Honours Welcome Lunch

right after this lecture
in the Psychology courtyard

Senior Undergrad Psychology Student volunteers wanted:

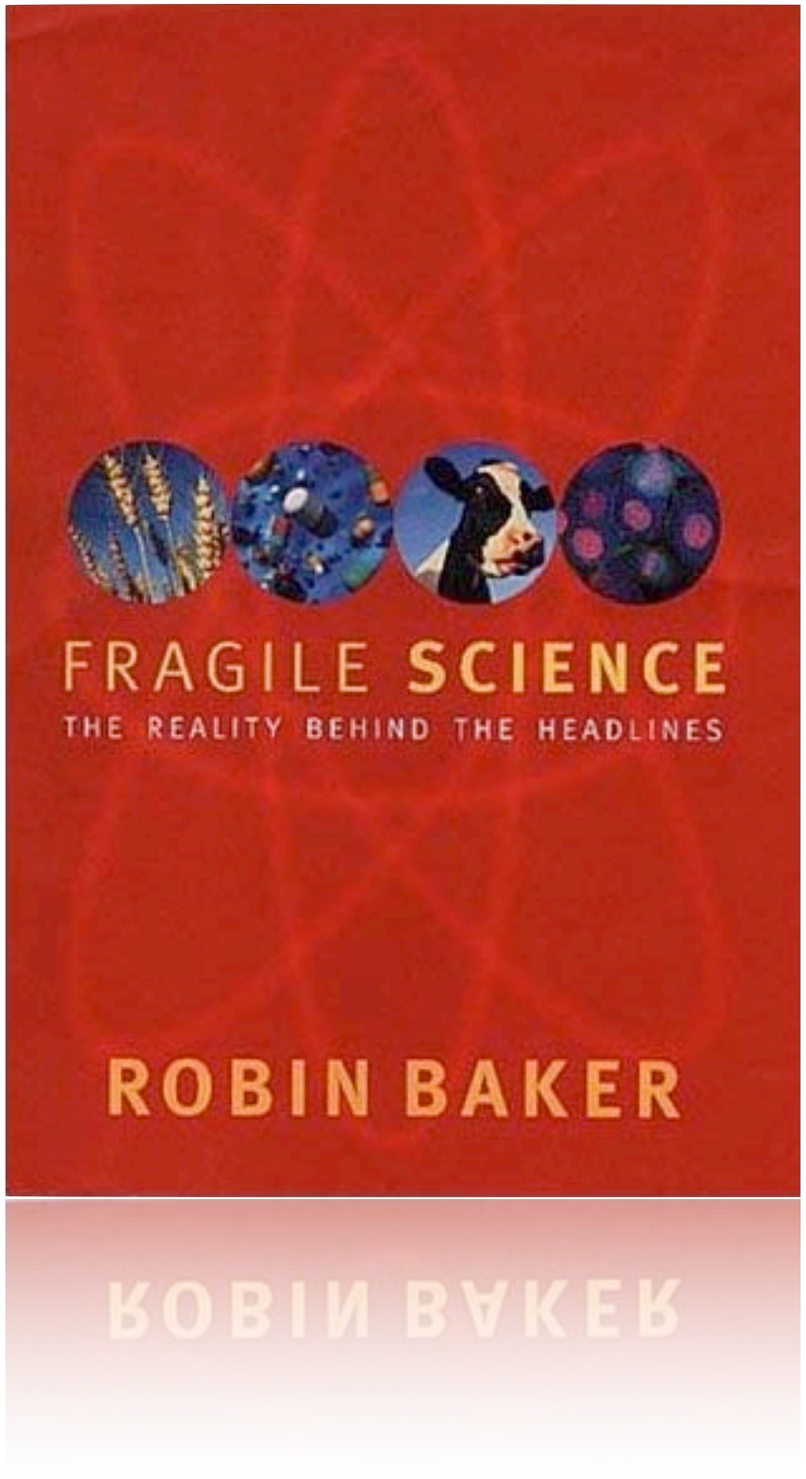
Fun, practical experience. Apply your psychology knowledge.

Conduct psychoeducative street theatre, campus workshops & peer counselling with professional supervision.

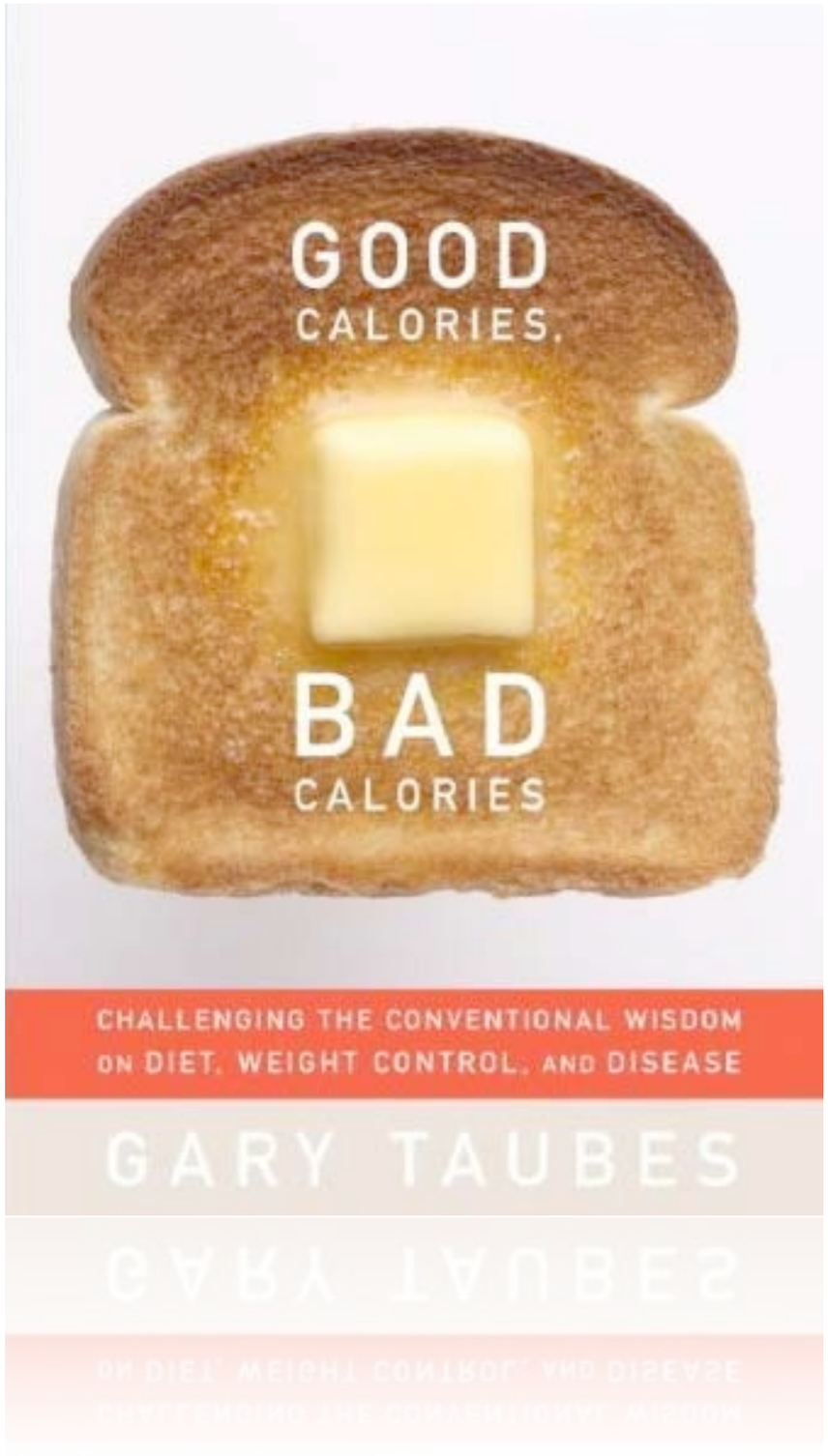
Meet:

Room 317 in the McElwain Building (24A) Thursday 6 & 13 March at 12.00

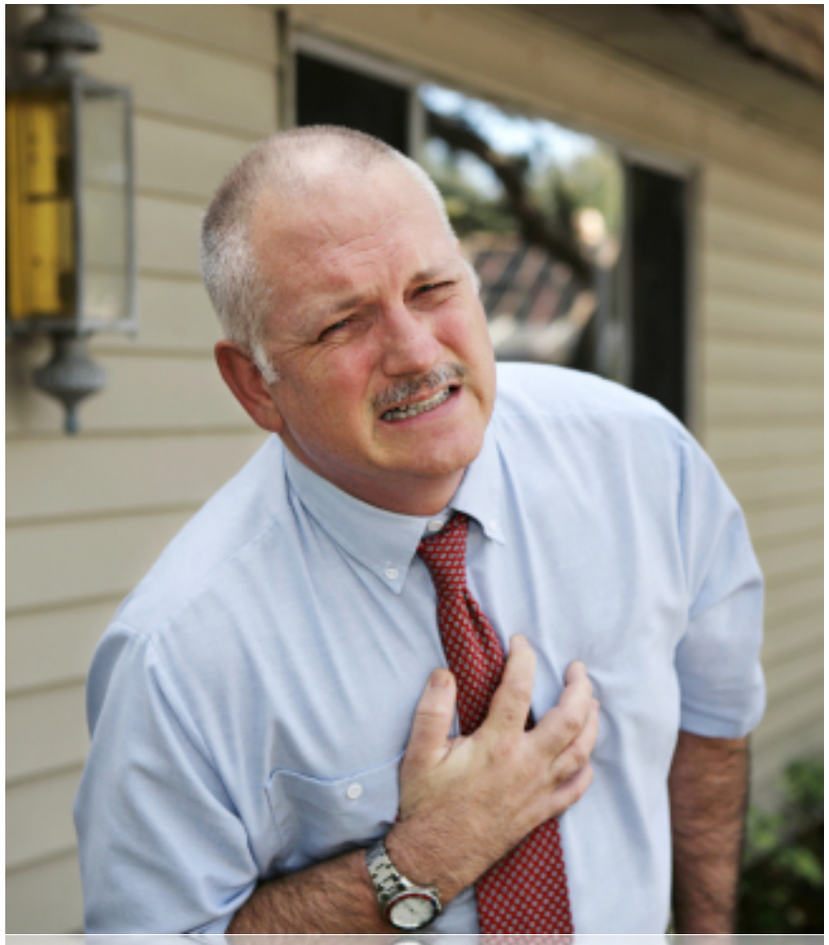
Correlational studies simply aren’t capable of telling us whether sunscreens are a protection or a potential menace.


FRAGILE SCIENCE
THE REALITY BEHIND THE HEADLINES
ROBIN BAKER


The New York Times Magazine
What if Fat Doesn't Make You Fat?
Influential researchers are beginning to embrace the medical heresy that maybe Dr. Atkins was right.
By Gary Taubes


GOOD
CALORIES.
BAD
CALORIES
CHALLENGING THE CONVENTIONAL WISDOM
ON DIET, WEIGHT CONTROL, AND DISEASE
GARY TAUBES

Robin Warren and Barry Marshall



Kurt Cobain's troubled last days

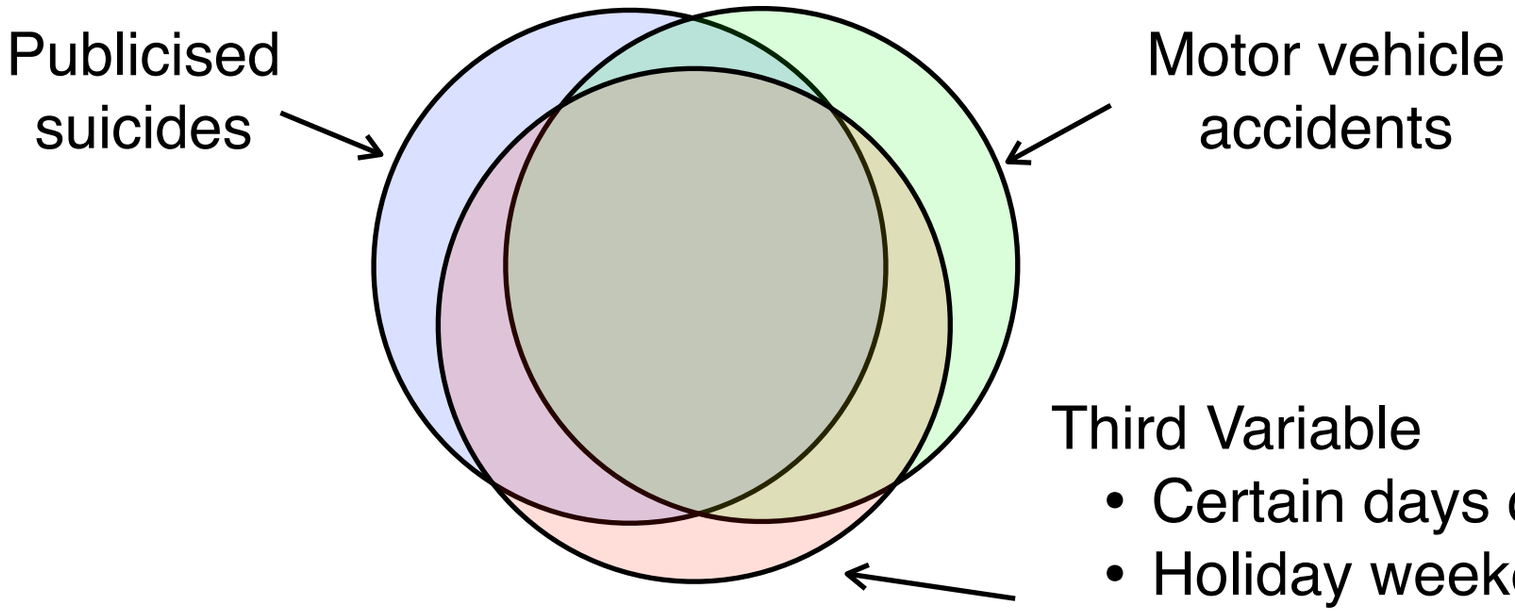
Drugs, guns and threats; and then he disappeared

Phillips (1977) claimed a systematic connection between the dates of widely publicised suicides, and the number of motor vehicle accidents within the 7 day periods following these particular dates.

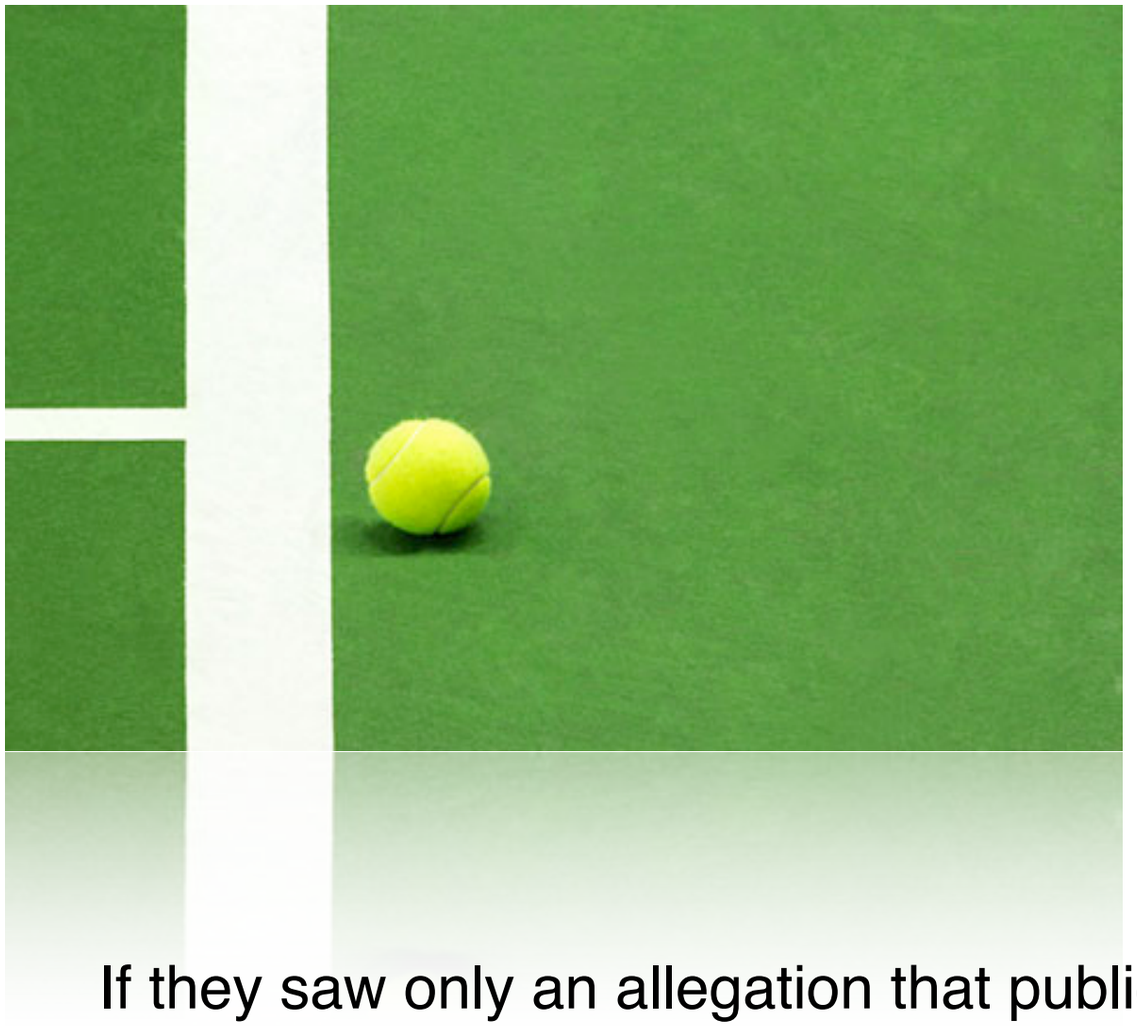
Mechanism: Publicised suicides encourage people with suicidal inclinations to take self-destructive action, one form of which is to deliberately crash a car.

