00829018 | 0.01488829 | 0.00674346 |
| 0.00898901 | 0.01111663 | 0.00947449 | 0.01106878 | 0.0089454 |
| 0.01384793 | 0.00752007 | 0.00736905 | 0.00822622 | 0.00635253 |

| | | | | |
|------------|------------|------------|------------|------------|
| 0.00853956 | 0.00763231 | 0.0064182 | 0.00845655 | 0.00755732 |
| 0.01384793 | 0.00672849 | 0.00634993 | 0.00880891 | 0.00913177 |
| 0.00813291 | 0.00608768 | 0.00719148 | 0.00511898 | 0.01184661 |
| 0.00764736 | 0.01002677 | 0.01388123 | 0.01136633 | 0.00768991 |
| 0.00883402 | 0.00532672 | 0.0052359 | 0.00535225 | 0.00695754 |
| 0.00883402 | 0.00616103 | 0.00678287 | 0.00535225 | 0.00842932 |
| 0.0066542 | 0.00824782 | 0.00890885 | 0.00621805 | 0.00755732 |
| 0.00692396 | 0.00691034 | 0.00877784 | 0.00880891 | 0.00684882 |
| 0.00853956 | 0.00601606 | 0.02131761 | 0.00709442 | 0.01217569 |
| 0.01384793 | 0.01002677 | 0.01455837 | 0.0136396 | 0.0112391 |
| 0.00701881 | 0.00752007 | 0.00806612 | 0.00593859 | 0.00742923 |
| 0.00914953 | 0.00897132 | 0.00686084 | 0.00700046 | 0.00695754 |
| 0.00985333 | 0.00983394 | 0.00785386 | 0.00741803 | 0.0112391 |
| 0.01506981 | 0.00616103 | 0.01126213 | 0.01887623 | 0.00654216 |
| 0.00764736 | 0.01966789 | 0.00877784 | 0.01006732 | 0.01461082 |
| 0.00883402 | 0.00763231 | 0.00694062 | 0.00621805 | 0.0089454 |
| 0.00813291 | 0.0086672 | 0.00596893 | 0.00716657 | 0.01217569 |
| 0.00883402 | 0.00838303 | 0.00817662 | 0.00604039 | 0.00706975 |
| 0.00985333 | 0.00983394 | 0.00694062 | 0.00862913 | 0.00626178 |
| 0.00457476 | 0.00672849 | 0.00663214 | 0.003782 | 0.00755732 |
| 0.00985333 | 0.00946972 | 0.0106588 | 0.00780125 | 0.00996193 |
| 0.00883402 | 0.00672849 | 0.01011683 | 0.00819433 | 0.00718565 |
| 0.01601167 | 0.00799008 | 0.00918297 | 0.02856943 | 0.00827028 |
| 0.00588935 | 0.01136367 | 0.02595187 | 0.00838944 | 0.00644595 |

