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Stepwise Regression for Blood Pressure Data

About the Data

The researchers were interested in determining if a relationship exists between blood pressure and age, weight, body surface area, duration, pulse rate and/or stress level for a group of 20 individuals

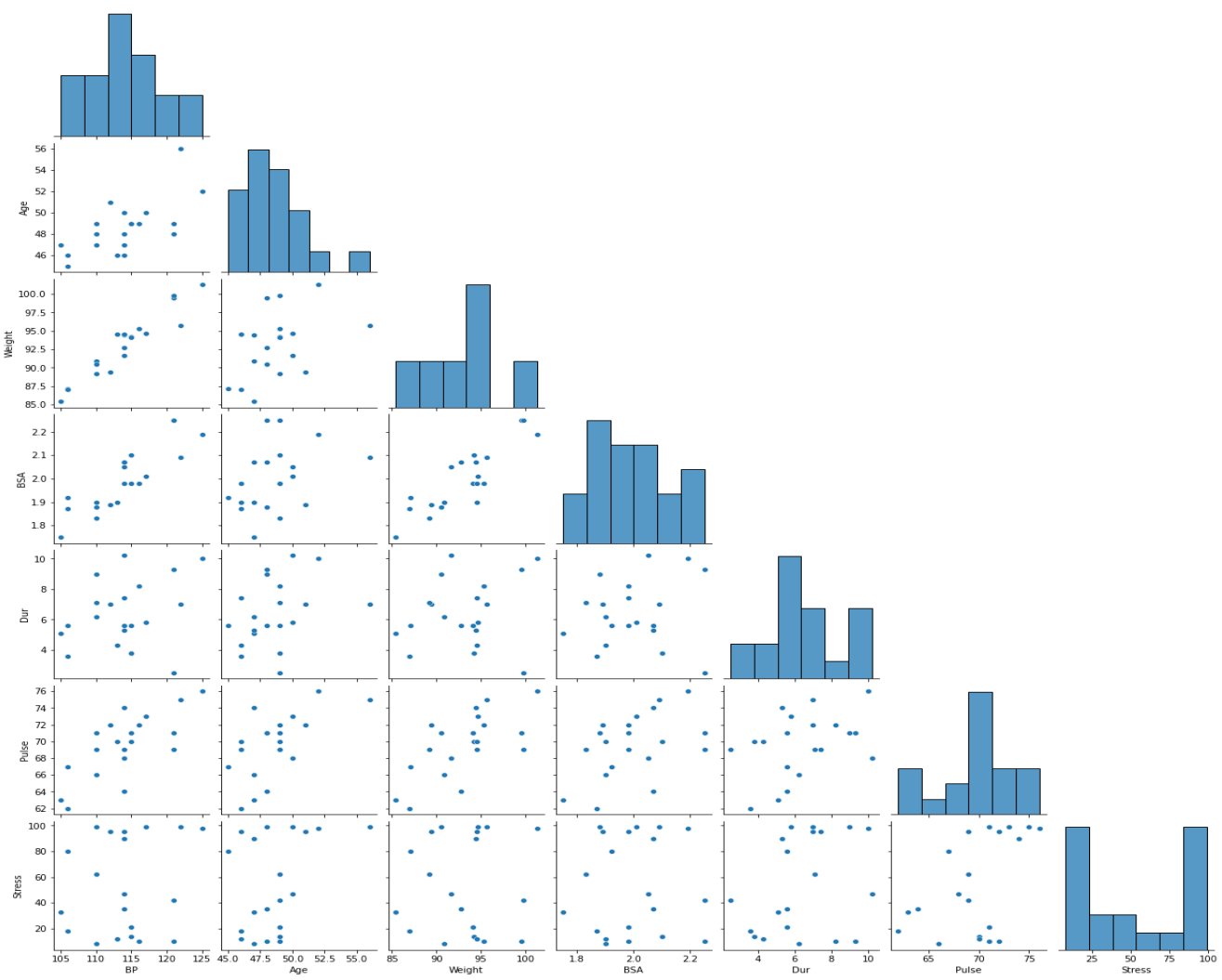
1. blood pressure (y = BP, in mm Hg)
2. age (x1 = Age, in years)
3. weight (x2 = Weight, in kg)
4. body surface area (x3 = BSA, in sq m)
5. duration of hypertension (x4 = Dur, in years)
6. basal pulse (x5 = Pulse, in beats per minute)
7. stress index (x6 = Stress)