But we should be especially suspicious of correlations between variables over time, because all kinds of events that have nothing to do with each other can co-occur in yearly, monthly, or weekly synchrony:

- Leap years
- Elections
- Betting on sport



- Certain days of the week have more suicides?
- Holiday weekends?
- Any other national/international crisis (e.g., war, terrorism, stock market crash) may result in mass stress, worse driving, and more suicides.



Burden of Proof

Using a tennis metaphor, the toughest critics wouldn't even acknowledge that the ball was in their court.

If they saw only an allegation that publicised suicides were systematically followed by traffic accidents, they would call the researcher's shot out of bounds, and not respond until the opponent produced a better serve.

The investigator would be better off presenting a *signature* – a bundle of evidence consistent with the hypothesis, and inconsistent with other explanations.

For example, Phillips (1986) found that suicides that received heavier publicity were followed by more automobile fatalities and fatal traffic accidents tended to be confined to cases with a lone driver.

These results begin to fill in a signature characterising a genuine link.

Important concepts so far...

- The importance of linear composites in multivariate analysis
  - a linear composite is a weighted ‘average’ of the variables
  - forming a linear composite reduces many variables to one
- Variances (and sums of squares) can be partitioned

Important concepts so far...

- Correlation is the basis for multivariate methods.
- One view of data analysis is that we are trying to model our data by using linear composites
  - Residuals give information on the lack of fit between model and data

Major questions answered by multiple regression

Question 1: Is there an overall relationship between the two predictors and the criterion?

Question 2: Is there a relationship between each *individual* predictor and the criterion? What is the relative importance of each predictor?

Question 1: Is there an overall relationship between the two predictors and the criterion?

- **Question 1A**: Strength of relationship

  How strong is the relationship between $X_1 \ldots X_p$ and Y?

  Consider the correlation between Y' and Y (i.e., the multiple correlation between the predictors and the criterion).

  $R^2 =$ the squared multiple correlation between the predictors and criterion.

  $\frac{Var_{regression}}{Var_{total}} = R^2$ represents the proportion of variance of the criterion that can be predicted by knowing $X_1 \ldots X_p$

  $1 - R^2$ represents the *lack of fit* of the model to the data.

Question 1: Is there an overall relationship between the two predictors and the criterion?

- **Question 1B**: Statistical significance

  So we've described the *strength* of the overall relationship with R^2 but is the strength of this overall relationship significantly different than no overall relationship at all?

  The null hypothesis is: $H_0 : R^2 = 0$

  ...which indicates that there is no predictable variance. What we know about one variable tells us nothing about the others.

  We test the null hypothesis using an F statistic:

$$F = \frac{MS_{regression}}{MS_{residual}} \ (df = p, N - p + 1)$$

$N =$ Sample size

$p =$ Number of potential independent variables: $X_1, X_2, \ldots X_p$

Question 2: Is there a relationship between each *individual* predictor and the criterion? What is the relative importance of each predictor?

1. Simple correlations
2. Standardised regression weights
   - significance testing
   - confidence intervals
3. Semipartial correlations
4. Partial correlations
5. Relative weights

From Tabachnick & Fidell (page 132):

	MOTIV	*QUAL*	*GRADE*	*COMPR*
MOTIV	1.00000	0.39658	0.37631	0.58613
QUAL	0.39658	1.00000	0.78329	0.73284
GRADE	0.37631	0.78329	1.00000	0.75043
COMPR	0.58613	0.73284	0.75043	1.00000

Let's delete the rating of qualifications for admissions to graduate training (QUAL) for convenience (so we only have to deal with 2 independent variables).

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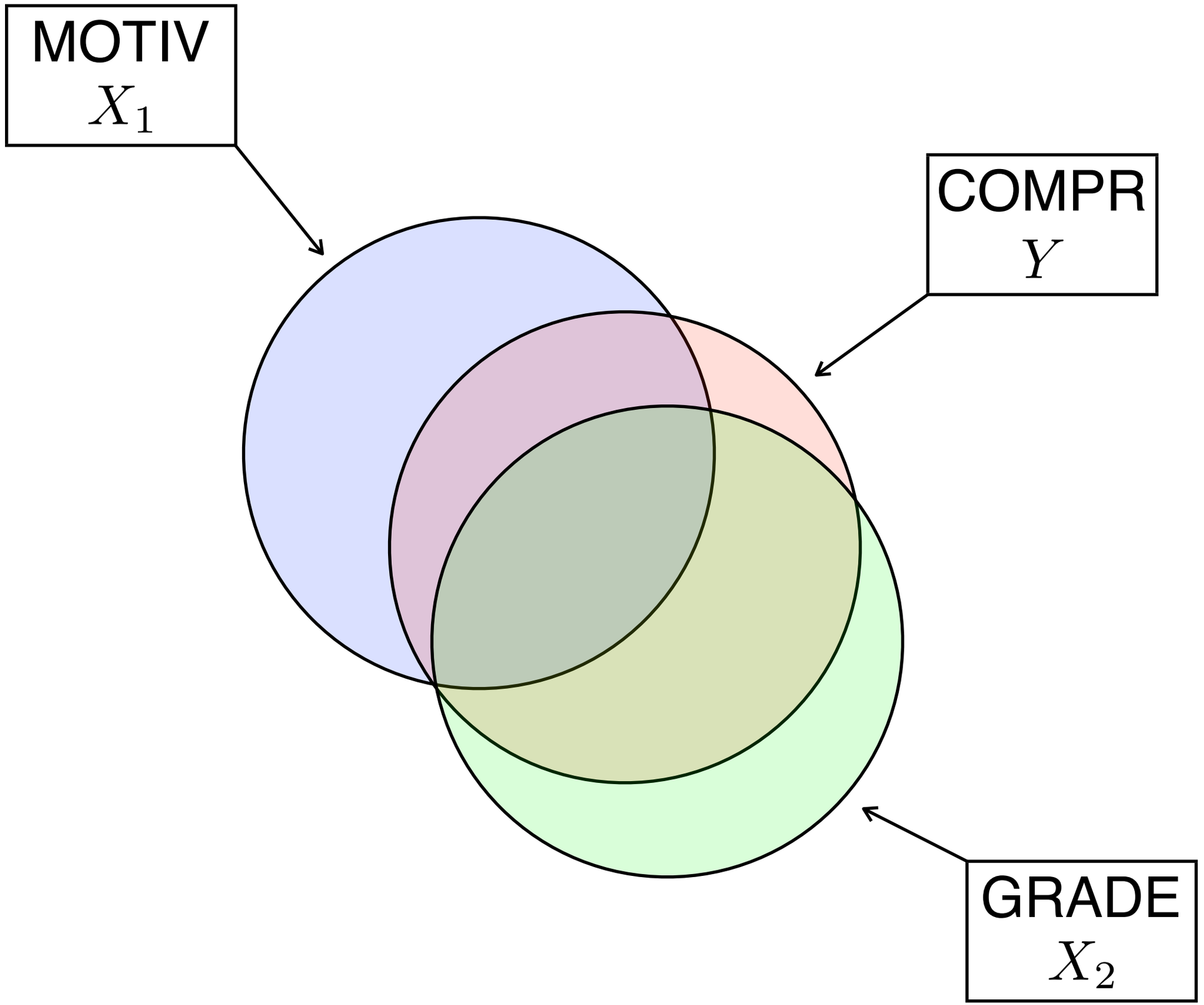
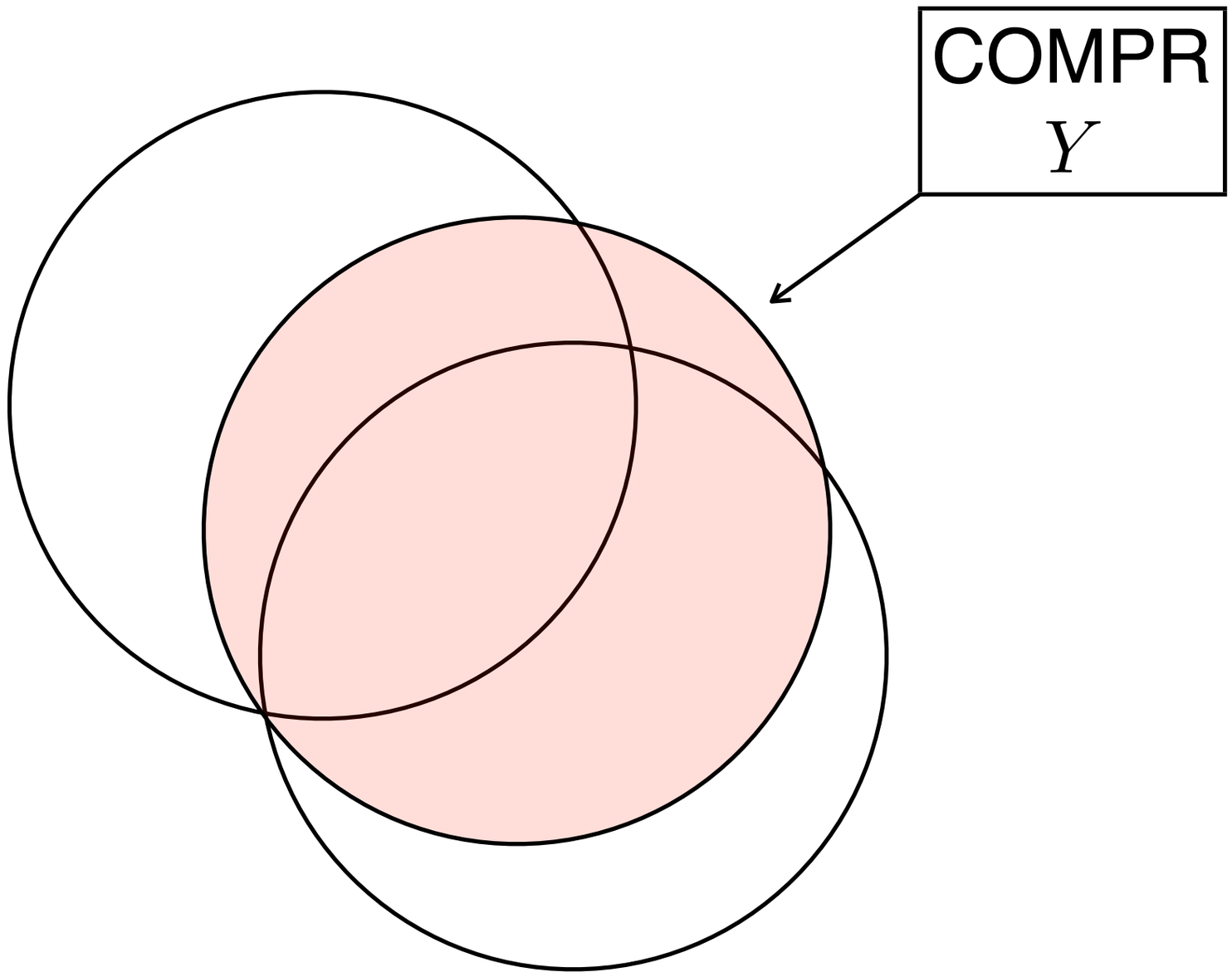
		X_1	X_2	Y
		MOTIV	*GRADE*	*COMPR*
X_1	*MOTIV*	1.00000	0.37631	0.58613
X_2	*GRADE*	0.37631	1.00000	0.75043
Y	*COMPR*	0.58613	0.75043	1.00000

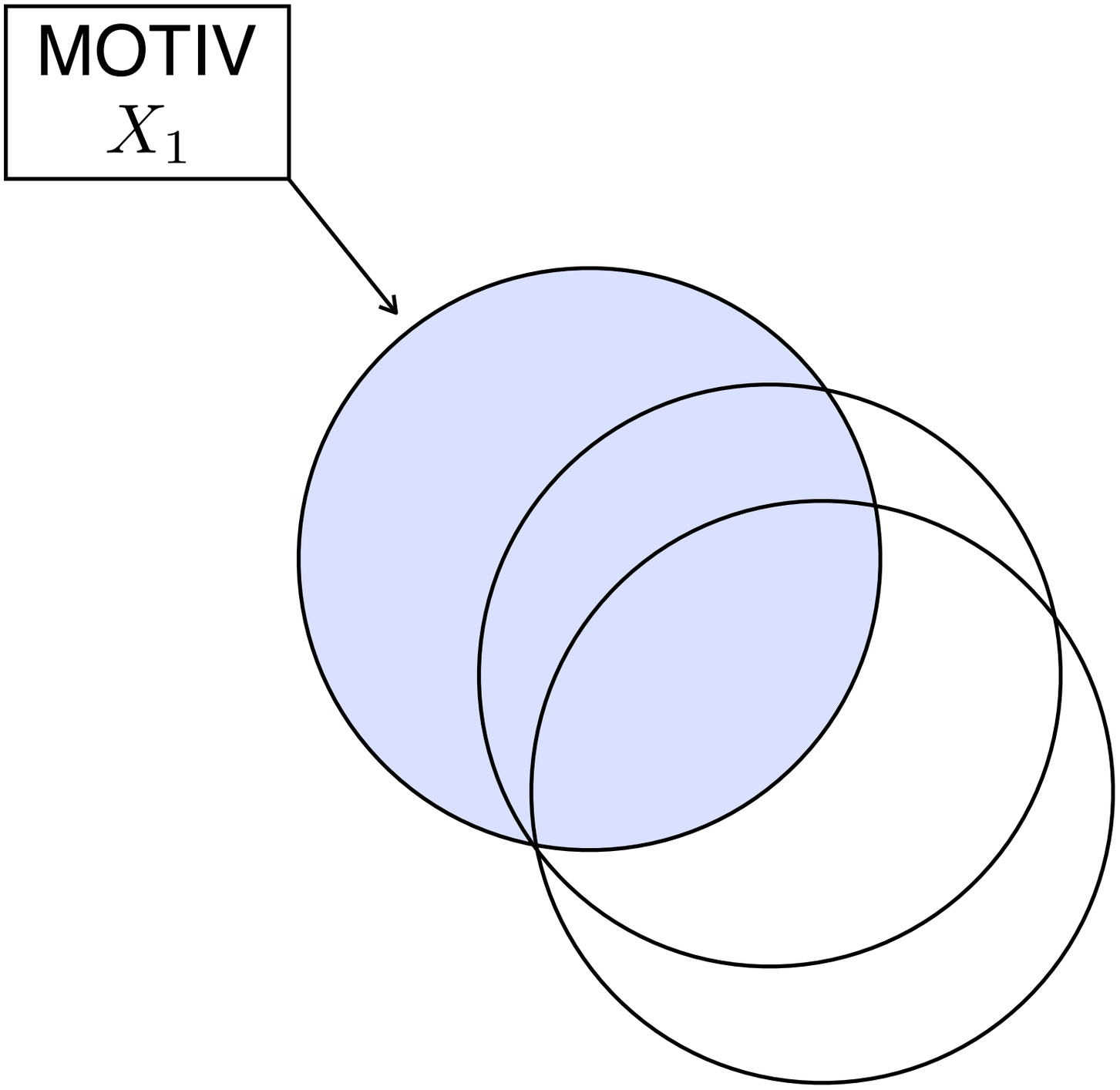
		X_1	X_2	Y
		MOTIV	*GRADE*	*COMPR*
X_1	*MOTIV*	1.00000	r_{12}	r_{y1}
X_2	*GRADE*		1.00000	r_{y2}
Y	*COMPR*			1.00000

