

# What is Confound variable

Confound variable is sometimes called a third variable which influences both dependent and independent variable.

And effects of independent variable mixed up with the effects of the third variable. In this situation we can not determine the original effects of independent variable alone.




Figure: Scatter plot of Shoe size and Literacy rate

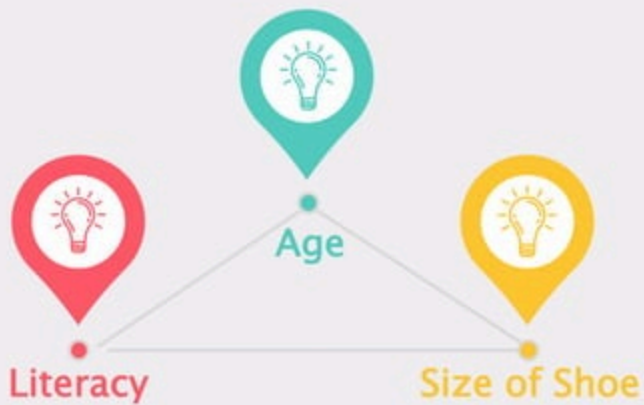
- literacy = c(0,1,2,3,4,5,6)
- shoe\_size = c(0,5,10,30,25,40,35)
- cor(literacy,shoe\_size)
- [1] 0.9360628

- We can see that two variables are highly correlated

Is there any  
third variable  
exists?



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Literacy = Constant +  $B_1$  Size of Shoe +  $B_2$  Age

So, here we can not say exactly how the yields of this model affected by size of shoe and how by the age variable, they're mixed-up i.e. confounded

# So What is Confounding in Factorial Design





- ❑ The information on some unimportant treatment combination specifically the interaction effect may be mixed up with the incomplete block in all replicate. This device is known as confounding

□ Now question may arise  
How the interaction effect mixed up with  
the block effect?



Consider a  $2^3$  factorial experiment. Let the three factors can be A,B,C each at two levels. Sign table for this factorial experiment is as follows:

Factorial effect	Treatment combinations							
	(1)	<i>a</i>	<i>b</i>	<i>ab</i>	<i>c</i>	<i>ac</i>	<i>bc</i>	<i>abc</i>
<i>I</i>	+	+	+	+	+	+	+	+
<i>A</i>	-	+	-	+	-	+	-	+
<i>B</i>	-	-	+	+	-	-	+	+
<i>AB</i>	+	-	-	+	+	-	-	+
<i>C</i>	-	-	-	-	+	+	+	+
<i>AC</i>	+	-	+	-	-	+	-	+
<i>BC</i>	+	+	-	-	-	-	+	+
<i>ABC</i>	-	+	+	-	+	-	-	+

Since the term  $\frac{1}{4r}$  is common in all factor, ignoring the  $\frac{1}{4r}$  we get

The various factorial effects are as follows:

$$A = (abc) + (ac) + (ab) + (a) - (bc) - (c) - (b) - (1)$$

$$B = (abc) + (bc) + (ab) + (b) - (ac) - (c) - (a) - (1)$$

$$C = (abc) + (bc) + (ac) + (c) - (ab) - (b) - (a) - (1)$$

$$AB = (abc) + (c) + (ab) + (1) - (bc) - (ac) - (b) - (a)$$

$$AC = (abc) + (ac) + (b) + (1) - (bc) - (c) - (ab) - (a)$$

$$BC = (abc) + (bc) + (a) + (1) - (ac) - (c) - (ab) - (b)$$

$$ABC = (abc) + (c) + (b) + (a) - (bc) - (ac) - (ab) - (1)$$

Let us put the group of treatment combination with positive sign in block 2 and block 1 having negative sign of the treatment combination in ABC

$$ABC = (abc) + (c) + (b) + (a) - (bc) - (ac) - (ab) - (1)$$

Block 2

Block 1

**Replication I**

Block 1:	(1)	(ab)	(ac)	(bc)
Block 2:	(a)	(b)	(c)	(abc)

### Replication I

Block 1: (1) (ab) (ac) (bc)  
Block 2: (a) (b) (c) (abc)

- In Block 1: For AB there are two negative sign (ac) and (bc) and two Positive sign (1) and (ab), so block effect cancel out
- In Block 2 For AB there are two negative sign (a) and (b) and two Positive sign (c) and (abc), so block effect cancel out

Factorial effect	Treatment Combination							
	(1)	(a)	(b)	(ab)	(c)	(ac)	(bc)	(abc)
AB	+	-	-	+	+	-	-	+

**Replication I**

Block 1: (1) (ab) (ac) (bc)  
 Block 2 : (a) (b) (c) (abc)

Similar for AC and BC, there are two positive and negative sign in each block, so block effect cancel out. That means the Interaction AB, AC and BC measure only interaction effect there is no option for mix-up the blocking effect

Factorial effect	Treatment combinations							
	(1)	<i>a</i>	<i>b</i>	<i>ab</i>	<i>c</i>	<i>ac</i>	<i>bc</i>	<i>abc</i>
<i>AC</i>	+	-	+	-	-	+	-	+

	Replication I			
Block 1:	(1)	(ab)	(ac)	(bc)
Block 2:	(a)	(b)	(c)	(abc)

- ❑ But for ABC there are 4 negative sign in Block 1 no positive sign
- ❑ In Block 2, there are 4 positive sign, no negative sign, so there exist a block effect

Factorial effect	Treatment combinations							
	(1)	<i>a</i>	<i>b</i>	<i>ab</i>	<i>c</i>	<i>ac</i>	<i>bc</i>	<i>abc</i>
<i>ABC</i>	-	+	+	-	+	-	-	+



Formula for interaction effect can be written as

$$ABC = \frac{1}{4}[(abc + a + b + c) - (ab + bc + ac + 1)]$$

$$ABC = \frac{(abc + a + b + c)}{4} - \frac{(ab + bc + ac + 1)}{4}$$

$$ABC = \text{Mean effect of Block 2} - \text{Mean effect of Block 1}$$

So, here ABC measures ABC interaction along with block effects

Hence ABC interaction cannot be separated from block effects.  
In fact we can not say how much above quantity  
Due to ABC interaction and  
how much due to block difference or block effects

Here the interaction effect ABC has been confounded with block effect

Similarly if AB is to be confounded, then the two blocks will consist of

Block 1	(abc)	(c)	(ab)	(1)
Block 2	(bc)	(ac)	(b)	(a)

Here AB is confounded with block effects and cannot be estimated independently whereas all other effects A, B, C, AC, Bc and ABC can be estimated independently.

## Remember one thing

- Allocating the treatment combinations in the block should be random. Any type of combinations can be appeared in the blocks.
- The interactions AB, AC or BC can be confounded. It is depends on allocating treatment combinations

# Analysis of Variance

in case of confounded effects



When an effect is confounded, it means that it is not estimable.  
Then we have to sacrifice the effect which is confounded!!

The following steps are followed to conduct the analysis of variance in case of factorial experiments with confounded effects:

- ✓ Obtain the sum of squares due to main and interaction effects in the usual way as if no effect is confounded.
- ✓ Drop the sum of squares corresponding to confounded effects and retain only the sum of squares due to unconfounded effects.
- ✓ Find the total sum of squares.
- ✓ Obtain the sum of squares due to error and associated degrees of freedom
- ✓ Conduct the test of hypothesis in the usual way.