| | | | | |
|------------|------------|------------|------------|------------|
| 0.01024747 | 0.0086672 | 0.00817662 | 0.00604039 | 0.00768991 |
| 0.00883402 | 0.00710229 | 0.0064182 | 0.00640648 | 0.0112391 |
| 0.0094884 | 0.00881664 | 0.00852704 | 0.0080081 | 0.01413951 |
| 0.00966742 | 0.01002677 | 0.00602922 | 0.0081313 | 0.00913177 |
| 0.01970667 | 0.00691034 | 0.00694062 | 0.01031287 | 0.00974055 |
| 0.01191566 | 0.06392064 | 0.00501591 | 0.00741803 | 0.00674346 |
| 0.01067445 | 0.00838303 | 0.00785386 | 0.00862913 | 0.0085946 |
| 0.0094884 | 0.00983394 | 0.00678287 | 0.01168032 | 0.01095812 |
| 0.00985333 | 0.01043602 | 0.00829018 | 0.01148988 | 0.0095288 |
| 0.01423259 | 0.01826304 | 0.00602922 | 0.0162626 | 0.00796954 |
| 0.00582243 | 0.00594611 | 0.00678287 | 0.00330334 | 0.01461082 |
| 0.00788267 | 0.00913152 | 0.00775186 | 0.00741803 | 0.01069085 |
| 0.01506981 | 0.00664111 | 0.0064182 | 0.01428471 | 0.00635253 |
| 0.00788267 | 0.01278413 | 0.00710587 | 0.00704713 | 0.00811712 |
| 0.01138608 | 0.007005 | 0.00563107 | 0.0069316 | 0.00932606 |
| 0.01067445 | 0.00594611 | 0.00590983 | 0.00515643 | 0.01252356 |
| 0.01004654 | 0.00763231 | 0.00775186 | 0.00739209 | 0.00664128 |
| 0.01313778 | 0.00623616 | 0.00579508 | 0.00464646 | 0.00876649 |
| 0.00776323 | 0.00664111 | 0.01297593 | 0.01084173 | 0.00876649 |
| 0.00800583 | 0.00601606 | 0.01492232 | 0.01747221 | 0.00755732 |
| 0.00800583 | 0.0086672 | 0.00702227 | 0.00907355 | 0.00695754 |
| 0.00582243 | 0.00655596 | 0.00829018 | 0.00660668 | 0.00782723 |
| 0.00721653 | 0.02223326 | 0.00765247 | 0.01095408 | 0.00974055 |
| 0.0104566 | 0.00774796 | 0.00655926 | 0.0069316 | 0.0128919 |
| 0.00800583 | 0.00568183 | 0.01705409 | 0.0199447 | 0.0112391 |
| 0.00898901 | 0.01461043 | 0.00852704 | 0.00992553 | 0.00644595 |
| 0.00839956 | 0.01217536 | 0.00865062 | 0.00939617 | 0.00626178 |

| | | | | |
|------------|------------|------------|------------|------------|
| 0.00640467 | 0.01893945 | 0.00719148 | 0.01041447 | 0.01252356 |
| 0.0075349 | 0.01504015 | 0.01170378 | 0.01664675 | 0.00996193 |
| 0.01090156 | 0.00811691 | 0.01658036 | 0.01236338 | 0.01217569 |
| 0.00731962 | 0.01088011 | 0.00890885 | 0.01321336 | 0.00811712 |
| 0.00764736 | 0.00741109 | 0.00918297 | 0.00726508 | 0.00718565 |
| 0.00764736 | 0.01111663 | 0.00765247 | 0.00648509 | 0.00876649 |
| 0.00883402 | 0.00852275 | 0.00694062 | 0.00679787 | 0.00768991 |
| 0.00764736 | 0.00913152 | 0.01865291 | 0.01381789 | 0.00635253 |
| 0.0075349 | 0.01002677 | 0.01029126 | 0.00969788 | 0.00974055 |
| 0.0071163 | 0.00538279 | 0.00727918 | 0.00451739 | 0.00706975 |
| 0.00692396 | 0.00983394 | 0.00890885 | 0.00644554 | 0.00827028 |
| 0.00966742 | 0.0096484 | 0.00962731 | 0.00873611 | 0.0112391 |
| 0.01463924 | 0.00881664 | 0.00710587 | 0.01215022 | 0.0104363 |
| 0.0075349 | 0.00691034 | 0.00755561 | 0.00939617 | 0.01217569 |
| 0.01164485 | 0.01088011 | 0.01218149 | 0.00873611 | 0.01252356 |
| 0.00731962 | 0.00774796 | 0.00505842 | 0.00450776 | 0.00742923 |
| 0.00764736 | 0.00838303 | 0.01047181 | 0.00546289 | 0.00664128 |
| 0.00914953 | 0.0068182 | 0.00579508 | 0.00679787 | 0.00768991 |
| 0.0074257 | 0.00881664 | 0.00678287 | 0.00611022 | 0.01184661 |
| 0.00826409 | 0.00824782 | 0.01047181 | 0.0169131 | 0.00827028 |
| 0.01090156 | 0.00527181 | 0.02210715 | 0.01194428 | 0.01217569 |
| 0.0075349 | 0.00741109 | 0.00994822 | 0.00729013 | 0.00782723 |
| 0.00853956 | 0.007005 | 0.01029126 | 0.017329 | 0.01217569 |
| 0.0086843 | 0.0102273 | 0.00962731 | 0.00662739 | 0.00635253 |
| 0.00931588 | 0.00581097 | 0.00806612 | 0.0065861 | 0.01217569 |
| 0.01348351 | 0.00929755 | 0.01147871 | 0.01499388 | 0.00635253 |
| 0.01191566 | 0.0051653 | 0.00719148 | 0.00537949 | 0.01252356 |