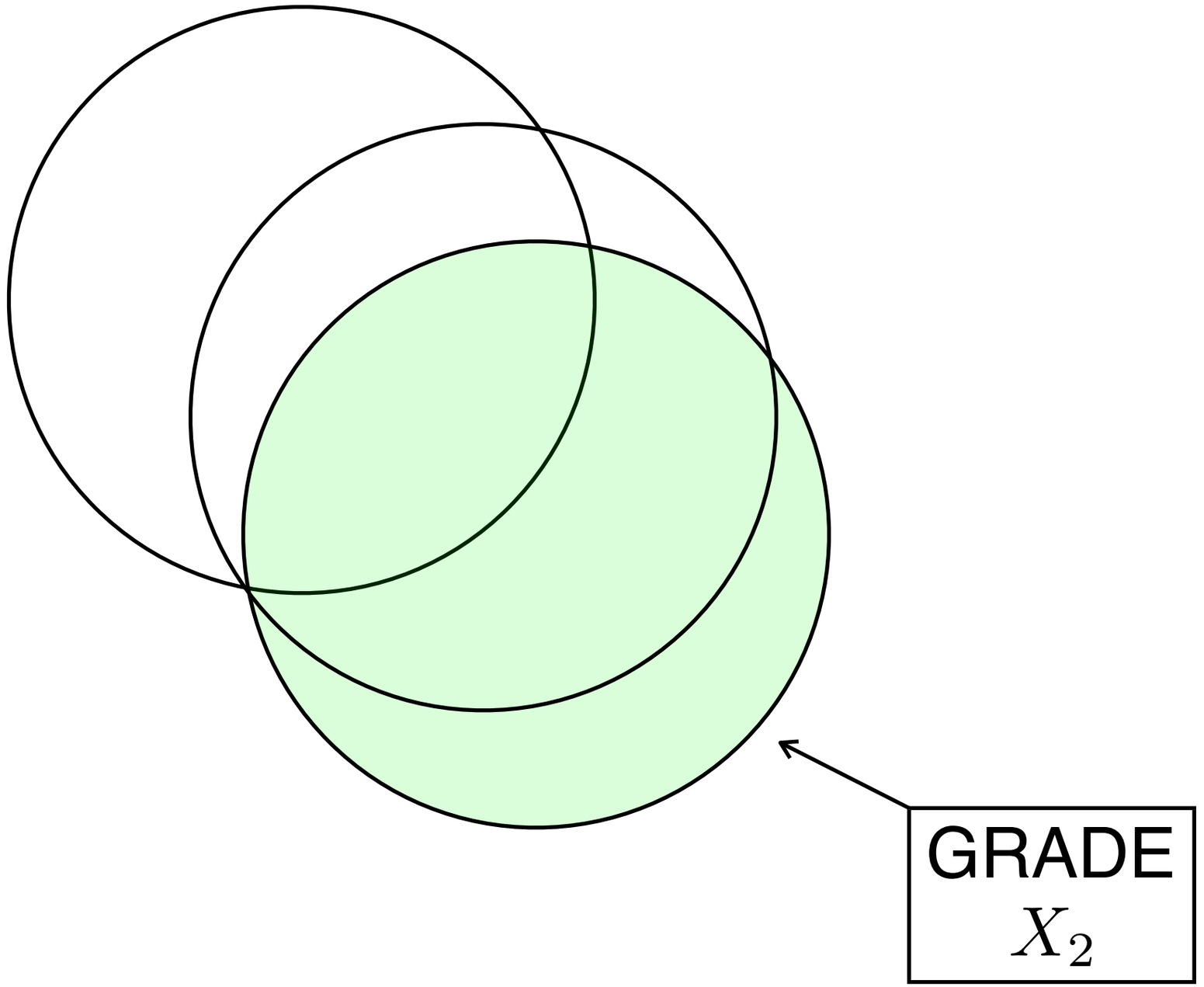
Let’s see how well we can predict performance on graduate comprehensive exams (COMPR) from measures of professional motivation (MOTIV) and performance in graduate courses (GRADE).

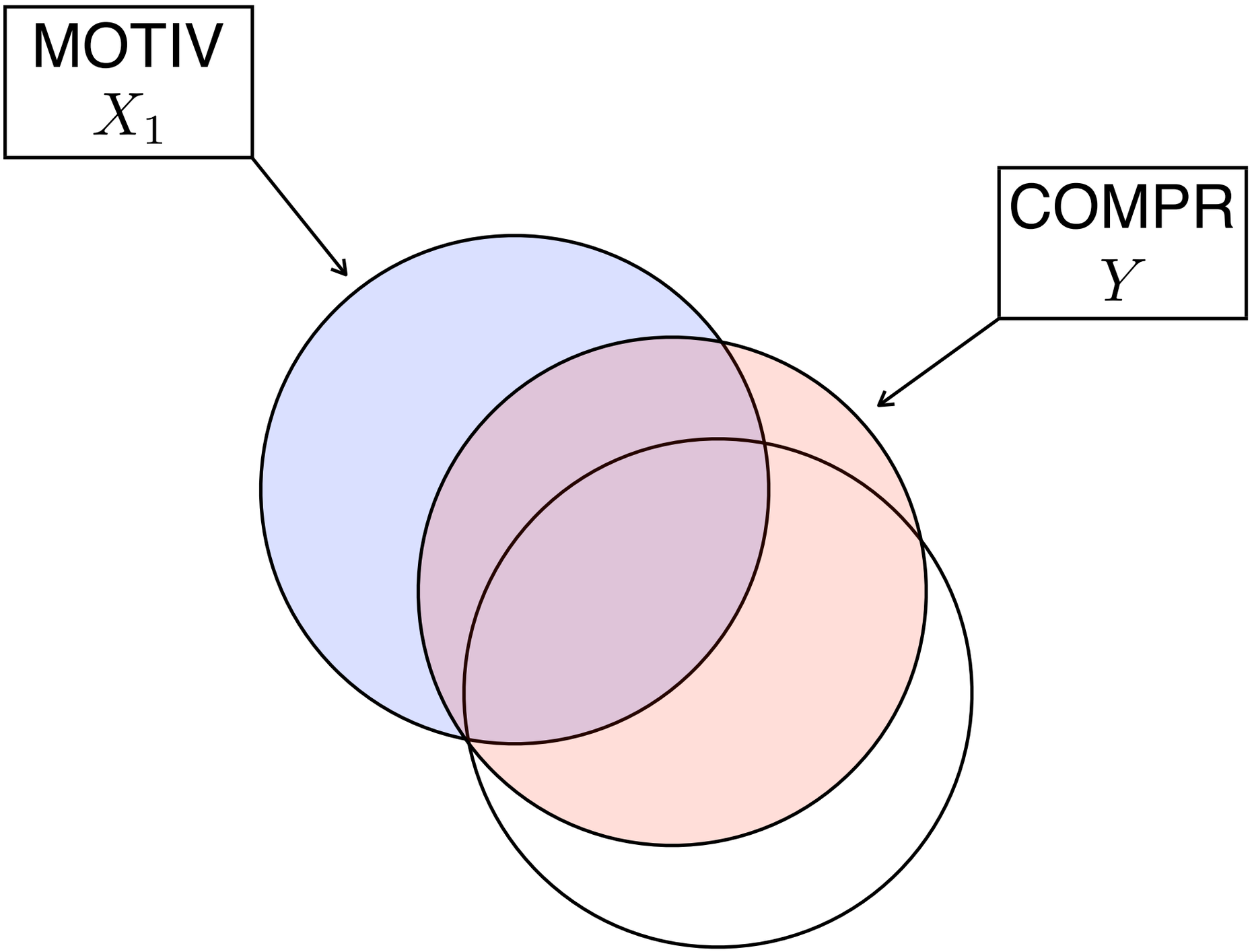
COMPR	$\leftarrow$	MOTIV	GRADE
Y	$\leftarrow$	X_1	X_2

