# Review & Map Way Forward

- ***Public Service Announcements:***

**Quiz:** **Have 6 and drop the lowest score (best 5 of 6)**

**Communal grading:** **Yes / No ?**

**HW 1:** **Due Monday – DON'T WAIT UNTIL LAST DAY**

- ***Objectives:***

Review statistical testing / significance determination

Discuss Index of Dispersion / Multi-scale Analysis

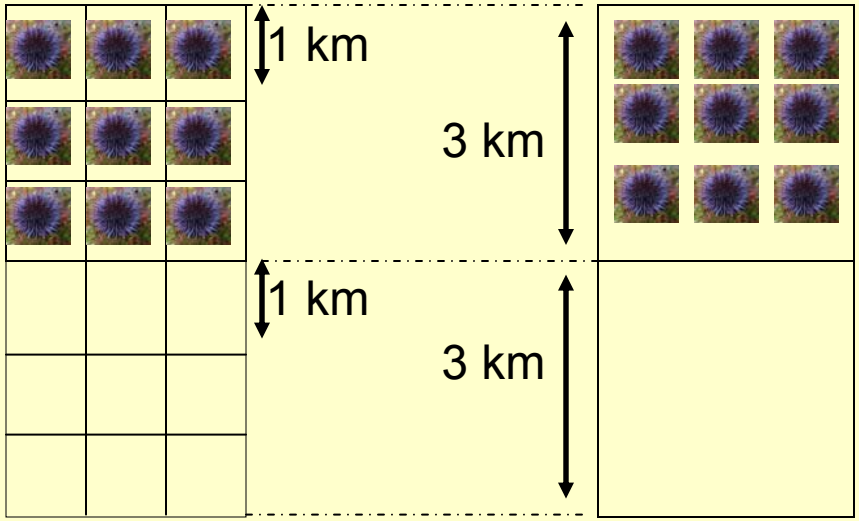
- ***Learning Outcomes:***

Nail critical foundations down – before we move ahead

# Multi-scale Analysis of Intensity

A) Small Scale  B) Large Scale

**Study:** Survey of urchin distribution with quadrats




**Study A:** 1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0,0,0

**Study B:** 9,0

**Mean A:** (1+1+1+1+1+1+1+1+1+0+0+0+0+0+0+0+0+0) / 18 = 0.5

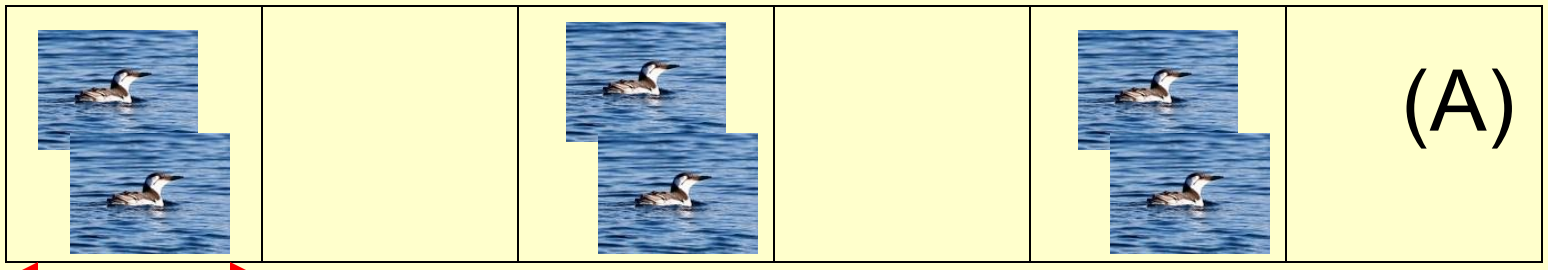
**Variance A:** $[9*(1 - 0.5)^2] + [9*(0 - 0.5)^2] = [9*(0.5)^2] + [9*(-0.5)^2] = \frac{4.5}{17}$