| | | | | |
|------------|------------|------------|------------|------------|
| 0.00776323 | 0.01065344 | 0.01105357 | 0.00719094 | 0.00742923 |
| 0.00826409 | 0.01217536 | 0.00947449 | 0.01142777 | 0.01369765 |
| 0.01024747 | 0.00852275 | 0.0056847 | 0.0066692 | 0.0128919 |
| 0.00883402 | 0.00824782 | 0.00727918 | 0.00664823 | 0.00974055 |
| 0.00985333 | 0.00913152 | 0.01218149 | 0.01428471 | 0.00811712 |
| 0.00898901 | 0.00730522 | 0.01011683 | 0.00927253 | 0.00674346 |
| 0.01090156 | 0.00799008 | 0.01243527 | 0.0162626 | 0.00782723 |
| 0.00656889 | 0.00691034 | 0.01218149 | 0.00819433 | 0.01328257 |
| 0.01067445 | 0.00983394 | 0.01326429 | 0.00780125 | 0.00695754 |
| 0.0104566 | 0.00710229 | 0.00663214 | 0.00602318 | 0.00974055 |
| 0.01113855 | 0.007005 | 0.01047181 | 0.00749694 | 0.01153486 |
| 0.0086843 | 0.00655596 | 0.00852704 | 0.00493957 | 0.00796954 |
| 0.01113855 | 0.00741109 | 0.00852704 | 0.0066692 | 0.0101936 |
| 0.00839956 | 0.0096484 | 0.01147871 | 0.01148988 | 0.01252356 |
| 0.0086843 | 0.00581097 | 0.00609074 | 0.00634876 | 0.01217569 |
| 0.01090156 | 0.00774796 | 0.00877784 | 0.01174521 | 0.01252356 |
| 0.00492667 | 0.00824782 | 0.00702227 | 0.00454653 | 0.00876649 |
| 0.00883402 | 0.00730522 | 0.00932645 | 0.00838944 | 0.0089454 |
| 0.0094884 | 0.00799008 | 0.00736905 | 0.01554513 | 0.00706975 |
| 0.0074257 | 0.00568183 | 0.01808767 | 0.00760481 | 0.00913177 |
| 0.00648574 | 0.01136367 | 0.0108526 | 0.00859406 | 0.0101936 |
| 0.01138608 | 0.00752007 | 0.00994822 | 0.01021323 | 0.00742923 |
| 1 | 1 | 1 | 1 | 1 |

Realizar el modelo de regresión con las variables significativas.

Regresión con todas las variables, con el método **paso a paso**.

Selección de términos escalonada

Términos candidatos: Factor Coagulación_1, Índice pronóstico_1, Función de enzima_1, Función de hígado_1, Edad, Género, Alcohol(moderado), Alcohol(Severo)

| | ----Paso 1---- | | ----Paso 2---- | | ----Paso 3---- | | ----Paso 4---- | |
|----------------------|----------------|-------|----------------|-------|----------------|-------|----------------|-------|
| | Coef | P | Coef | P | Coef | P | Coef | P |
| Constante | 658.1 | | 658.1 | | 658.1 | | 609.1 | |
| Función de hígado_1 | 236.2 | 0.000 | 173.1 | 0.000 | 121.4 | 0.000 | 131.2 | 0.000 |
| Función de enzima_1 | | | 129.8 | 0.000 | 155.5 | 0.000 | 155.6 | 0.000 |
| Índice pronóstico_1 | | | | | 116.0 | 0.000 | 115.0 | 0.000 |
| Alcohol(Severo) | | | | | | | 252.2 | 0.000 |
| Factor Coagulación_1 | | | | | | | | |
| S | 256.568 | | 230.946 | | 205.185 | | 179.323 | |
| R-cuadrado | 46.10% | | 56.74% | | 66.18% | | 74.42% | |
| R-cuadrado(ajustado) | 45.59% | | 55.92% | | 65.20% | | 73.42% | |
| Cp de Mallows | 133.44 | | 88.57 | | 48.99 | | 14.71 | |
| AICc | 1508.94 | | 1487.35 | | 1462.97 | | 1435.07 | |
| BIC | 1516.76 | | 1497.69 | | 1475.79 | | 1450.33 | |