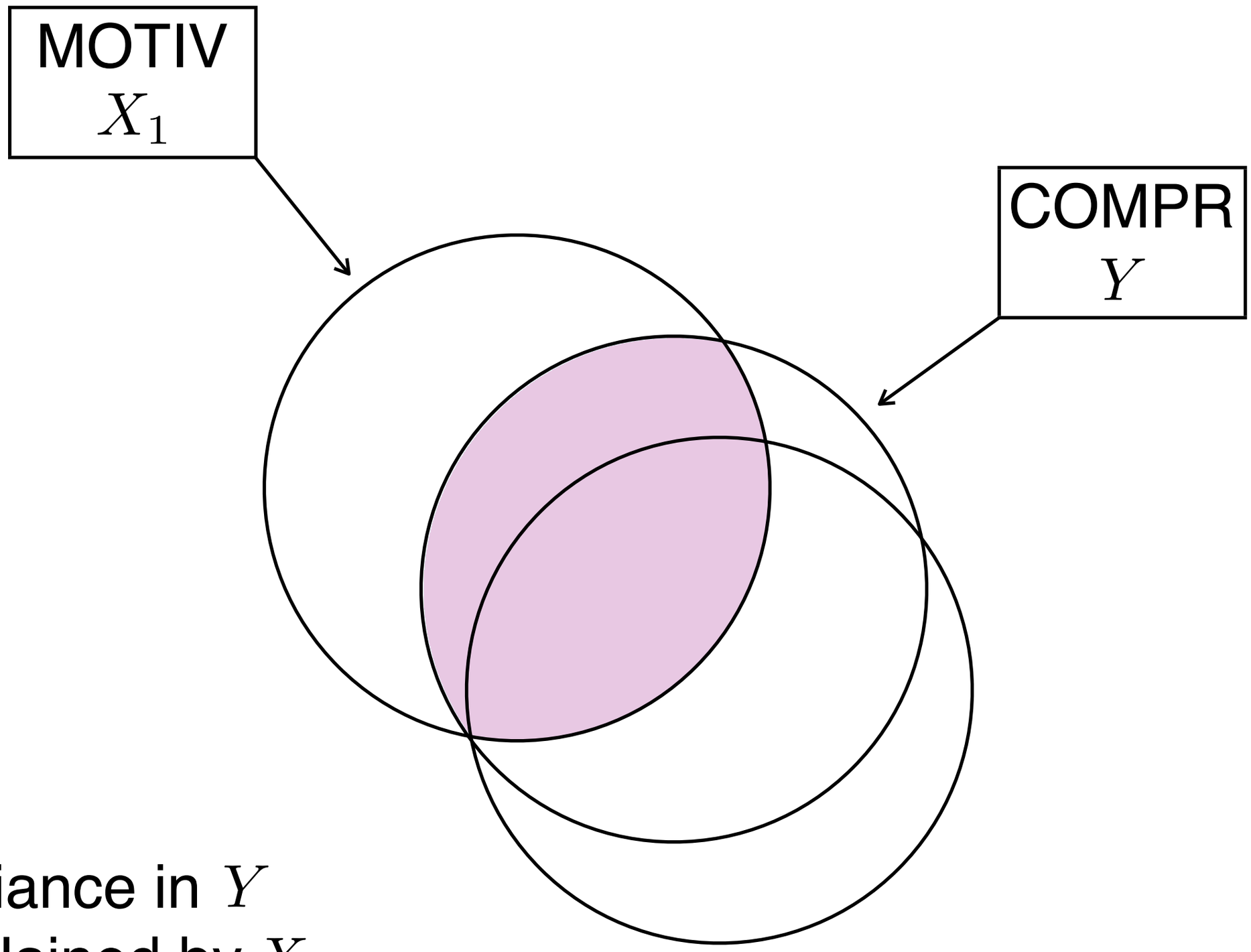

MOTIV
X_1
COMPR
Y
GRADE
X_2


COMPR
Y

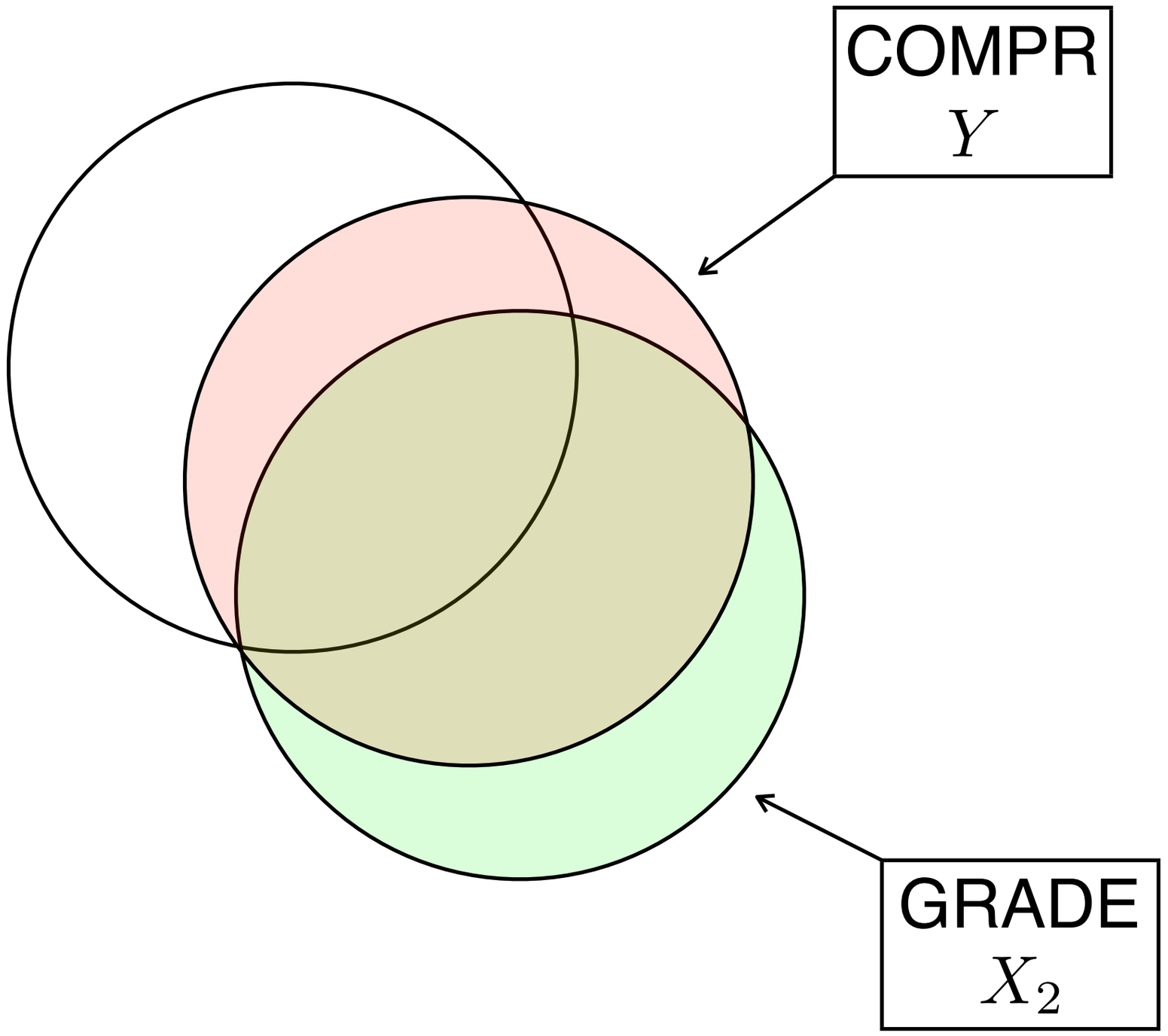

MOTIV
X_1

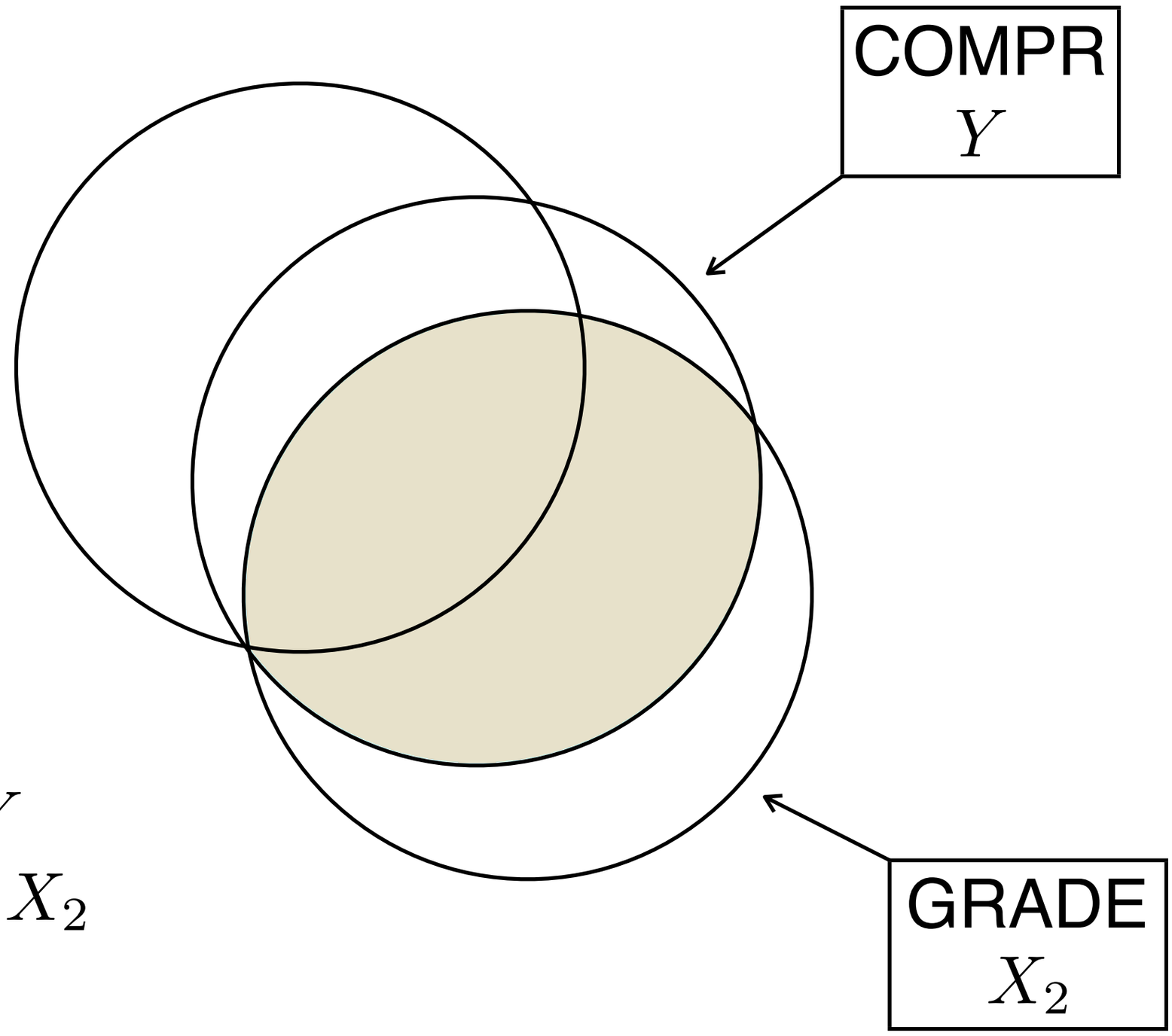

GRADE
X_2


MOTIV
X_1
COMPR
Y

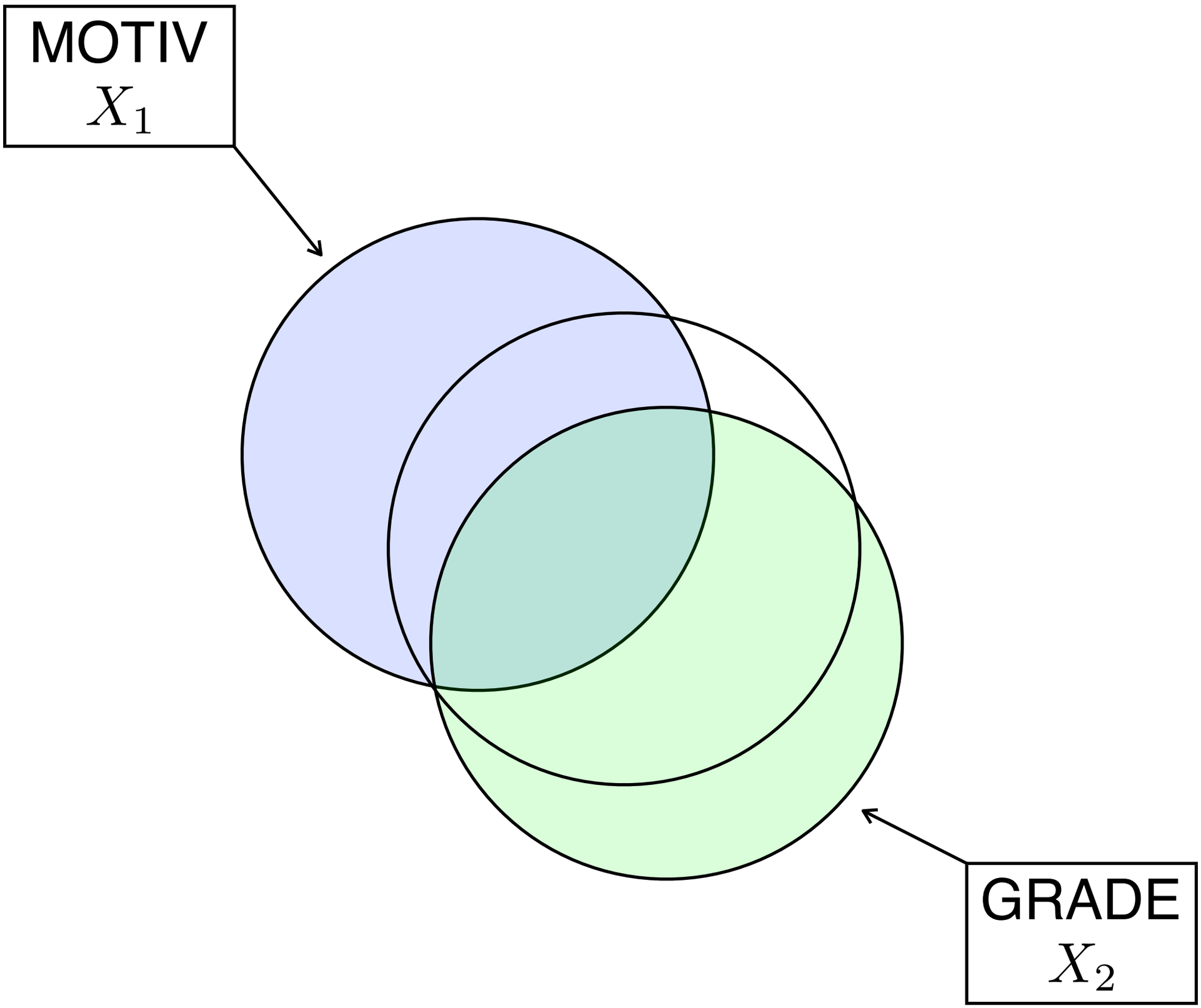


Variance in Y
explained by X_1

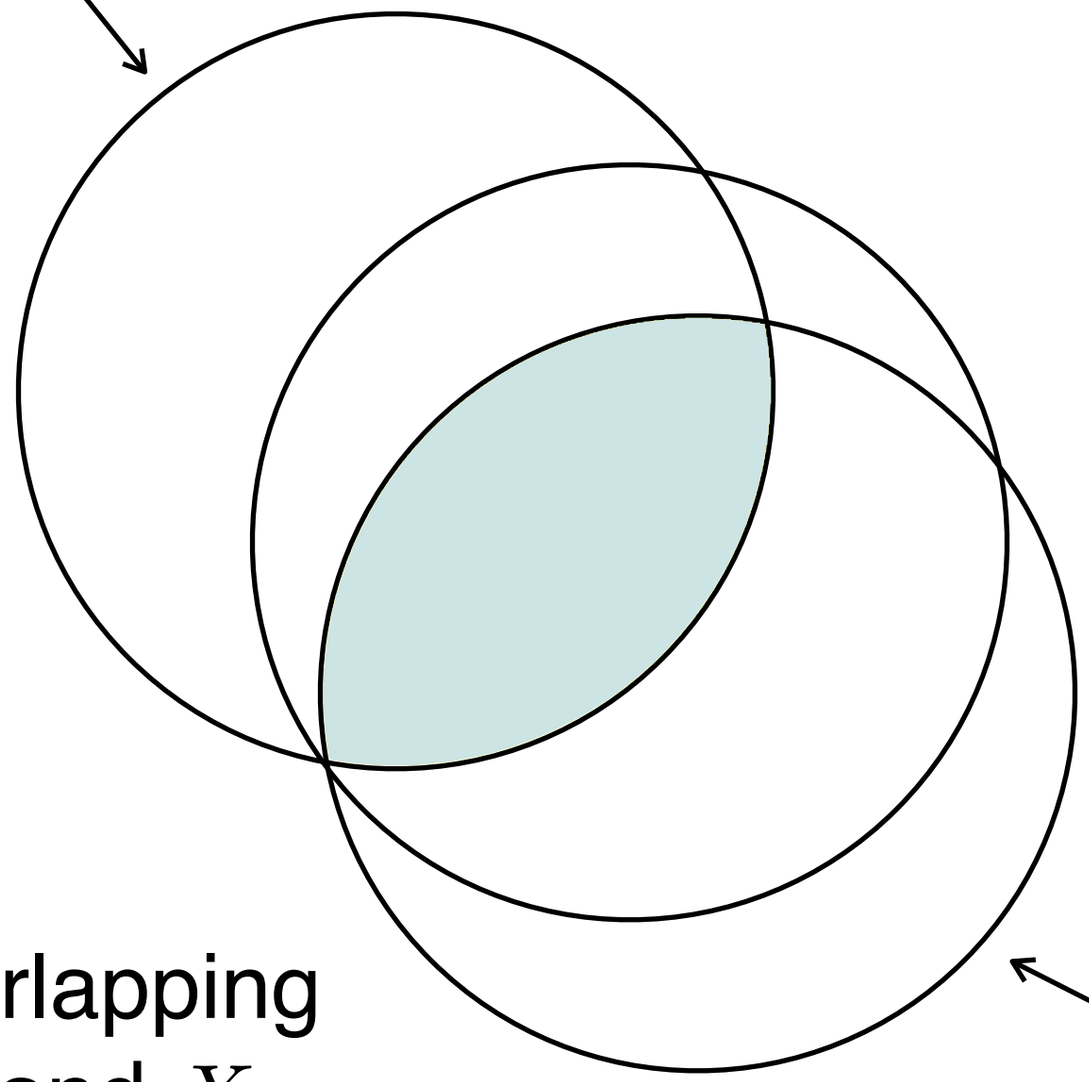

COMPR
Y
GRADE
X_2



Variance in Y
explained by X_2

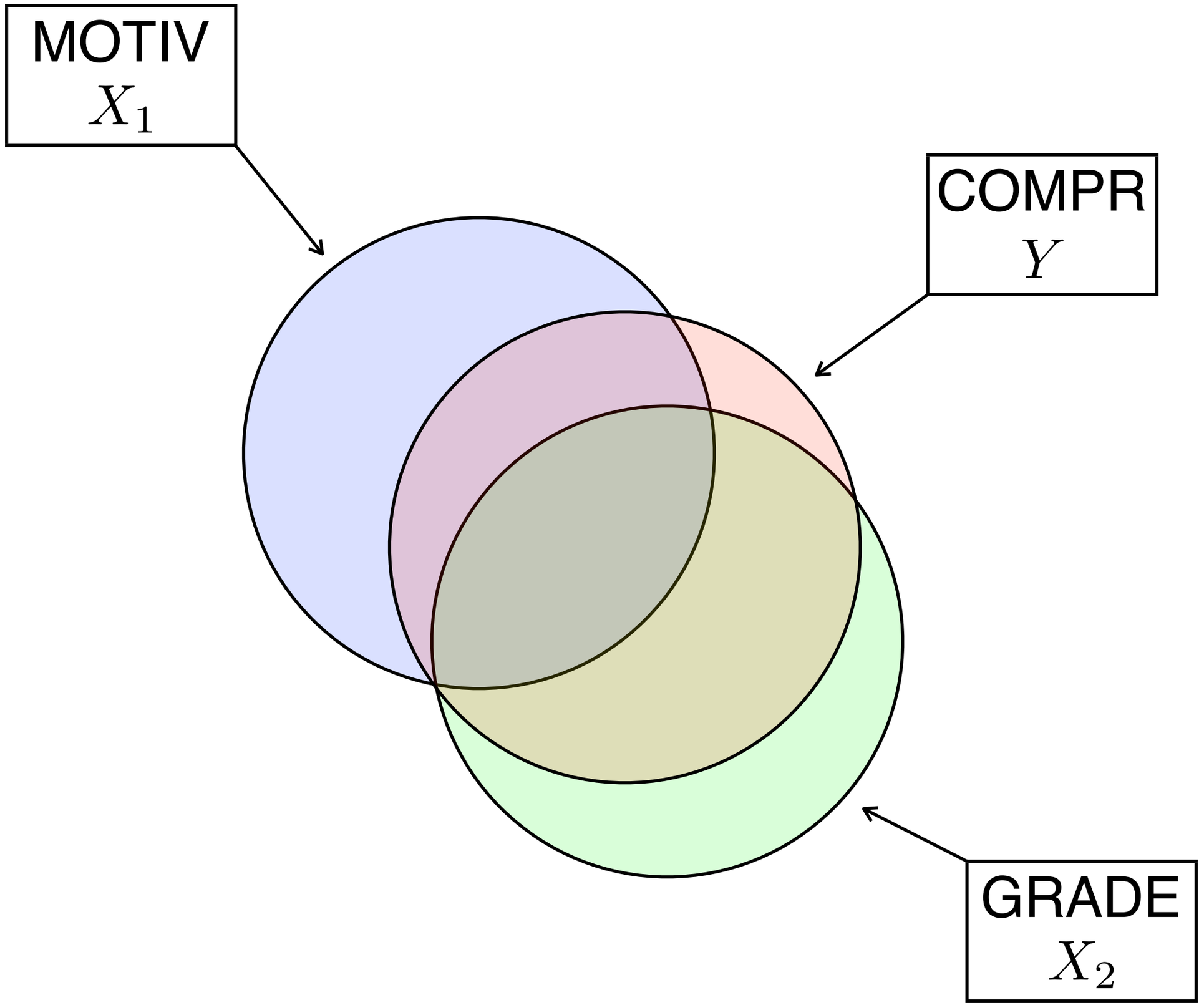

MOTIV
X_1
GRADE
X_2

MOTIV
X_1

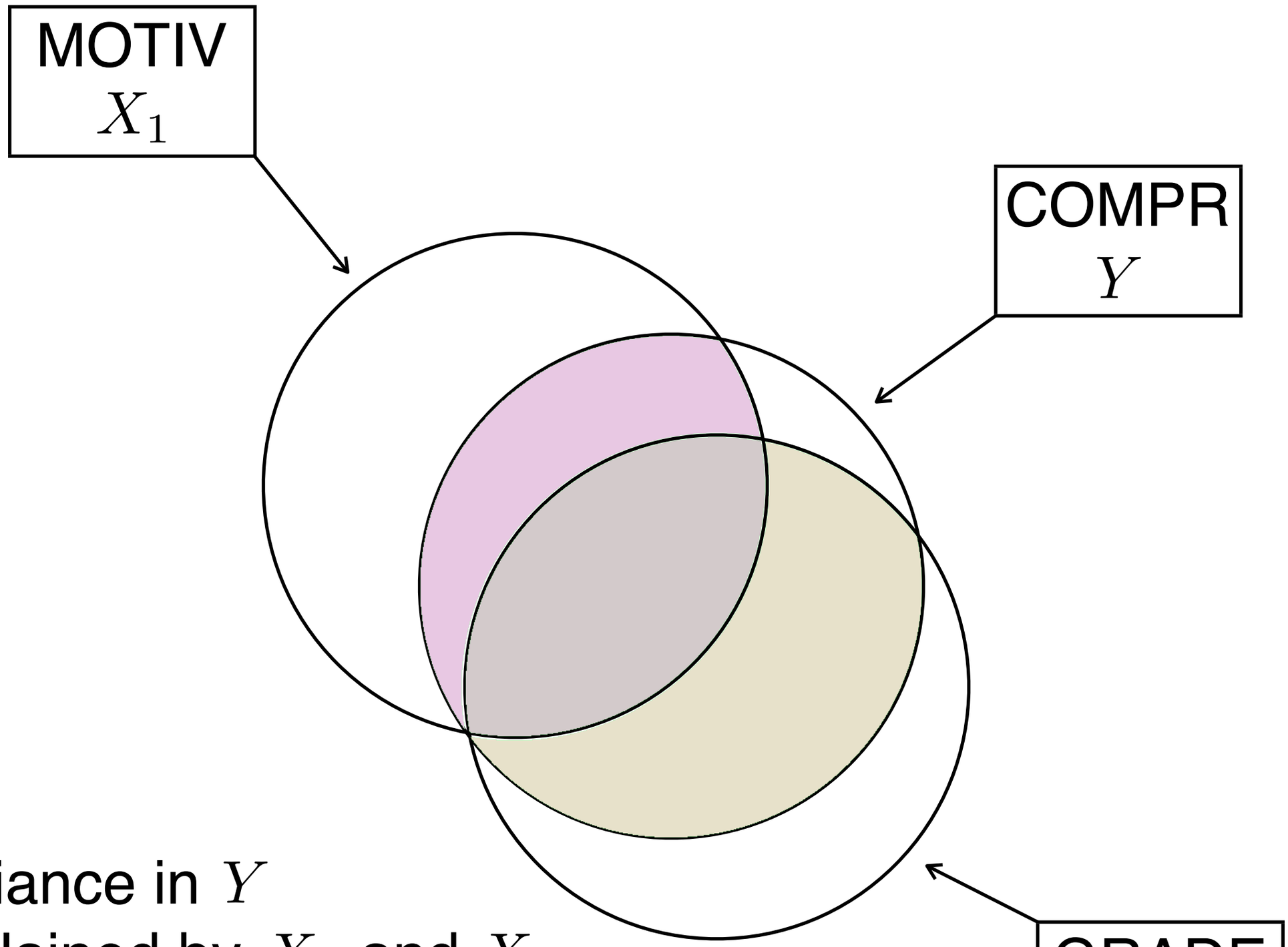


GRADE
X_2

Variance overlapping between X_1 and X_2

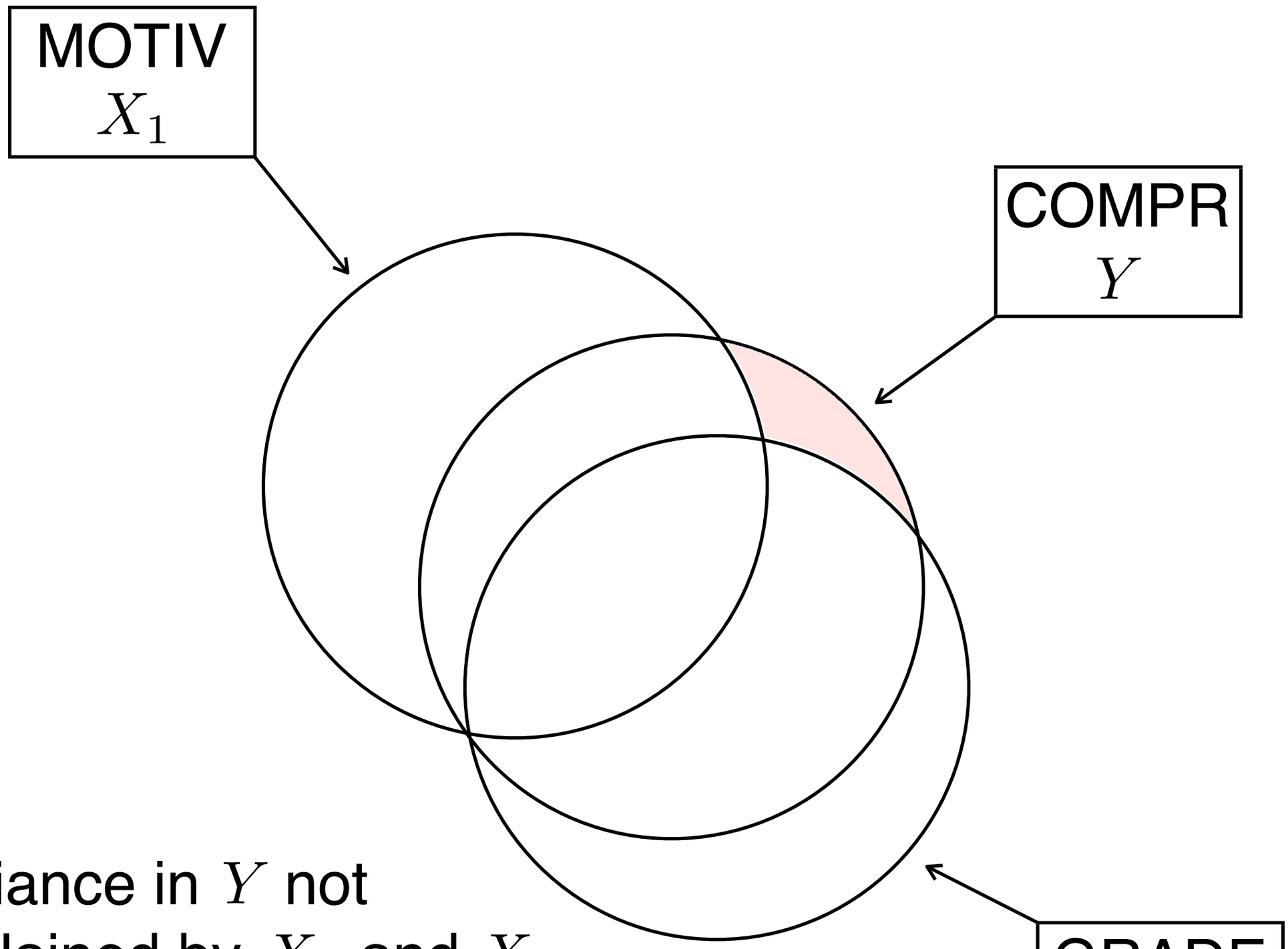

MOTIV
X_1
COMPR
Y
GRADE
X_2

Question 1A: Strength of relationship



Variance in Y
explained by X_1 and X_2

*This is R^2



Variance in Y not explained by X_1 and X_2

*This is $1 - R^2$

Hypothesis testing of the size of R^2 using an F-statistic:

$$H_0 : R^2_{pop} = 0$$

$$F_{p,N-p-1} = \frac{R^2/p}{(1-R^2)/(N-p-1)}$$

$$= \frac{MS_{reg}}{MS_{residual}}$$

$$MS_{reg} = \frac{SS_{reg}}{p} \qquad MS_{residual} = \frac{SS_{residual}}{N-p-1}$$

Question 2: Is there a relationship between each *individual* predictor and the criterion? What is the relative importance of each predictor?

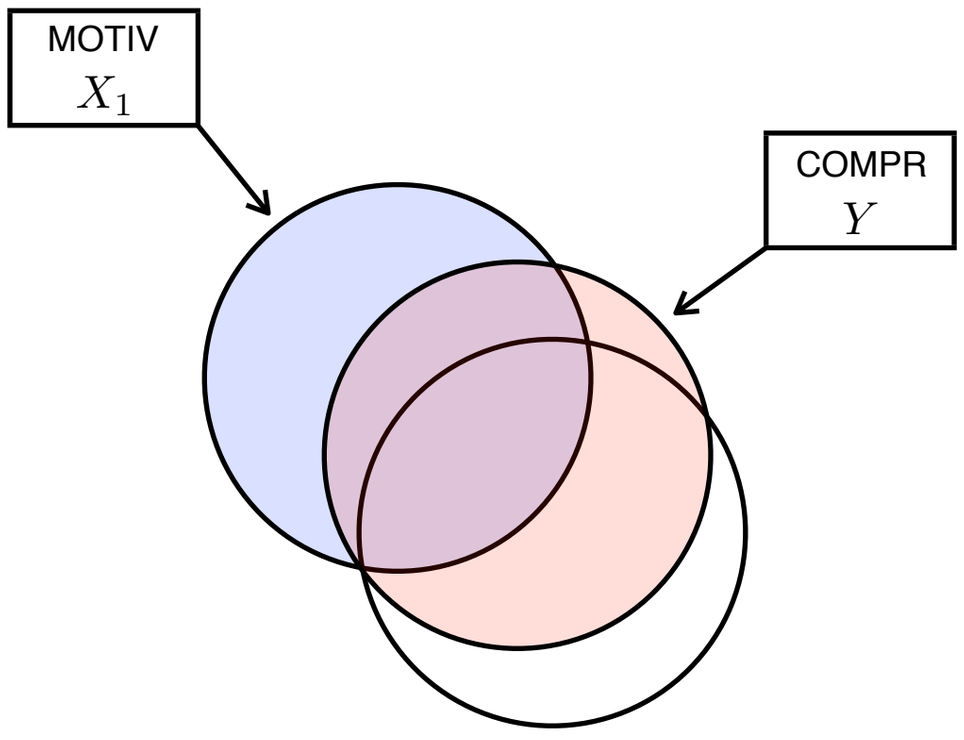
With only a single predictor, $Y \leftarrow X$, there is only one variable so its statistical significance and r^2 indicates the importance of the variable. However once there are two or more predictors, then there are at least five measures of the relative importance of the predictors. We will use the two predictor case as the example since it's easier in the formulae to see what each measure of relative importance is doing.