**Mean B:** (9+0) / 2 = 4.5

**Variance B:** $(9 - 4.5)^2 + (0 - 4.5)^2 = (4.5)^2 + (-4.5)^2 = 20.25 + 20.25 = \frac{40.50}{1}$

# Aggregating 1-D Data

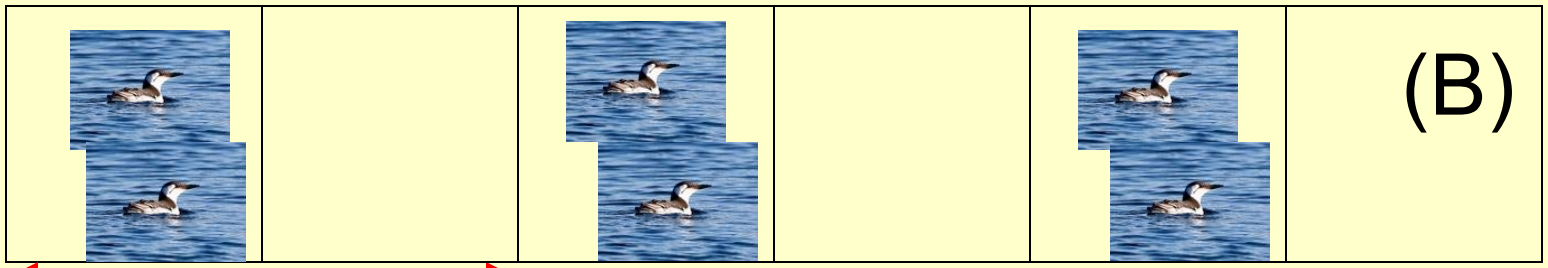
Samples: 6
Mean: 1
Variance: 1.2



1 km

(A)

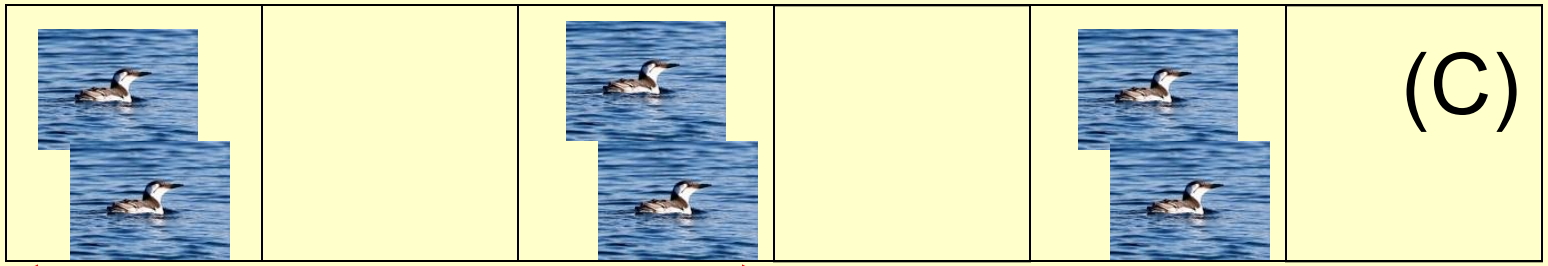
Samples: 3
Mean 2
Variance: 0



2 km

(B)