| | ----Paso 5---- | |
|----------------------|----------------|-------|
| | Coef | P |
| Constante | 615.1 | |
| Función de hígado_1 | 80.3 | 0.002 |
| Función de enzima_1 | 184.8 | 0.000 |
| Índice pronóstico_1 | 135.0 | 0.000 |
| Alcohol(Severo) | 221.3 | 0.000 |
| Factor Coagulación_1 | 71.6 | 0.001 |
| S | 170.178 | |
| R-cuadrado | 77.18% | |
| R-cuadrado(ajustado) | 76.06% | |
| Cp de Mallows | 4.52 | |
| AICc | 1425.00 | |
| BIC | 1442.65 | |

α a entrar = 0.05, α a retirar = 0.05

Ecuación de regresión

Sobrevivencia(Días) = 615.1 + 71.6 Factor Coagulación_1 + 135.0 Índice pronóstico_1
+ 184.8 Función de enzima_1 + 80.3 Función de hígado_1
+ 221.3 Alcohol(Severo)

Estandarización por Excel

Selección de términos escalonada

Términos candidatos: Factor Coagulación, Índice pronóstico, Función de enzima, Función de hígado, Edad, Género, Alcohol(moderado), Alcohol(Severo)

| | -----Paso 1----- | | -----Paso 2----- | | -----Paso 3----- | |
|----------------------|------------------|-------|------------------|-------|------------------|-------|
| | Coef | P | Coef | P | Coef | P |
| Constante | 1059.3 | | 1260.7 | | 1240.9 | |
| Función de hígado | -43323 | 0.000 | -33489 | 0.000 | -37685 | 0.000 |
| Función de enzima | | | -31587 | 0.000 | -30717 | 0.000 |
| Alcohol(Severo) | | | | | 260.3 | 0.000 |
| Índice pronóstico | | | | | | |
| S | 302.362 | | 283.182 | | 264.962 | |
| R-cuadrado | 25.15% | | 34.96% | | 43.60% | |
| R-cuadrado(ajustado) | 24.44% | | 33.72% | | 41.98% | |
| Cp de Mallows | 48.63 | | 30.62 | | 14.99 | |
| AICc | 1544.41 | | 1531.39 | | 1518.19 | |
| BIC | 1552.23 | | 1541.73 | | 1531.02 | |

| | -----Paso 4----- | |
|----------------------|------------------|-------|
| | Coef | P |
| Constante | 1392.0 | |
| Función de hígado | -35003 | 0.000 |
| Función de enzima | -34612 | 0.000 |
| Alcohol(Severo) | 256.1 | 0.000 |
| Índice pronóstico | -15020 | 0.000 |
| S | 249.969 | |
| R-cuadrado | 50.5% | |
| R-cuadrado(ajustado) | 48.36% | |
| Cp de Mallows | 3.36 | |
| AICc | 1506.81 | |
| BIC | 1522.07 | |

Alfa = 0.05 o a retirar = 0.05

Probar si se deben agregar interacciones o términos polinomiales.

Selección de términos escalonada

Términos candidatos: Factor Coagulación_1, Índice pronóstico_1, Función de enzima_1, Función de hígado_1, Edad, Género, Alcohol(moderado), Alcohol(Severo), Factor Coagulación_1*Índice pronóstico_1, Factor Coagulación_1*Función de enzima_1, Factor Coagulación_1*Función de hígado_1, Índice pronóstico_1*Función de enzima_1, Índice pronóstico_1*Función de hígado_1, Función de enzima_1*Función de hígado_1