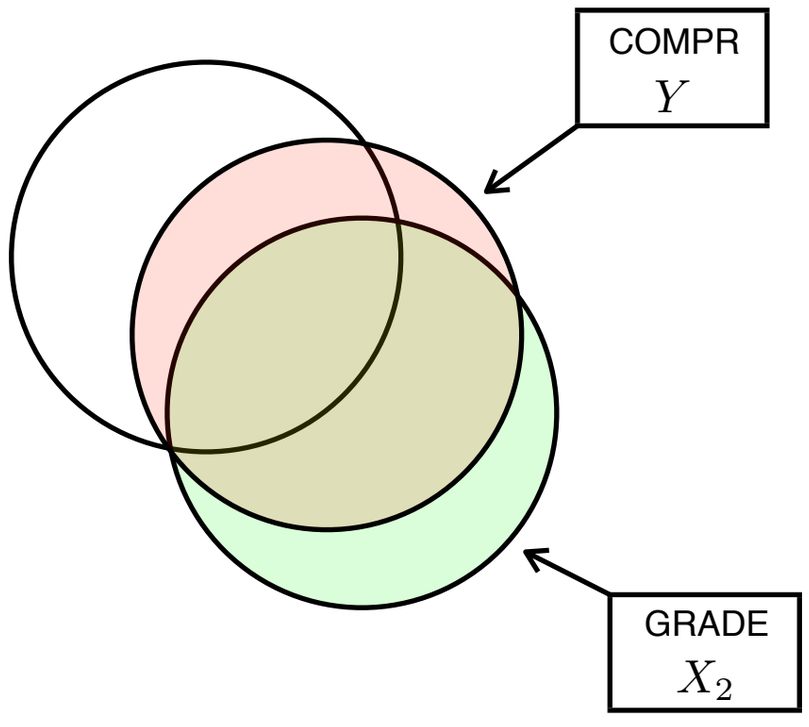
1. Simple correlations
2. Standardised regression weights
   - significance testing
   - confidence intervals
3. Semipartial correlations
4. Partial correlations
5. Relative weights

1. Simple Correlations (r)

- Measure the strength of the relationship between each predictor and the criterion.
- Note: these do not take into account the correlation between the predictors.

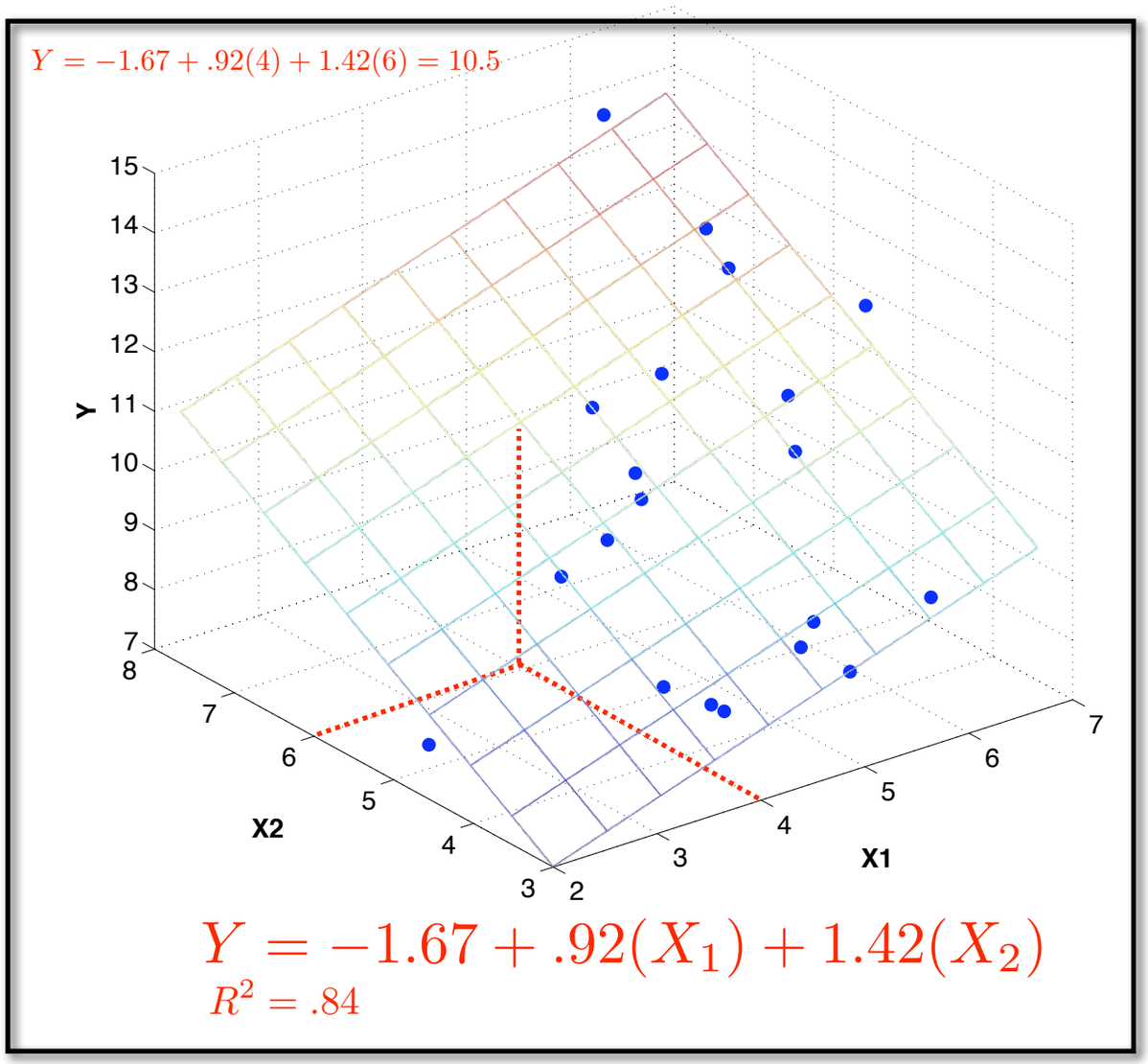
$$r_{y1} \leftrightarrow r_{y2}$$





2. Standardised regression weights (β)

- The standardised version of the slope of the regression equation (b)



$$Y_i = a + b_1 X_{1i} + b_2 X_{2i} + e_i$$

2. Standardised regression weights (β)

- The standardised version of the slope of the regression equation (b)
- A measure of the relationship between the predictor and the criterion which is *corrected* for the correlation between the predictors:

$$\beta_1 = \frac{r_{y1} - r_{y2}r_{12}}{1 - r_{12}^2} \qquad \beta_2 = \frac{r_{y2} - r_{y1}r_{12}}{1 - r_{12}^2}$$

$$\beta_1 = \frac{.59 - (.75)(.38)}{1 - .38^2} = .354 \qquad \beta_2 = \frac{.75 - (.59)(.38)}{1 - .38^2} = .617$$

- Each regression weight can be tested for statistical significance using a t statistic.

2. Standardised regression weights (β)

Significance testing of b and β

- Each regression weight can be tested for statistical significance using the t statistic.

$$H_0 : b_{i(pop)} = 0$$

$$t = \frac{b_i - b_{i(pop)}}{SE_{b_i}} = \frac{b_i - b_{i(pop)}}{\sqrt{MS_{res} / \left(\sum X_i^2 (1 - r_{12}^2)\right)}}$$

- Is the unstandardised regression coefficient significantly different than zero?