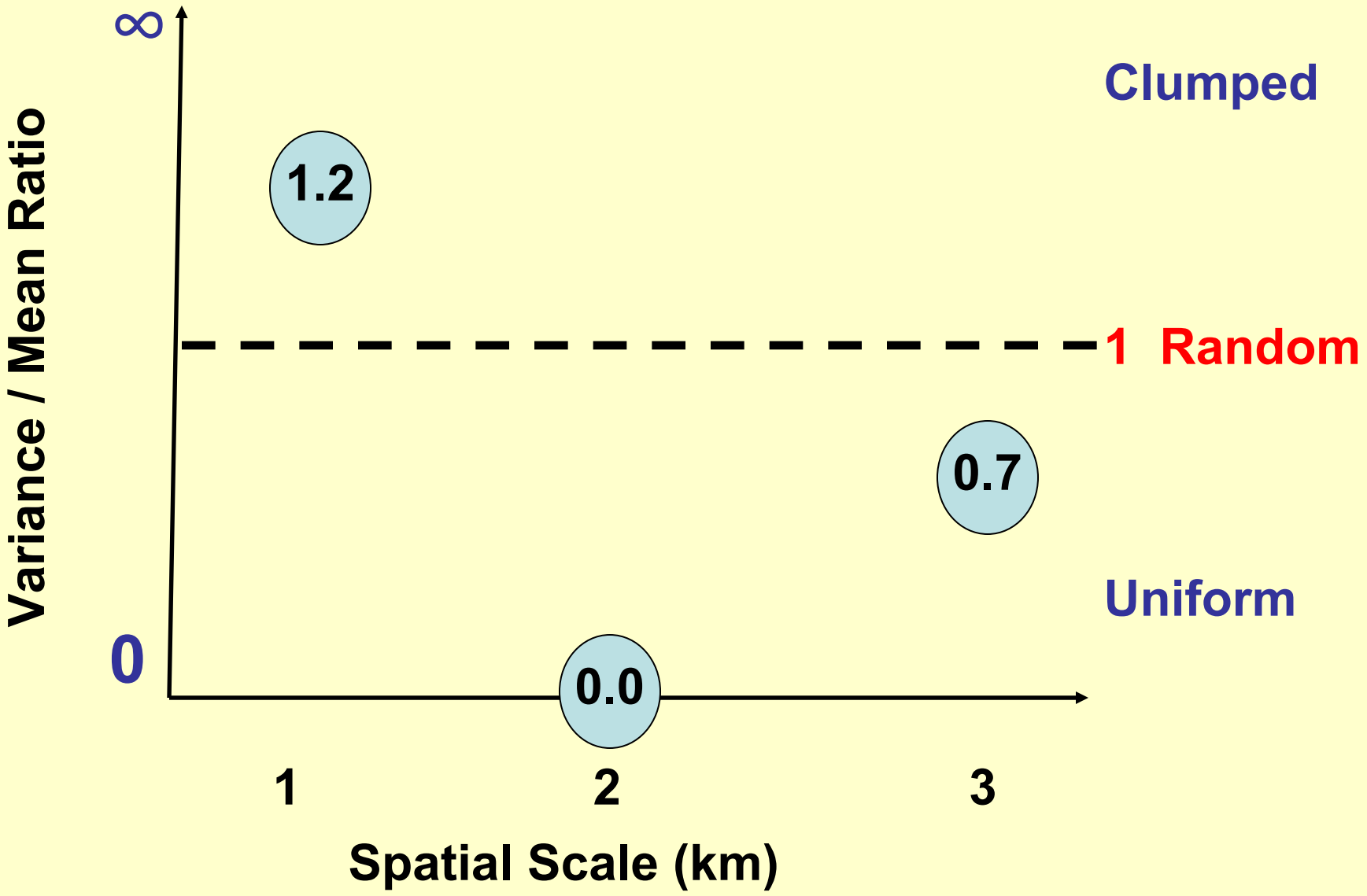
Samples: 2
Mean: 3
Variance: 2



3 km

(C)

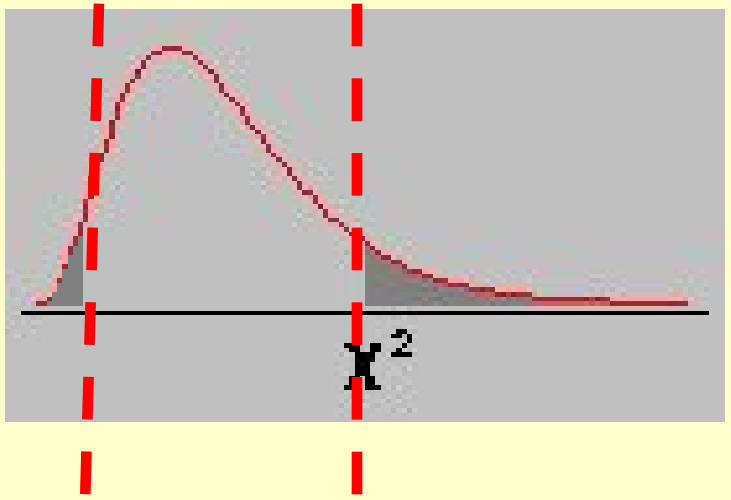
# Variance / Mean Ratio – Interpretation



# Statistical Significance – P Values

| Degrees of Freedom | Level of Significance (two tail) | | | |
|---|---|---|---|---|
| | 0.99 | 0.95 | 0.05 | 0.01 |
| 1 | 0.000 | 0.004 | 3.84 | 6.64 |
| 2 | 0.020 | 0.103 | 5.99 | 9.21 |
| 3 | 0.115 | 0.352 | 7.82 | 11.35 |
| 4 | 0.297 | 0.711 | 9.49 | 13.28 |
| 5 | 0.554 | 1.145 | 11.07 | 15.09 |

| Chi-Square | Df | Result |
|---|---|---|
| 1.2 | 5 | N.S. |
| 0.0 | 2 | Sig. |
| 0.7 | 1 | N.S. |