| | ----Paso 1---- | | ----Paso 2---- | | ----Paso 3---- | |
|--|----------------|-------|----------------|-------|----------------|-------|
| | Coef | P | Coef | P | Coef | P |
| Constante | 658.1 | | 658.1 | | 658.1 | |
| Función de hígado_1 | 236.2 | 0.000 | 173.1 | 0.000 | 121.4 | 0.000 |
| Función de enzima_1 | | | 129.8 | 0.000 | 155.5 | 0.000 |
| Índice pronóstico_1 | | | | | 116.0 | 0.000 |
| Alcohol(Severo) | | | | | | |
| Factor Coagulación_1 | | | | | | |
| Factor Coagulación_1*Función de enzima_1 | | | | | | |
| S | 256.568 | | 230.946 | | 205.185 | |
| R-cuadrado | 46.10% | | 56.74% | | 66.18% | |
| R-cuadrado(ajustado) | 45.59% | | 55.92% | | 65.20% | |
| Cp de Mallows | 161.74 | | 111.28 | | 66.75 | |
| AICc | 1508.94 | | 1487.35 | | 1462.97 | |
| BIC | 1516.76 | | 1497.69 | | 1475.79 | |
| | ----Paso 4---- | | ----Paso 5---- | | ----Paso 6---- | |
| | Coef | P | Coef | P | Coef | P |
| Constante | 609.1 | | 615.1 | | 620.2 | |
| Función de hígado_1 | 131.2 | 0.000 | 80.3 | 0.002 | 72.8 | 0.003 |
| Función de enzima_1 | 155.6 | 0.000 | 184.8 | 0.000 | 188.2 | 0.000 |
| Índice pronóstico_1 | 115.0 | 0.000 | 135.0 | 0.000 | 132.2 | 0.000 |
| Alcohol(Severo) | 252.2 | 0.000 | 221.3 | 0.000 | 211.7 | 0.000 |
| Factor Coagulación_1 | | | 71.6 | 0.001 | 65.6 | 0.001 |
| Factor Coagulación_1*Función de enzima_1 | | | | | 48.6 | 0.003 |
| S | 179.323 | | 170.178 | | 163.785 | |
| R-cuadrado | 74.42% | | 77.18% | | 79.07% | |
| R-cuadrado(ajustado) | 73.42% | | 76.06% | | 77.83% | |
| Cp de Mallows | 28.14 | | 16.50 | | 9.18 | |
| AICc | 1435.07 | | 1425.00 | | 1418.00 | |
| BIC | 1450.33 | | 1442.65 | | 1438.00 | |

α a entrar = 0.05, α a retirar = 0.05

Ecuación de regresión

$$\begin{aligned}\text{Sobrevivencia(Días)} = & 620.2 + 65.6 \text{ Factor Coagulación}_1 + 132.2 \text{ Índice pronóstico}_1 \\ & + 188.2 \text{ Función de enzima}_1 + 72.8 \text{ Función de hígado}_1 \\ & + 211.7 \text{ Alcohol(Severo)} + 48.6 \text{ Factor Coagulación}_1 * \text{Función de enzima}_1\end{aligned}$$

Podemos ver una disminución de **R2** y **R2 ajustada**, por lo que no es un buen cambio.

Interpretar la tabla ANOVA, R2, R2 ajustada, p-values y FIV.

Anova con todas las variables:

Información del factor

| Factor | Niveles | Valores |
|--------|---------|--|
| Factor | 9 | Género, Alcohol(moderado), Alcohol(Severo), Sobrevivencia(Días), Factor Coagulación_1, Índice pronóstico_1, Función de enzima_1, Función de hígado_1, Edad_1 |

Análisis de Varianza

| Fuente | GL | SC Ajust. | MC Ajust. | Valor F | Valor p |
|--------|-----|-----------|-----------|---------|---------|
| Factor | 8 | 41563412 | 5195427 | 386.44 | 0.000 |
| Error | 963 | 12946971 | 13444 | | |
| Total | 971 | 54510383 | | | |

Resumen del modelo

| S | R-cuadrado | R-cuadrado(ajustado) | R-cuadrado (pred) |
|---------|------------|----------------------|-------------------|
| 115.950 | 76.25% | 76.05% | 75.80% |

SC ajust nos indica que el número total de variabilidad total en los datos, es de 54,510,383 , tenemos un error de 12,946,971 y un factor de 41,563,412.

El valor F es de 387, es la razón entre MC ajust del factor y MC ajust del error, un valor F alto nos indica que gran variabilidad explicada por el modelo.

R2: el modelo explica el 76.25% de la variabilidad en los datos.

R2 ajustada, nos sirve para comparar diferentes modelos con diferentes número de predictores, que aumente no siempre significa que es mejor el modelo.

El valor p es < 0.05, por lo que se rechaza la hipótesis nula, esto significa que hay suficiente evidencia para concluir que al menos una de las medias de los grupos es significativamente diferente de las demás.

Verificar el cumplimiento de los supuestos.