2. Standardised regression weights (β)

Confidence intervals for b and β

- provides a range of values which are likely to include the "true" population value of a regression weight.
- a wider confidence interval indicates a less trustworthy estimate of the weight
- a confidence interval which spans zero indicates a non-significant weight

2. Standardised regression weights (β)

Confidence intervals for b and β

A Confidence Interval =

Sample Value $\pm$ Critical Value $\times$ Sample Standard Error

A $(1-\alpha)\%$ Confidence Interval for b_i =

$$b_i \pm t_{N-p-1,\alpha/2} \times SE_{b_i}$$

A $(1-\alpha)\%$ Confidence Interval for β_i =

$$\beta_i \pm t_{N-p-1,\alpha/2} \times SE_{\beta_i}$$

$$.617 \pm 3.182 \times .37$$

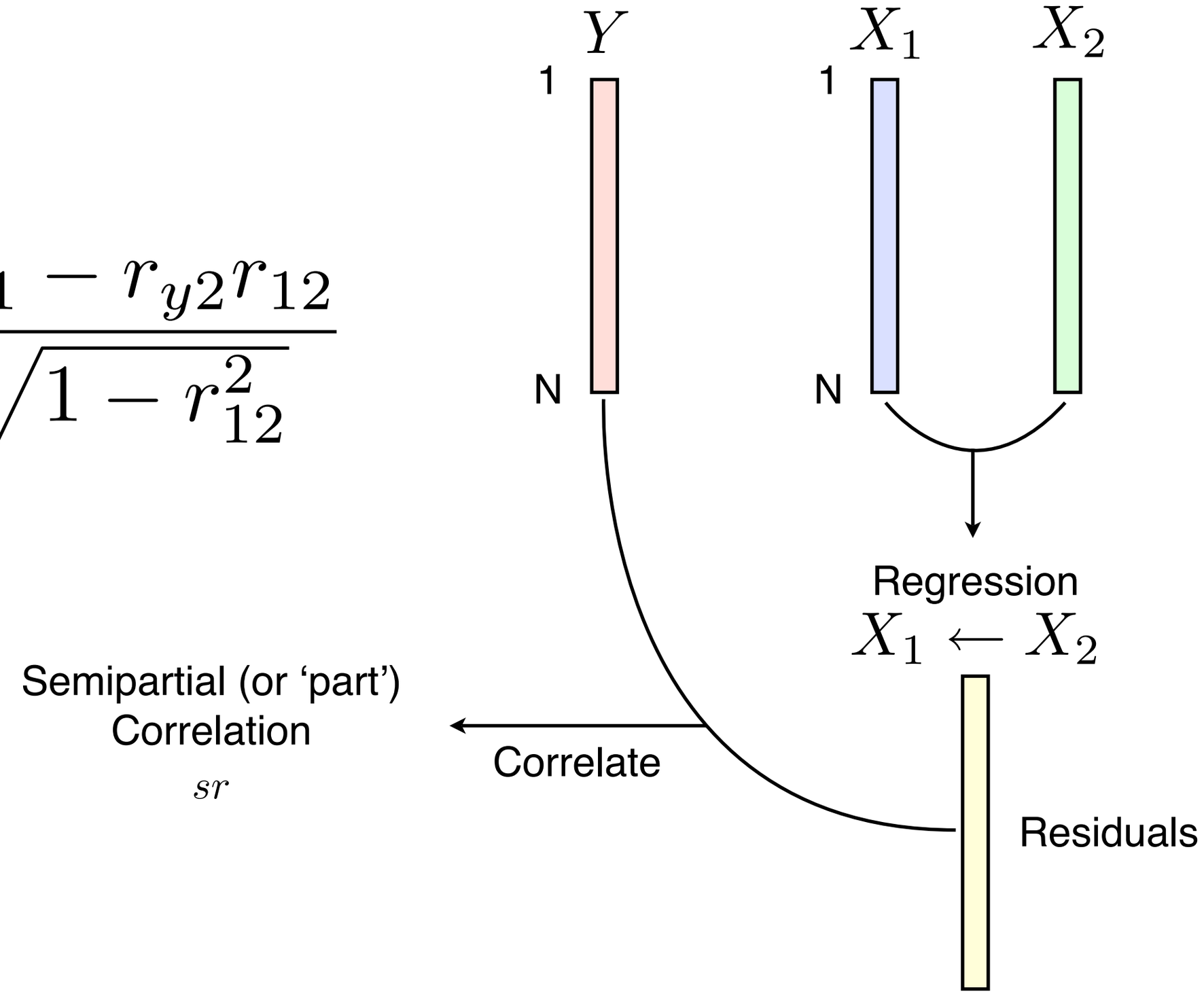
$$= -.56 \leftrightarrow 1.79$$

3. Semipartial (or 'part') correlations (sr)

- Another measure of the relationship between the predictor and the criterion corrected for the correlation between the predictors
- Uses a different correction to the one used by beta weights.
- sr^2 gives the proportion of variance in Y which is uniquely explained by the predictor (the "usefulness" of the predictor)

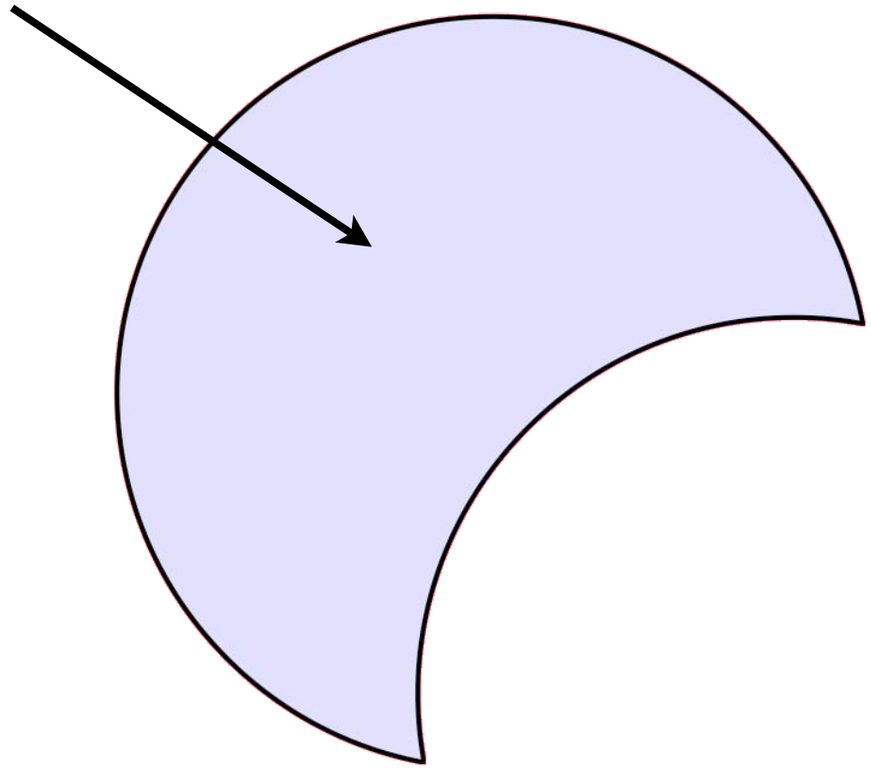
3. Semipartial (or ‘part’) correlations (sr)

$$sr_1 = \frac{r_{y1} - r_{y2}r_{12}}{\sqrt{1 - r_{12}^2}}$$



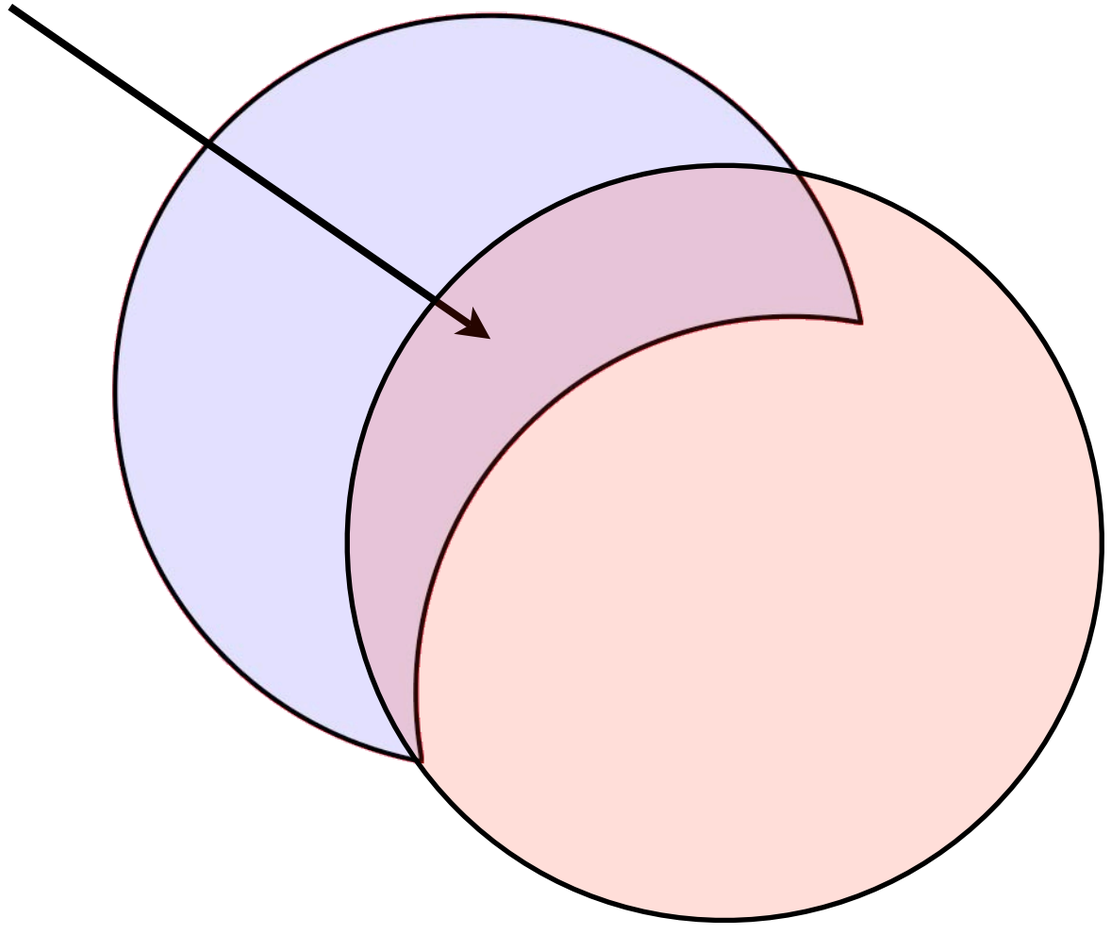
3. Semipartial (or 'part') correlations (sr)

X_1 with the effect of X_2 removed



3. Semipartial (or 'part') correlations (sr)

Relationship between the remainder of X_1 and Y after the effect of X_2 has been removed.

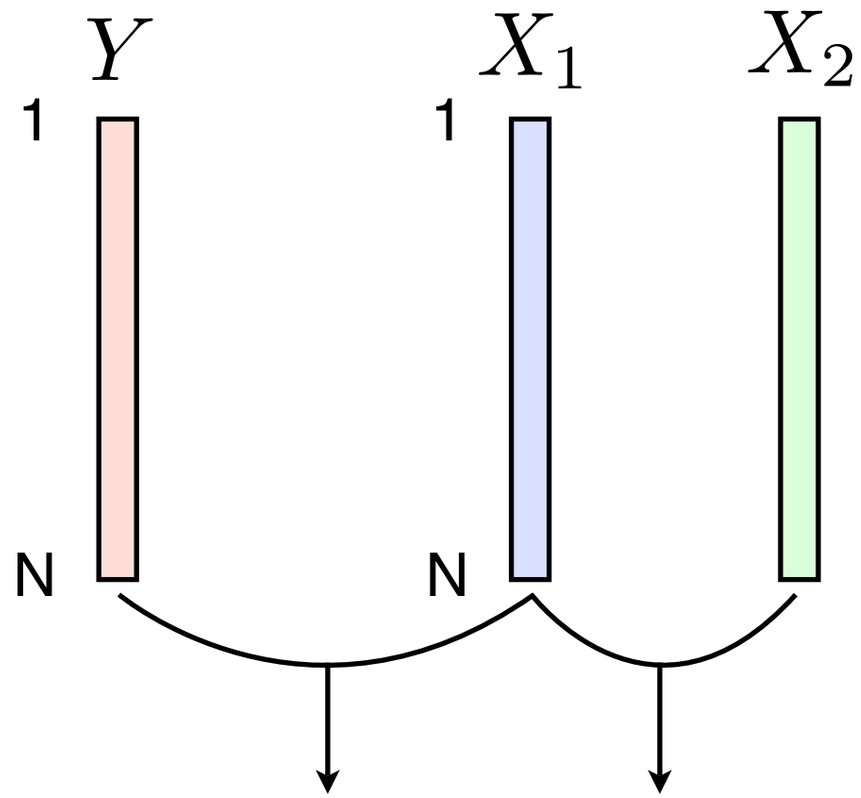


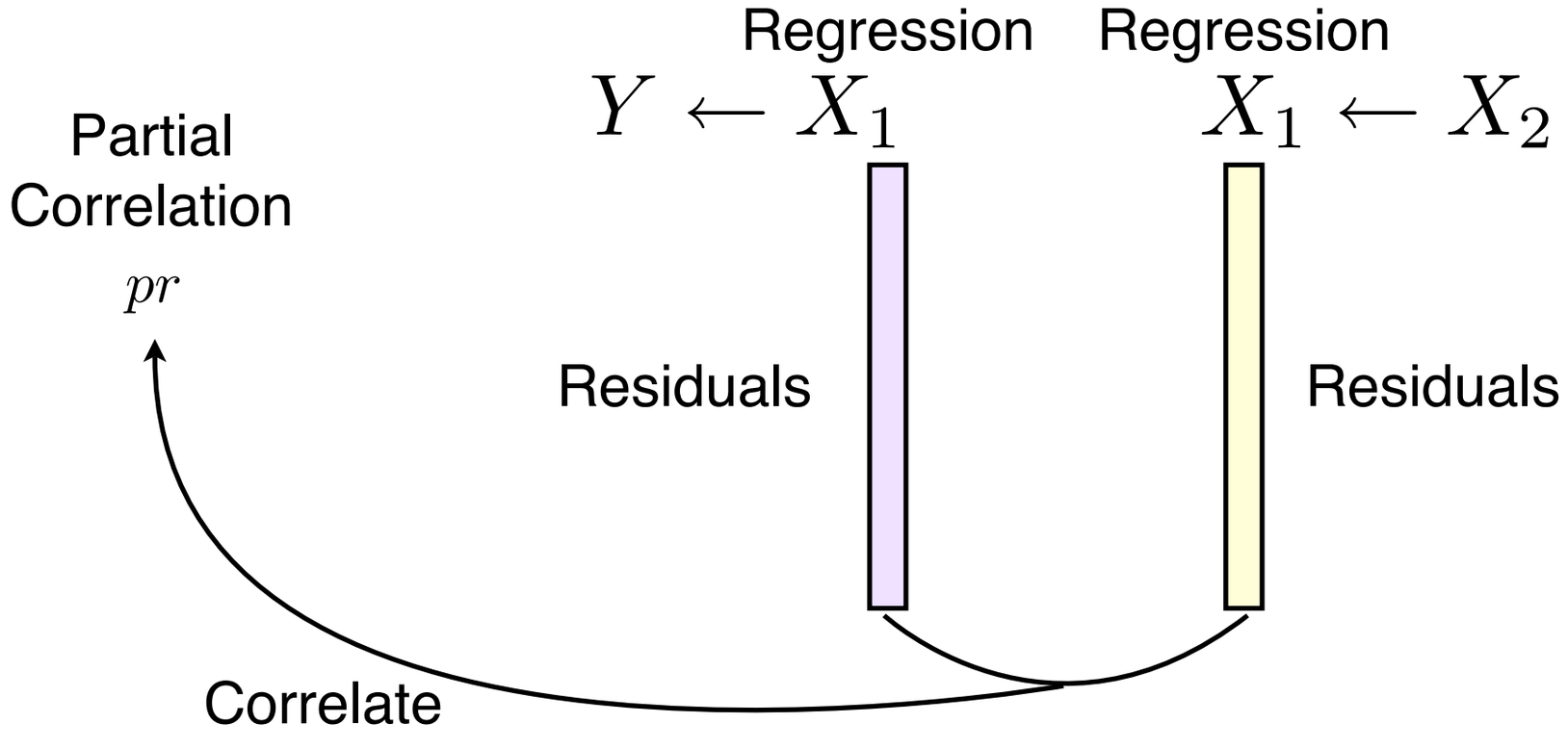
4. Partial correlations (pr)

- Yet another measure of the relationship between the predictor and the criterion corrected for the correlation between the predictors
- Uses a different correction to the ones used by beta weights and semipartials