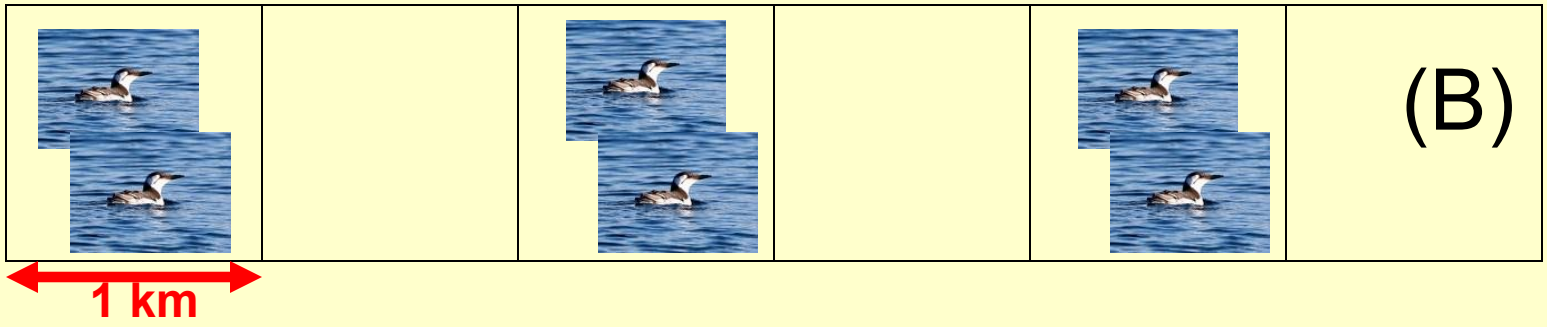


# Green's Index – 1 km scale

Let's consider the bird distribution t three spatial scales:

$$G(x) = \frac{(V / M) - 1}{\sum X - 1}$$

| Scale B | Birds |
|---|---|
| count | 6.0 |
| mean | 1.0 |
| variance | 1.2 |



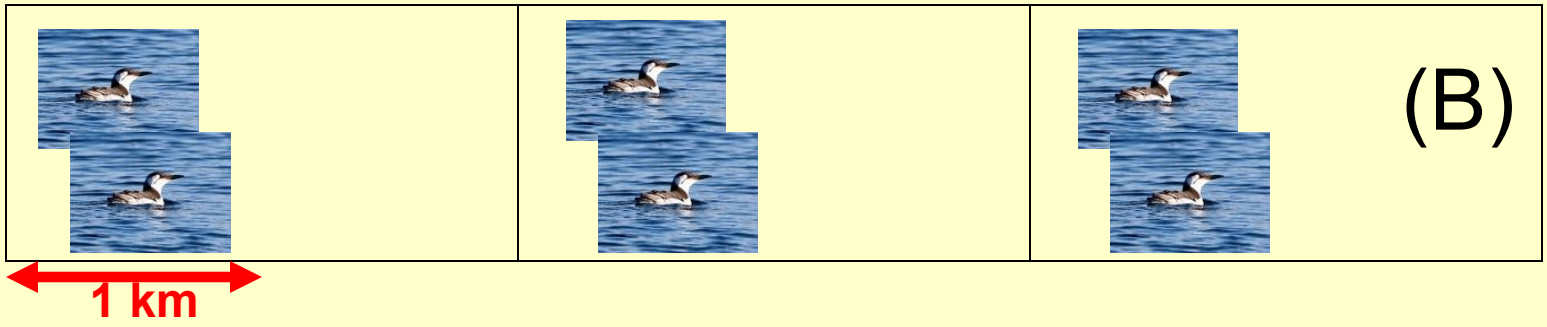

**G (birds) =** $\dfrac{(1.2 / 1) - 1}{6 - 1}$ **= 0.2 / 5 = + 0.04**

# Green's Index – 2 km scale

Let's consider the bird distribution t three spatial scales:

$$G(x) = \frac{(V / M) - 1}{\sum X - 1}$$

| Scale B | Birds |
|---|---|
| count | 6.0 |
| mean | 2.0 |
| variance | 0.0 |



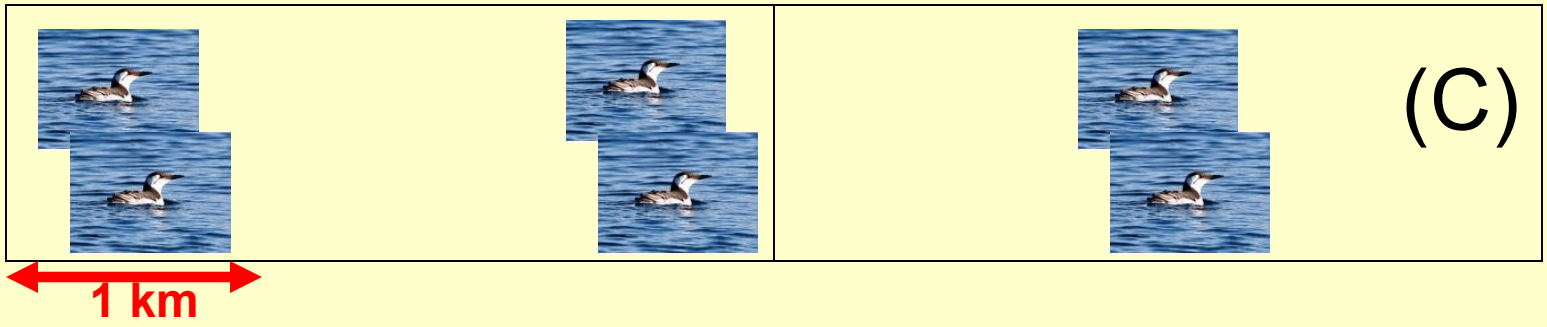

$$\text{G (birds)} = \frac{(0 / 2) - 1}{6 - 1} = -1 / 5 = -0.20$$

# Green's Index – 3 km scale

Let's consider the bird distribution t three spatial scales:

$$G(x) = \frac{(V / M) - 1}{\sum X - 1}$$

| Scale C | Birds |
|---|---|
| count | 6.0 |
| mean | 3.0 |
| variance | 2.0 |




$$G(\text{birds}) = \frac{(2 / 3) - 1}{6 - 1} = -0.33 / 5 = -0.06$$

# Green's Index – Interpretation

$$G(x) = \frac{(V / M) - 1}{\sum X - 1}$$

***Random:*** **(1 – 1) / (∑X – 1)**

***Uniform:*** **(0 – 1) / (∑X – 1)**

***Aggregated:*** **(∑X – 1) / (∑X – 1)**

Why does the variance only goes up to a value of (∑X) ?

Remember the Quizz (9,0,0,0,0,0,0,0,0) ?

Mean = 1, Variance = $\mathbf{8^2 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 = 72 / 8 = 9}$

# Hints – Notation

$$\sum (Xi - \bar{X})(Yi - \bar{Y})$$

$$\sum X - 1$$

# Hints – where is (n-1) ?

$$r = \frac{Covariance}{\sqrt{(Variance\ X)(Variance\ Y)}}$$

$$\frac{\frac{\sum (Xi - \bar{X})(Yi - \bar{Y})}{(n-1)}}{\sqrt{\frac{\sum (Xi - \bar{X})^2}{(n-1)} \frac{\sum (Yi - \bar{Y})^2}{(n-1)}}}$$

# Hints – where is (n-1) ?

$$r = \frac{Covariance}{\sqrt{(Variance\ X)(Variance\ Y)}}$$

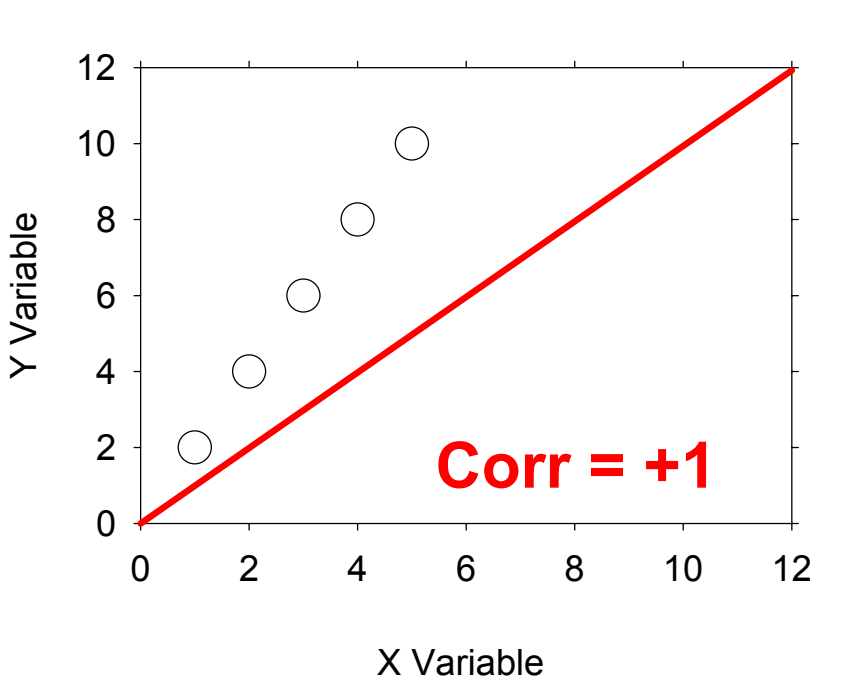
$$\frac{\sum (Xi - \bar{X})(Yi - \bar{Y})}{(n-1)}$$