Descriptive Statistics

	Blood Pressure	Age	Weight	Body Surface Area	Duration Hypertension	Basal Pulse	Stress
count	20.000000	20.000000	20.000000	20.000000	20.000000	20.000000	20.00000
mean	114.000000	48.600000	93.090000	1.998000	6.430000	69.600000	53.35000
count	5.428967	2.500526	4.294905	0.136482	2.145276	3.803046	37.08635
min	105.000000	45.000000	85.400000	1.750000	2.500000	62.000000	8.00000
25%	110.000000	47.000000	90.225000	1.897500	5.250000	67.750000	17.00000
50%	114.000000	48.500000	94.150000	1.980000	6.000000	70.000000	44.50000
75%	116.250000	49.250000	94.850000	2.075000	7.600000	72.000000	95.00000
max	125.000000	56.000000	101.300000	2.250000	10.200000	76.000000	99.00000

Correlation Analysis

1. Pairs Plot



2. Correlation Plot

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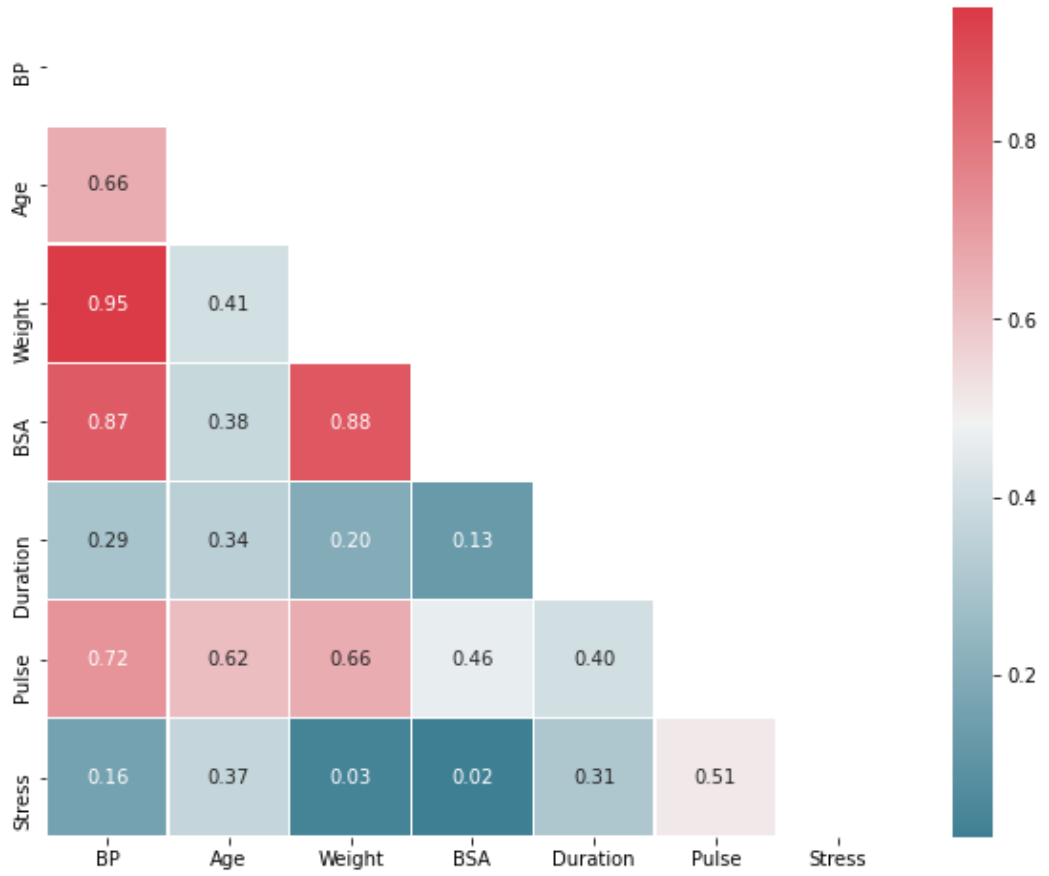