4. Partial correlations (pr)

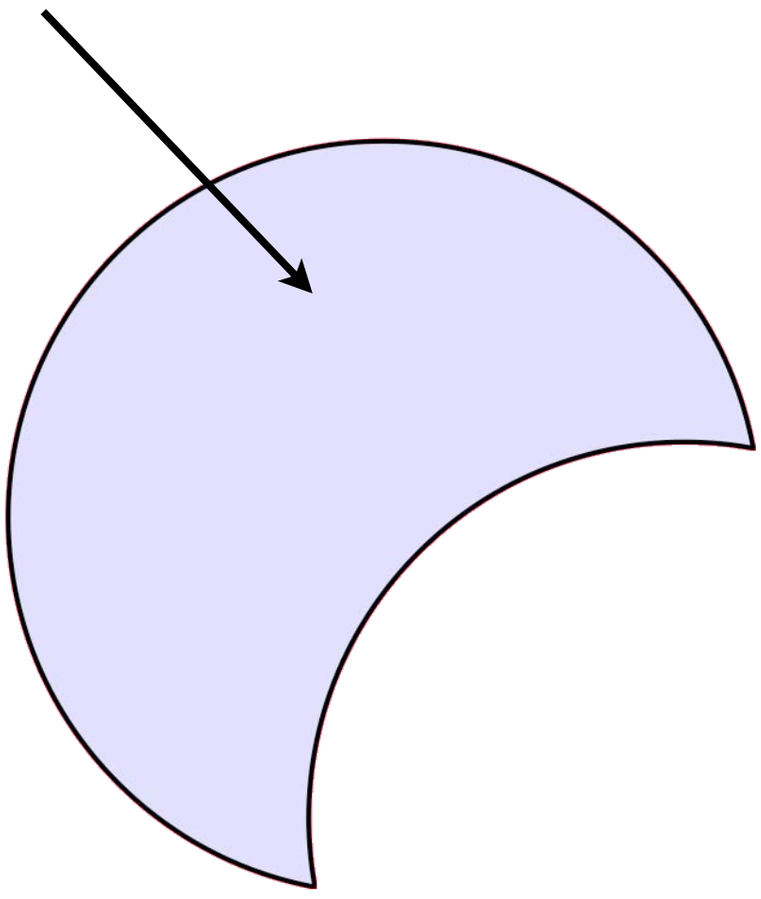
$$pr_1 = \frac{r_{y1} - r_{y2}r_{12}}{\sqrt{1 - r_{y2}^2}\sqrt{1 - r_{12}^2}}$$



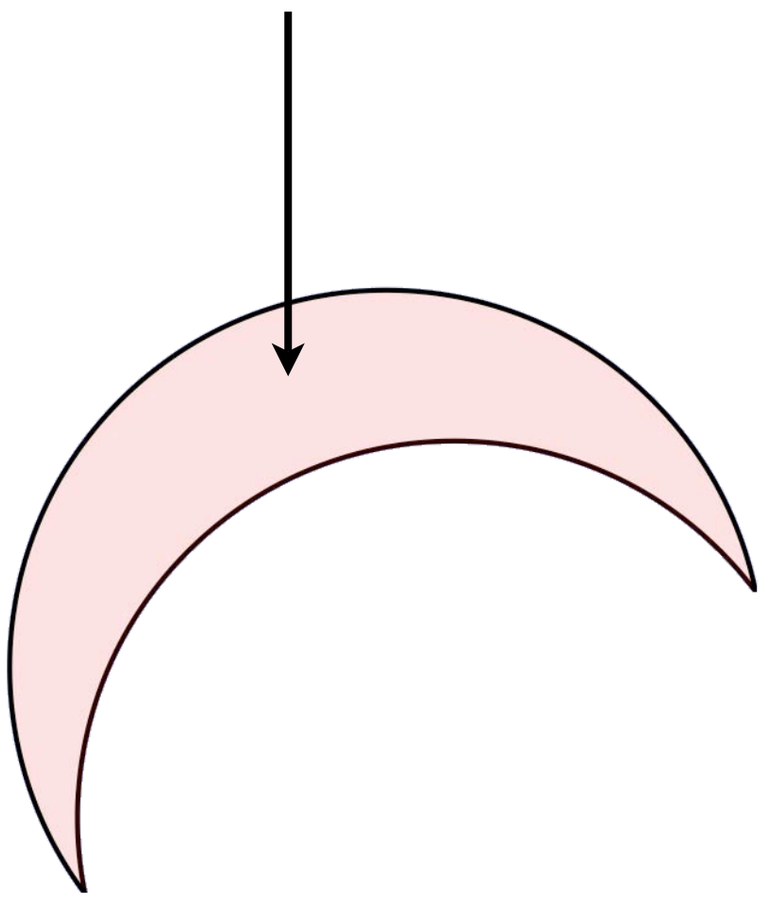


4. Partial correlations (pr)

X_1 with the effect of X_2 removed

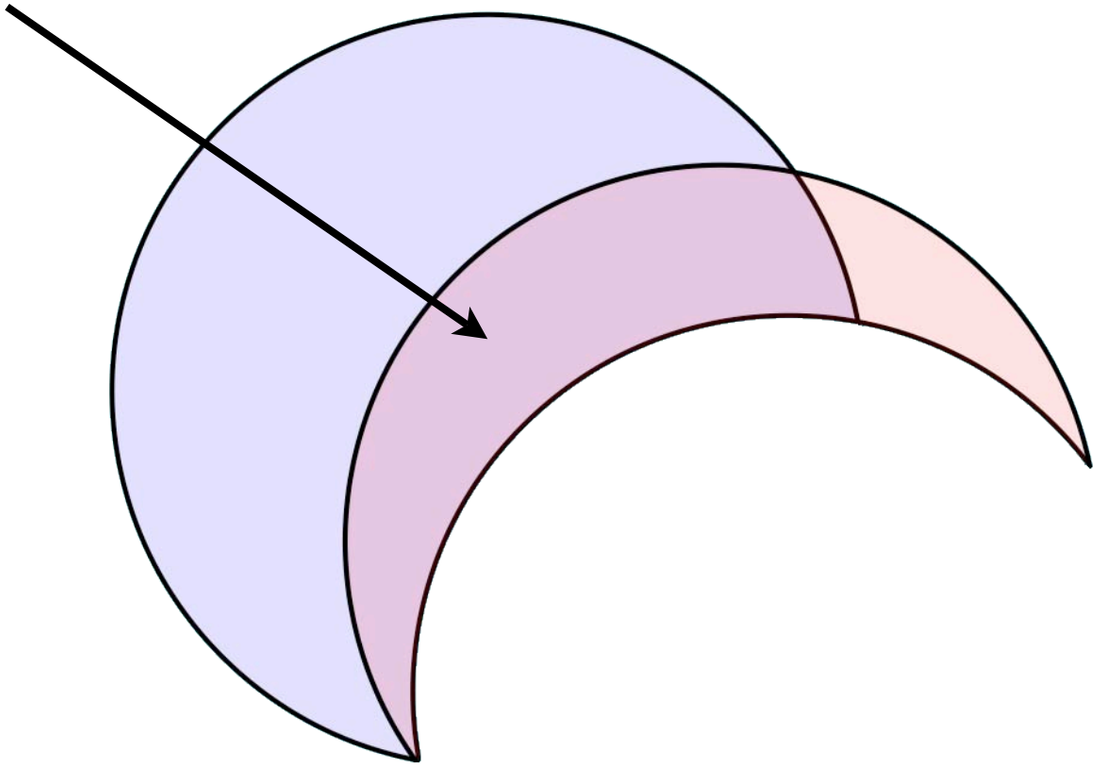


Y with the effect of X_2 removed



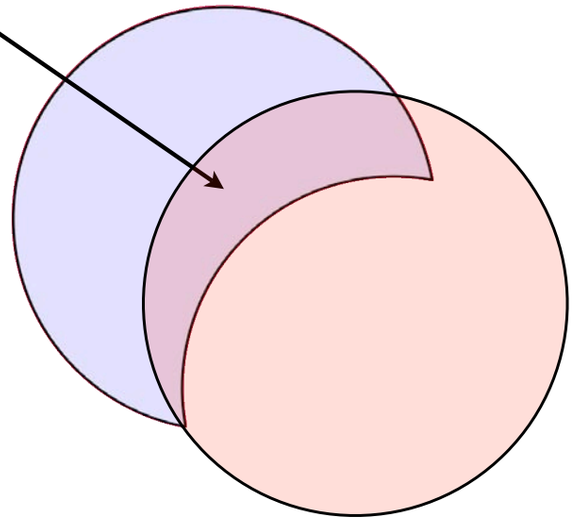
4. Partial correlations (pr)

Relationship between the remainder of X_1 and the remainder of Y after the effect of X_2 has been removed.



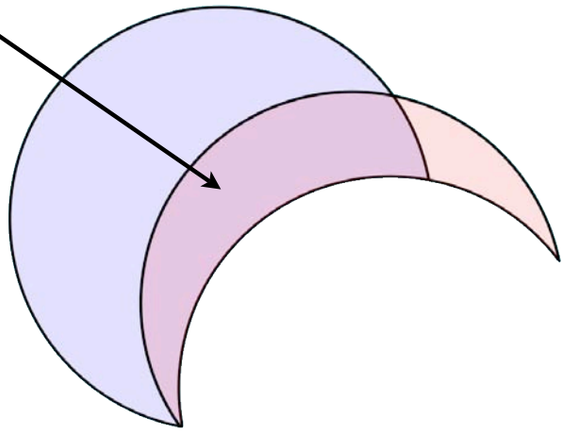
Semi Partial

Relationship between the remainder of X_1 and Y after the effect of X_2 has been removed.



Partial

Relationship between the remainder of X_1 and the remainder of Y after the effect of X_2 has been removed.



Comparing the formulas for β, sr and pr

Beta Weights

$$\beta_1 = \frac{r_{y1} - r_{y2}r_{12}}{1 - r_{12}^2}$$

Semi-Partial Correlations

$$sr_1 = \frac{r_{y1} - r_{y2}r_{12}}{\sqrt{1 - r_{12}^2}}$$

Partial Correlations

$$pr_1 = \frac{r_{y1} - r_{y2}r_{12}}{\sqrt{1 - r_{y2}^2}\sqrt{1 - r_{12}^2}}$$

5. Relative Weights (RW)

- Gives the relative proportion of the total explained variance that each predictor accounts for.
- Sum of all relative weights is 1.

$$RW_i = \frac{\beta_i r_{yi}}{R^2}$$

- These give the relative proportion of the total variance each variable accounts for. In other words, they give the proportion of the ‘pie’ attributable to each variable, but don’t take into account all the shared variance.

All measures of the importance of individual predictors

	Simple Correlation	Standardised Regression Weight	Semipartial Correlation	Usefulness	Partial Correlation	Relative Weights
	r	β	sr	sr^2	pr	RW
MOTIV (X_1)	0.59	0.35	0.33	10.75%	0.50	30.93%
GRADE (X_2)	0.75	0.62	0.57	32.71%	0.71	69.07%

Various ways of thinking about R^2

$$R^2 = \frac{SS_{reg}}{SS_{tot}}$$

$\Leftarrow$ The first expresses its interpretation as the proportion of total variance accounted for by the predictors.

$$R^2 = r_{y1}\beta_1 + r_{y2}\beta_2$$

$\Leftarrow$ The second links β weights and simple correlations.

$$R^2 = r_{y1}^2 + r_{y(2\cdot1)}^2 = r_{y1}^2 + sr_2^2$$
$$R^2 = r_{y2}^2 + r_{y(1\cdot2)}^2 = r_{y2}^2 + sr_1^2$$

$\Leftarrow$ The third and fourth equations link simple correlations and semipartial correlations and can be stated in words as:

$R^2 =$ Variance X_1 accounts for $+$ Variance X_2 accounts for after X_1 is in the equation

The implication of the last two equations is that the relative contributions of X_1 and X_2 to the prediction of Y depends on the order with which they are entered into the regression equation.

Summary so far:

- The principle is that the two predictor case generalises to the multiple predictor case.
- The major questions addressed by multiple regression is the same.
- R^2 has the same interpretation.
- Beta weights and their confidence intervals have the same interpretation.
- sr^2 has the same interpretation.

Regression strategies:

- Standard or simultaneous regression
  - Standard regression is typically used to develop a subset of predictors that is useful in predicting the criterion and to eliminate those predictors that do not provide additional prediction to the predictors already in the equation.
- Sequential or hierarchical regression
  - Covered later
- Stepwise regression
  - For stepwise regression, the goal is to provide the best prediction equation for the particular sample being analysed, particularly if the researcher does not care what these predictors are.
  - It is a form of mechanised ‘data snooping’ likely to lead to errors of interpretation. It is a controversial procedure with very good reason.
  - It is NOT recommended.

Regression strategies:

- Setwise (all possible subsets) regression.
  - This strategy is used when the best possible subset of the predictors is needed to get maximum predicability of the criterion. It is not implemented in SPSS.
- Ridge regression
  - Ridge regression is used when there is strong multicollinearity among the predictors. Ridge regression artificially reduces the correlations among the predictors in order to obtain more stable estimates of the regression coefficients.

Choose the one that matches the nature of the research question and analysis.

Standard multiple regression

- The purpose involves mainly explaining the nature of the relationship between the predictors and the criterion.
- All predictors enter into the regression equation at once.
- Each predictor is assessed as if it had entered the regression equation after all the other predictors had entered.

Questions

1. Distinguish between the different regression strategies. Why are stepwise methods not recommended.
2. Distinguish between statistical significance of the overall relationship and the strength of the relationship.
3. Could you find a regression equation that would be acceptable as statistically significant and yet offer no acceptable interpretational value to the researcher?
4. What are the parameters of the linear model being fitted in multiple regression?

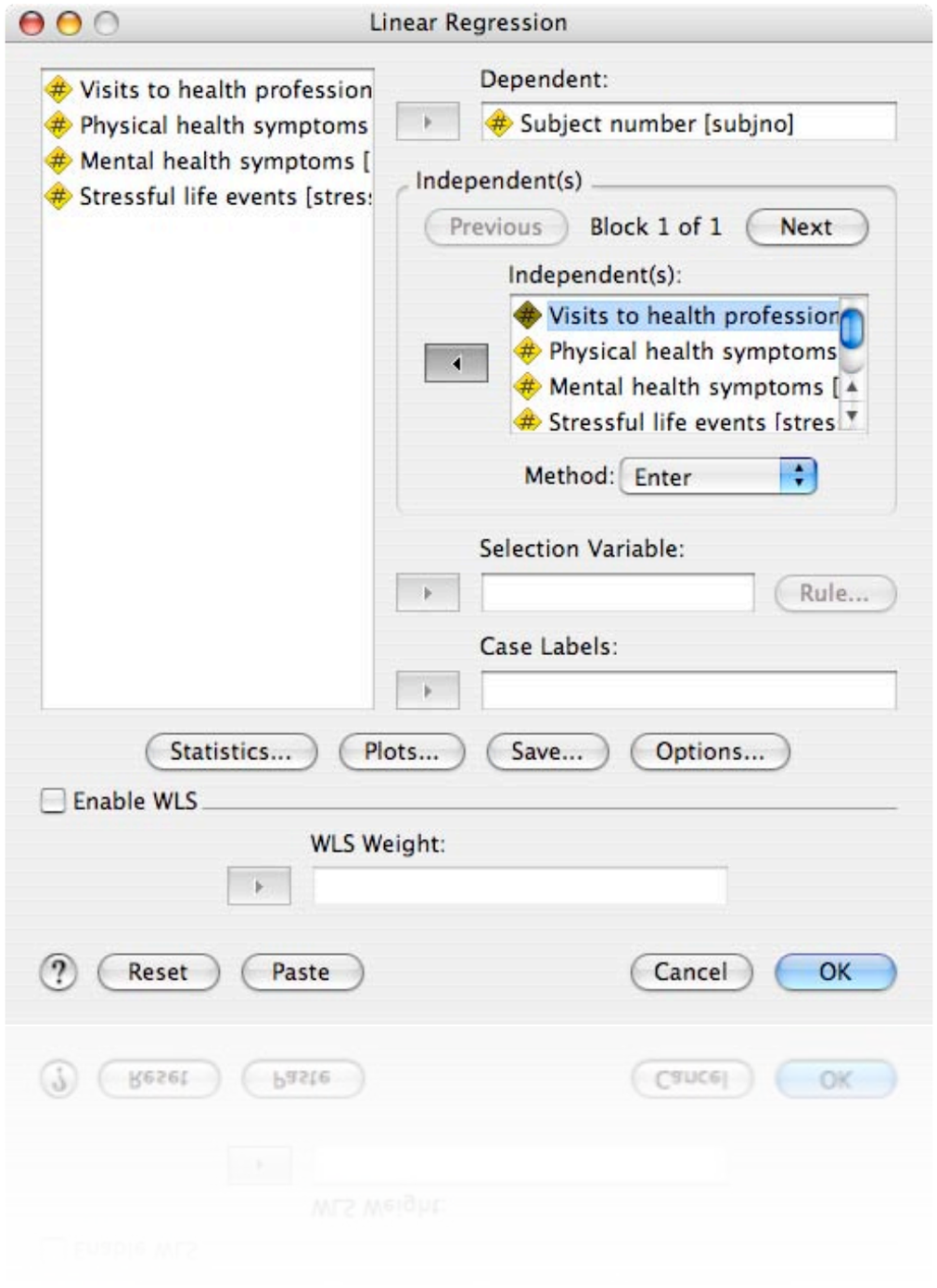
Questions

5. How are linear composites used in multiple regression with two predictors? How is this similar to simple regression?
6. What role does partitioning variance play in multiple regression with two predictors?
7. How would you explain the relative importance of the predictor variables used in regression equation?
8. Why are there at least five different measure of relative importance of predictors?