$$\sqrt{\frac{\sum (Xi - \bar{X})^2}{(n-1)} \frac{\sum (Yi - \bar{Y})^2}{(n-1)}}$$

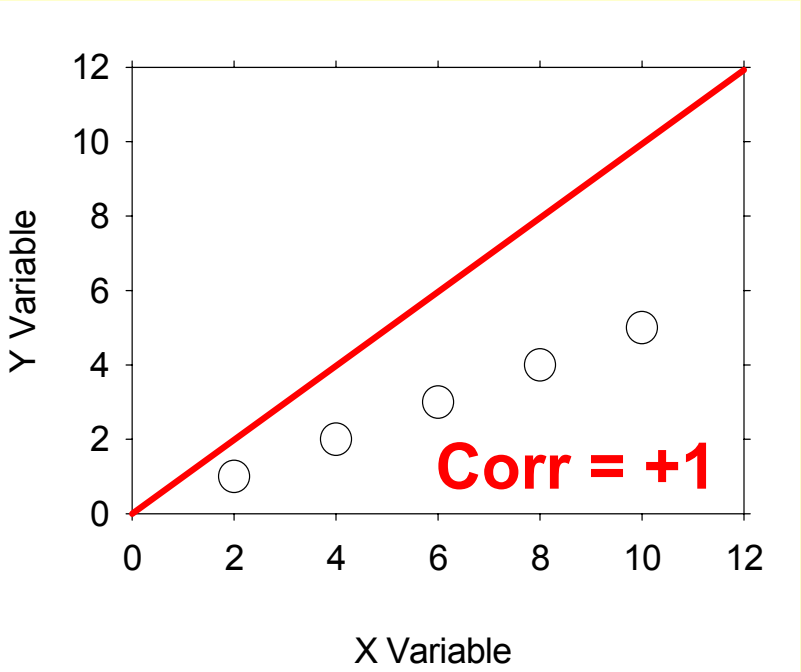
# Autocorrelation – Background

The correlation coefficient ($-1 \leq r \leq 1$) indicates strength and direction of a linear relationship between two variables