Interpretation: There is a strong positive correlation between blood pressure and age, weight, body surface aread and pulse and considering $\alpha_E = 0.15$ and $\alpha_R = 0.15$.

Stepwise Linear Regression

Regressing y on x_1, regressing y on x_2, regressing y on x_3, regressing y on x_4, regressing y on x_5, regressing y on x_6, we obtain:

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	44.4545	18.728	2.374	0.029	5.109	83.800
Age	1.4310	0.385	3.718	0.002	0.622	2.240

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	2.2053	8.663	0.255	0.802	-15.996	20.406
Weight	1.2009	0.093	12.917	0.000	1.006	1.396

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	112.7200	2.193	51.389	0.000	108.112	117.328
Stress	0.0240	0.034	0.705	0.490	-0.048	0.096

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	109.2350	3.856	28.327	0.000	101.133	117.337
Duration	0.7411	0.570	1.299	0.210	-0.457	1.939

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	42.3231	16.240	2.606	0.018	8.203	76.443
Pulse	1.0298	0.233	4.420	0.000	0.540	1.519

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	45.1833	9.392	4.811	0.000	25.452	64.915
BSA	34.4428	4.690	7.343	0.000	24.589	44.297

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Age, Weight, Body Surface Area and Pulse predictors are candidate to be entered into the stepwise model because each t-test P-value is less than α_E = 0.15. But weight, Body Surface Area and pulse have the least P value and weight has a higher t value which means it has the lower P Value compared to pulse. Thus **we enter Age to our stepwise model.**

Now we fit each of the two-predictor models that include Age as a predictor that is, we regress Weight, BP on Age, Pulse; BP on Age, Duration; BP on Age, BSA. BP on Age, Weight.

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	-16.5794	3.007	-5.513	0.000	-22.925	-10.234
Age	0.7083	0.054	13.235	0.000	0.595	0.821
Weight	1.0330	0.031	33.154	0.000	0.967	1.099

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	16.0037	9.657	1.657	0.116	-4.370	36.378
Age	0.8398	0.199	4.225	0.001	0.420	1.259
BSA	28.6199	3.642	7.859	0.000	20.937	36.303

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	45.9573	19.572	2.348	0.031	4.664	87.250
Age	1.3749	0.420	3.275	0.004	0.489	2.261
Duration	0.1901	0.489	0.388	0.703	-0.842	1.223

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	27.1441	17.654	1.538	0.143	-10.103	64.391
Age	0.7483	0.427	1.752	0.098	-0.153	1.650
Pulse	0.7254	0.281	2.582	0.019	0.133	1.318

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	41.6248	20.081	2.073	0.054	-0.743	83.993
Age	1.5038	0.423	3.553	0.002	0.611	2.397
Stress	-0.0133	0.029	-0.468	0.646	-0.074	0.047

Duration and Stress are not eligible into stepwise model because its t-test P value is greater than 0.15. The predictors weight, BSA and pulse are candidates because each t-test P-value is less than α_E = 0.15. But has the lowest p value as the t value is highest for weight. **As a result of the second step, we enter weight into our stepwise model**.

Now, since Age was the first predictor in the model, we must step back and see if entering weight into the stepwise model affected the significance of the Age predictor. It did not, the t-test P-value for testing $\beta_1 = 0$ is less than 0.001, and thus smaller than α_R = 0.15. **Therefore, we proceed to the third step with both Age and Weight as predictors in our stepwise model.**

Now, we fit each of the three-predictor models that include *Age* and *Weight* as predictors.