Questions

9. How can confidence intervals on standardised regression weights be used?
10. Why does the order with which a variable is entered into the regression equation matter?
11. Why can data analysis be considered in terms of model fitting and model testing?
12. Why are residuals important?

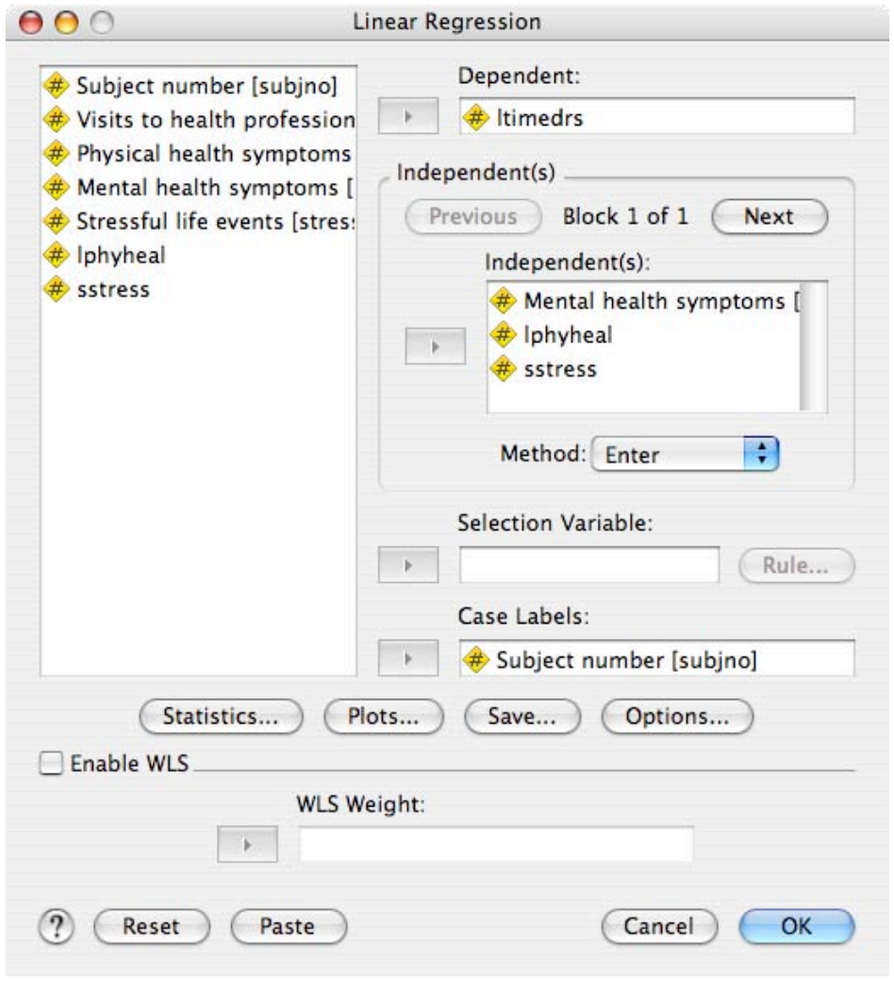
SPSS Regression Procedure



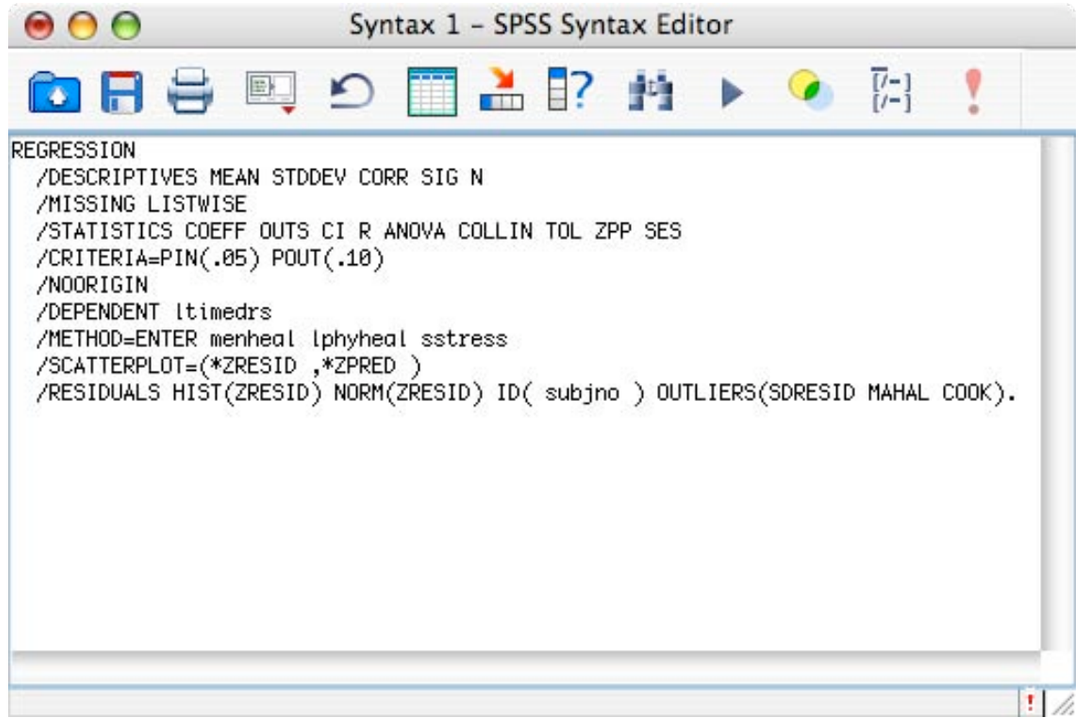
- Overview
- T&F large sample multiple regression research question
- data transformations
- menu sequences
- syntax for regression command

SPSS Regression Procedure Overview

Two ways of giving commands to SPSS:



clicking menu options in dialogue boxes



typing commands into the syntax window

SPSS Regression Procedure Overview

- Some regression options are not available from within dialogue boxes.
  - They can only be given by typing into the syntax window.

Model		Unstandardized Coefficients		Standardized Coefficients	
		B	Std. Error	Beta	Std. Error
1	(Constant)	-.155	.058		
	Mental health symptoms	1.884E-03	.004	.019	.044
	LPHYHEAL	1.040	.087	.516	.043
	SSTRESS	1.571E-02	.003	.188	.040

a. Dependent Variable: LTIMEDRS

```
REGRESSION
  /DESCRIPTIVES MEAN STDDEV CORR SIG N
  /MISSING LISTWISE
  /STATISTICS COEFF OUTS CI R ANOVA COLLIN TOL ZPP SES
  /CRITERIA=PIN(.05) POUT(.10)
  /NOORIGIN
  /DEPENDENT ltimedrs
  /METHOD=ENTER menheal lphyheal sstress
  /SCATTERPLOT=(*ZRESID ,*ZPRED )
  /RESIDUALS HIST(ZRESID) NORM(ZRESID) ID( subjno ) OUTLIERS(SDRESID MAHAL COOK).
```

The research question

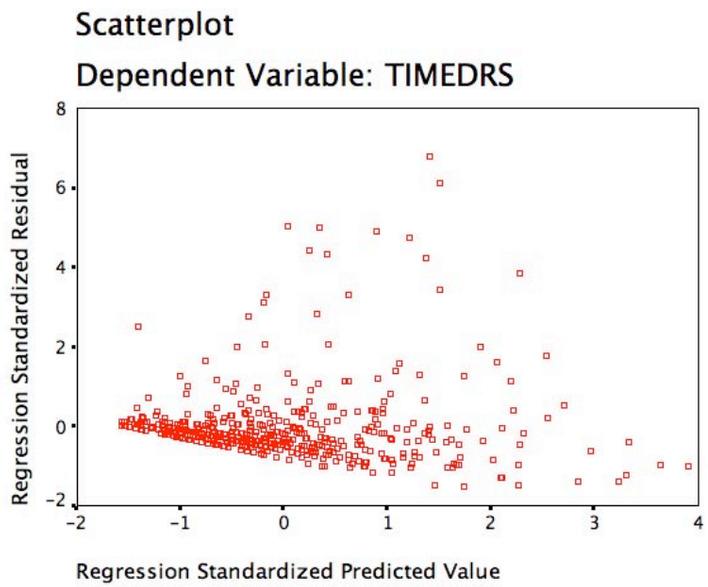
- In the T&F Women's Health study, a question of interest is whether the number of times a woman visits the doctor is related to their physical health, mental health and stress levels.

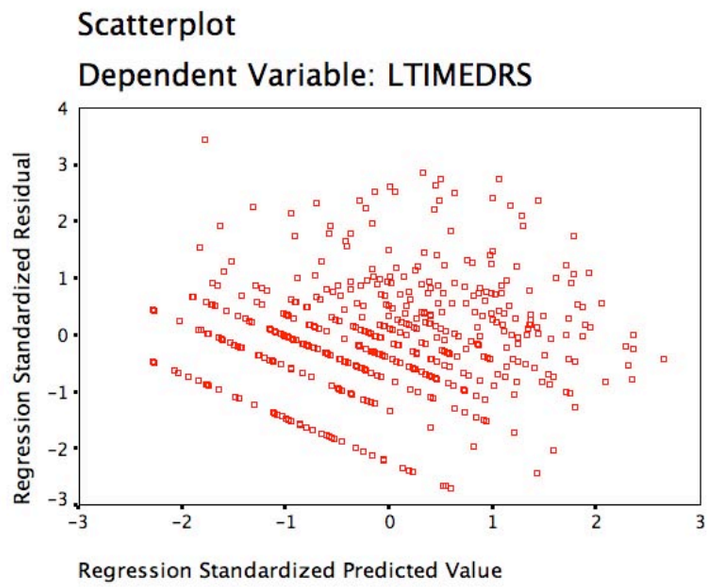
$$timedrs \leftarrow phyheal \;\; menheal \;\; stress$$

- See Section 5.7 of Chapter 5, page 161: Complete Examples of Regression Analysis, and Section B.1 of Appendix B: Women's Health and Drug Study.

Data transformations

- From data screening, T&F decide to transform the variables to make the distribution less skew:



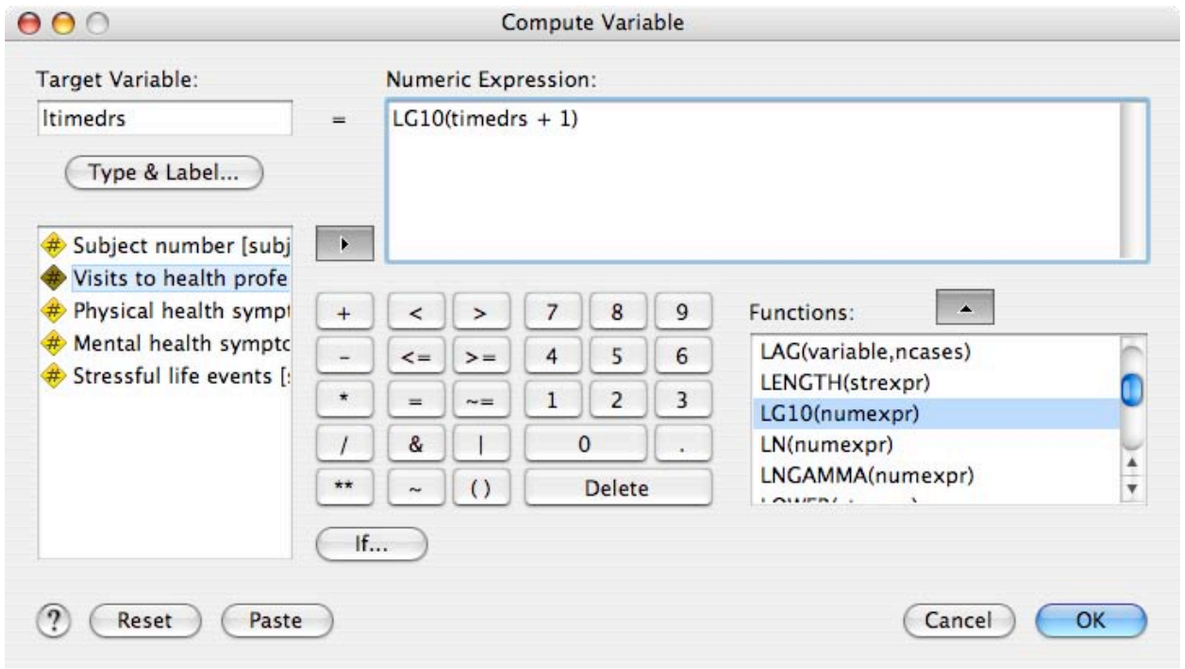


Use syntax

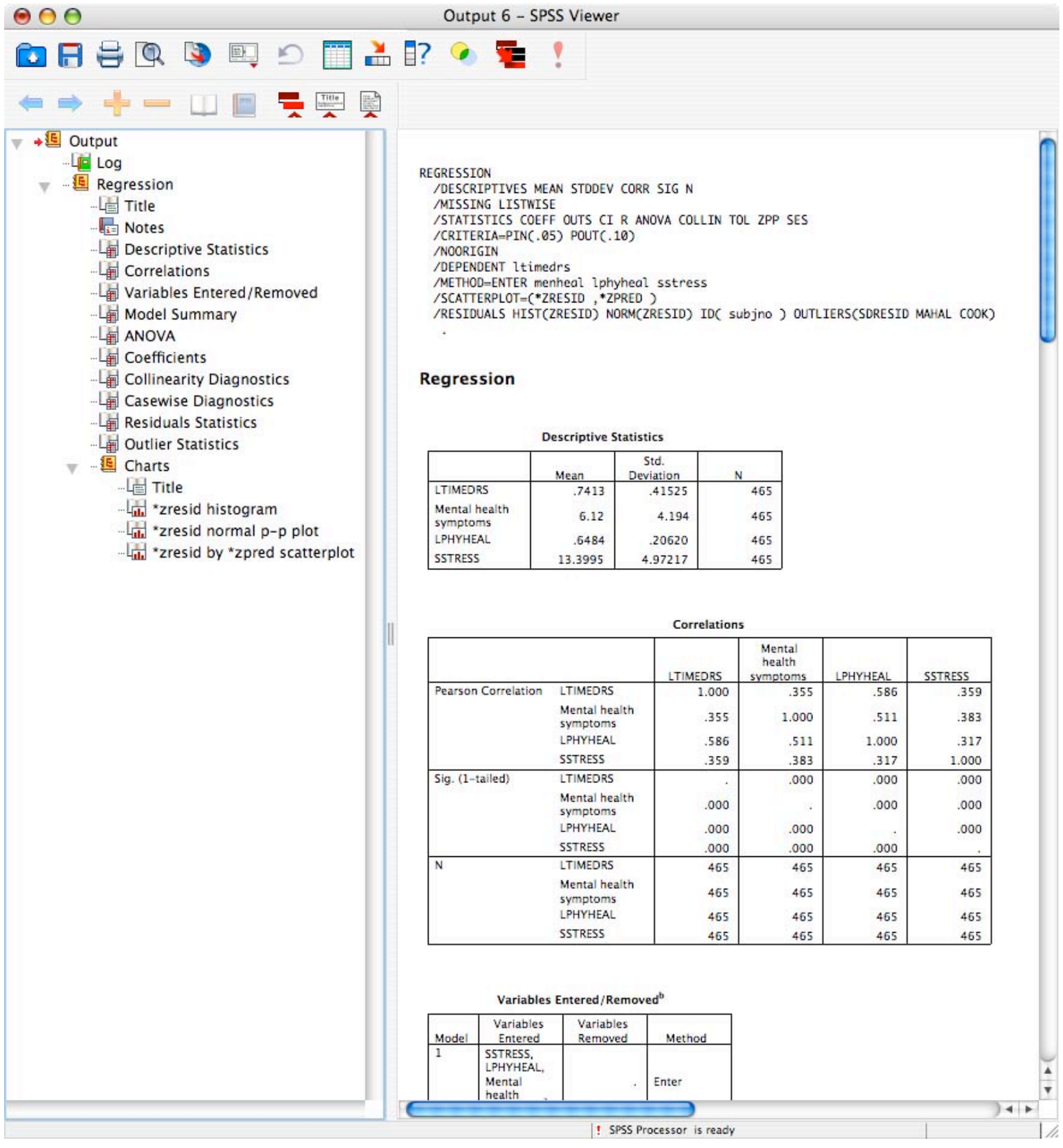
```
compute ltimedrs = LG10(timedrs +1).
compute lphyheal = LG10(phyheal).
compute sstress  = SQRT(stress).
execute.
```

Much More on the issue of Robust Interpretation later.

Or the dialogue



Regression command



The ‘results’ of the menu sequence is pasted into the output window.

Next week...

- Regression strategies
- SPSS Regression procedure
- Interpreting the Output
- Regression Diagnostics