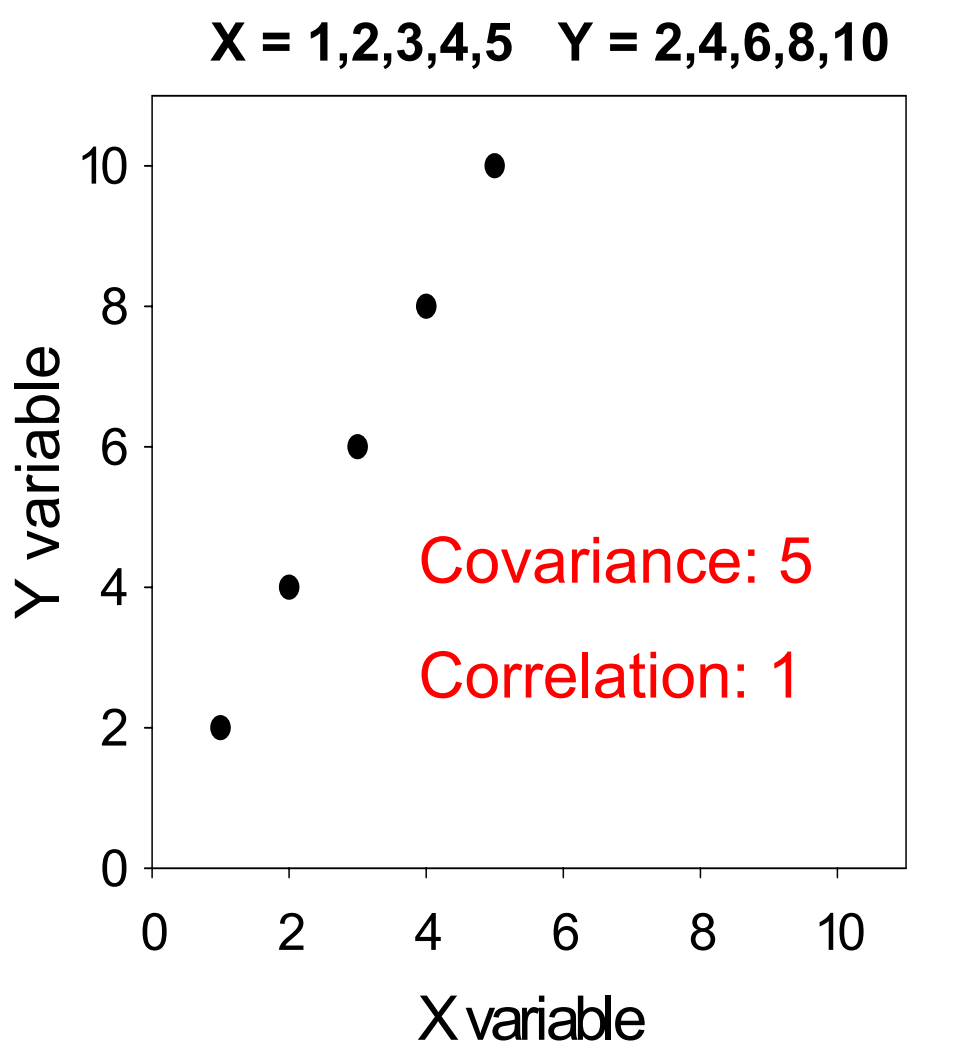
**X = 1,2,3,4,5  Y = 2,4,6,8,10**




**Y = 1,2,3,4,5  x = 2,4,6,8,10**



# Review of Covariance / Correlation




$$\frac{\sum (Xi - \overline{X})(Yi - \overline{Y})}{\sqrt{\sum (Xi - \overline{X})^2 \sum (Yi - \overline{Y})^2}}$$

Calculate the means and deviations for X and Y

# Review of Covariance / Correlation

| X | Mean | Dev_X | Dev_Sq | Y | Mean | Dev_Y | Dev_Sq |
|---|---|---|---|---|---|---|---|
| 5 | 3 | 2 | 4 | 10 | 6 | 4 | 16 |
| 4 | 3 | 1 | 1 | 8 | 6 | 2 | 4 |
| 3 | 3 | 0 | 0 | 6 | 6 | 0 | 0 |
| 2 | 3 | -1 | 1 | 4 | 6 | -2 | 4 |
| 1 | 3 | -2 | 4 | 2 | 6 | -4 | 16 |
| | | | **10** | | | | **40** |

**For variance, divide by (n-1):** **2.5** **10**

# Review of Covariance / Correlation

| Dev_X | Dev_Y | Product |
|---|---|---|
| 2 | 4 | 8 |
| 1 | 2 | 2 |
| 0 | 0 | 0 |
| -1 | -2 | 2 |
| -2 | -4 | 8 |
| | | **20** |