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	-13.6672	2.647	-5.164	0.000	-19.278	-8.057
Age	0.7016	0.044	15.961	0.000	0.608	0.795
Weight	0.9058	0.049	18.490	0.000	0.802	1.010
BSA	4.6274	1.521	3.042	0.008	1.403	7.852

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	-16.0949	3.104	-5.185	0.000	-22.676	-9.514
Age	0.6953	0.057	12.280	0.000	0.575	0.815
Weight	1.0312	0.032	32.639	0.000	0.964	1.098
Duration	0.0482	0.062	0.784	0.445	-0.082	0.179

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	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	-16.6900	2.938	-5.681	0.000	-22.917	-10.463
Age	0.7502	0.061	12.350	0.000	0.621	0.879
Weight	1.0614	0.037	28.722	0.000	0.983	1.140
Pulse	-0.0657	0.049	-1.353	0.195	-0.169	0.037

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	-16.1963	3.090	-5.242	0.000	-22.747	-9.646
Age	0.6912	0.059	11.748	0.000	0.566	0.816
Weight	1.0362	0.032	32.518	0.000	0.969	1.104
Stress	0.0027	0.004	0.748	0.465	-0.005	0.010

The predictor Duration, Pulse and Stress are not eligible for entry into the stepwise model because its t-test P-value is greater than $\alpha_E = 0.15$. Our final regression model, based on the stepwise procedure contains only the predictors Age, Weight and BSA .

Now, since Age, Weight were the previous predictor in the model, we must step back and see if entering BSA into the stepwise model affected the significance of the Age and Weight predictor. It did not, the t-test P-value for testing $\beta_1 = 0$ is less than 0.001, and thus smaller than $\alpha_R = 0.15$. **Therefore, we proceed to the third step with Age, Weight and BSA as predictors in our stepwise model.**

OLS Regression Results

Dep. Variable:	BP	R-squared:	0.995
Model:	OLS	Adj. R-squared:	0.994
Method:	Least Squares	F-statistic:	971.9
Date:	Tue, 15 Jun 2021	Prob (F-statistic):	2.62e-18
Time:	19:22:11	Log-Likelihood:	-9.5930
No. Observations:	20	AIC:	27.19
Df Residuals:	16	BIC:	31.17
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Intercept	-13.6672	2.647	-5.164	0.000	-19.278	-8.057
Age	0.7016	0.044	15.961	0.000	0.608	0.795
Weight	0.9058	0.049	18.490	0.000	0.802	1.010
BSA	4.6274	1.521	3.042	0.008	1.403	7.852

Omnibus:	1.164	Durbin-Watson:	1.896
Prob(Omnibus):	0.559	Jarque-Bera (JB):	1.011
Skew:	-0.363	Prob(JB):	0.603
Kurtosis:	2.172	Cond. No.	2.93e+03

Conclusion

In order to determining if a relationship exists between blood pressure and age, weight, body surface area, duration, pulse rate and/or stress level for a group of 20 individuals Stepwise Linear Regression was carried. The scatter plot showed that there is a strong positive correlation between blood pressure and age, weight, body surface area and pulse. Further this is was verified with Pearson's correlation. Stepwise Regression was carried to investigate the factors that help best predict the Blood Pressure. The final model obtained was,
$\hat{y}_i = \boldsymbol{\beta_o} + \boldsymbol{Age_i\beta_1} + \boldsymbol{Weight_i\beta_2} + \boldsymbol{BSA_i\beta_2}$ where i = 1,…,20 β_o is -13.67, coefficient of Age was 0.706,Weight was 0.9058 and Body Surface Area was 4.627.

This means that when Weight and BSA of the individual is held constant BP reduces by 13 mm Hg as Age increases by 0.71 years on average. When Age and Weight is held constant the BP reduces by 13mm Hg as Body Surface Area increases by 4.63 sq m. When Age and BSA is held constant BP reduces by 13 mm Hg as Weight increases by 0.91 kg. The adjusted R^2 value of 99.4 means that 99.4 % f variability in Blood Pressure is explained by the model.

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**************Thank You**************