**Numerator = 20 / (n-1)**

**= 5.0**

**Denominator =** $\sqrt{2.5 * 10}$

**= 5.0**

$r = 5 / 5 = 1$

# Autocorrelation – Background

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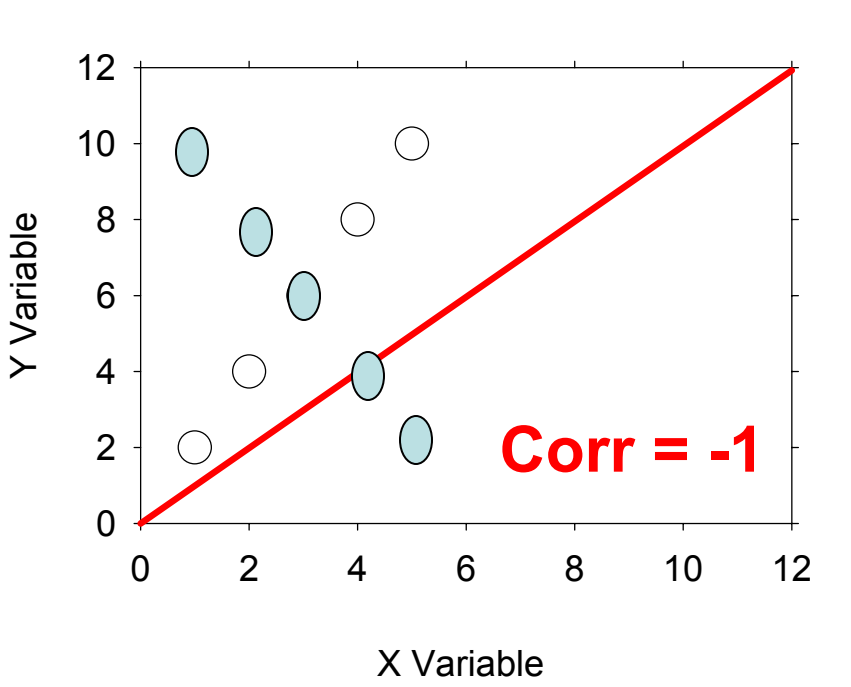
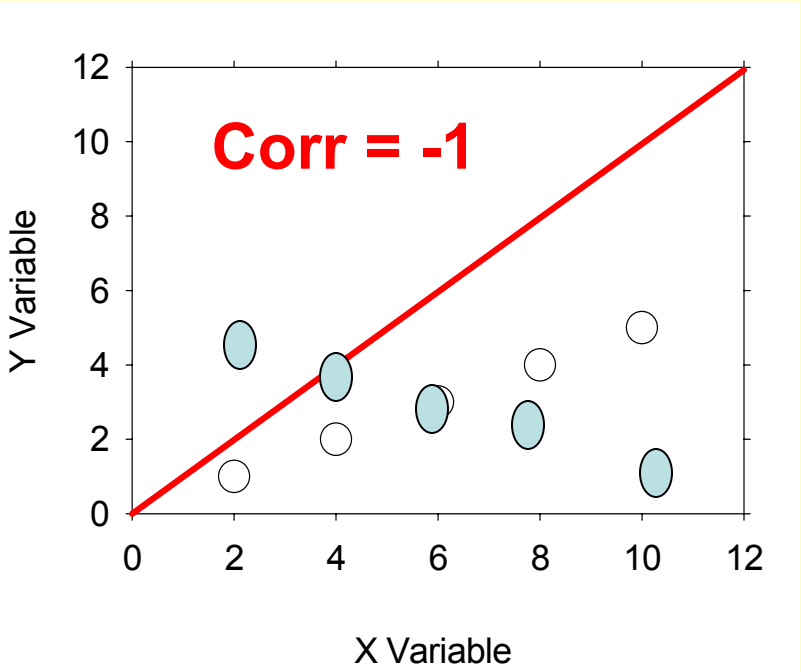
**X = 1,2,3,4,5  Y = 2,4,6,8,10**




**Y = 1,2,3,4,5  x = 2,4,6,8,10**



# Review of Covariance / Correlation

| X | Mean | Dev_X | Dev_Sq | Y | Mean | Dev_Y | Dev_Sq |
|---|---|---|---|---|---|---|---|
| 5 | 3 | 2 | 4 | 2 | 6 | -4 | 16 |
| 4 | 3 | 1 | 1 | 4 | 6 | -2 | 4 |
| 3 | 3 | 0 | 0 | 6 | 6 | 0 | 0 |
| 2 | 3 | -1 | 1 | 8 | 6 | 2 | 4 |
| 1 | 3 | -2 | 4 | 10 | 6 | 4 | 16 |
| | | | **10** | | | | **40** |

**For variance, divide by (n-1):** **2.5** **10**

# Review of Covariance / Correlation

| Dev_X | Dev_Y | Product |
|---|---|---|
| 2 | -4 | -8 |
| 1 | -2 | -2 |
| 0 | 0 | 0 |
| -1 | 2 | -2 |
| -2 | 4 | -8 |
| | | **-20** |

**Numerator = -20 / (n-1)**

**= -5.0**

**Denominator =** $\sqrt{2.5 * 10}$

**= 5.0**

$r = -5 / 5 = -1$

# Statistical Significance – P Values

## Pearson Correlation Coefficient

## Table of Critical Values

| df= n-2<br>n = number of pairs of data | Level of significance for two-tailed test | | | |
|---|---|---|---|---|
| | .10 | .05 | .02 | .01 |
| 1 | .988 | .997 | .9995 | .9999 |
| 2 | .900 | .950 | .980 | .990 |
| 3 | .805 | .878 | .934 | .959 |
| 4 | .729 | .811 | .882 | .917 |
| 5 | .669 | .754 | .833 | .874 |
| 6 | .622 | .707 | .789 | .834 |