Module 1 Covariances Pen/2 atlasteren welnted at vonance for Dum Data Set. In he session, we looking at vording for higher Bum. data Sets. The inhuhan and dofuntar nuchad larlier does not really want in he same way in higher dimensioni, and Squerry vectors is not really dylaned Ossume we have a 2 bain danset, we On now Coupute variano in he x director and of direction But he vonace are insufficient to describe what s going on in the data set.

In particular, we only have he wonon han of the data in either direction independent of he other direction, but mon we also be entersted inthe relationship between the x ady warable. and this consulted he concept of the Cormance Setween her Components come into play. Let have a lock at an Example in 2 Dun's: For this data set we can compute the variance in of drechon, and variance in a direction, which indicated by vertical and honzarta (Bar: la pc)

But how can be unsplicent, because we con lot at other Eg's where he variances in' X,y drecha are same, but data set hash very dupon There of data set, but vonance in x, y diechon are exactly he seme, (see pic)

and mean values are also identical.

and I can look at deferent sets leke the one here,

and the one ( true 4 data set looks very deplacent)

You've ken 4 deplerenteg's, with 4 deplerent properties or shopes of data set, but vortances in x ordy, and wen values are identical.

If we exclusively flocus on the herizantal and vertical spread of data, we cont explain only correlation between, x and y.

In the last sligure we concleanly see that an awayed If the x value of data point increas, theran average pre y-value decreas (see pi) he correlation can be captured by extending the notion of the vonance to what is called to co-vortance of deeta. The Co-vorance between xady is defleted as I he expected value of it menis M(mean) in x drector times of mens M(mean) in y diedan" " Mix is he expected value in it drector" my is he expected value in y drector" my is he expected value in y drector"

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"Coverage Letwer y and 2"  (SMAM) MAIGRAUDITHERAS	aforementioned learner arising from or incidental to the use of the sutti service.  I confirm the use of the shuttle service is voluntary and I accept a significant in the shuttle on Kent (Pty) Ltd or any of its representatives shall not be liable for any loss, damage, injury or illness of whatsoever nature and howsoever caused, softered by me or the minor learner as a result, directly or indirectly, of using the shuttle service due to any reason whatsoever.
PARENTI GUARDIAN (NAME)  PRENTI GUARDIAN (NAME)	We also have be Co-vorance term:
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. 01/27	PARENTIGUARDIAN (NAME)
·······································	· · · Cov [x,y]
Car [ty, x]	Car Ety, x]

we con summarze the volue in his matrix, Called he Co-voiance matrix, with 4 entres; in top left Comer we have venance in a drection; hen Co-vonance tem between kady in top noput comer; O verance between yard x in bottom left Commer; and von ance of y in bottom right comers Vor [c] : Cov [x,y] Cov [y,x] Vor [y] Il Corrane between x, q is possible, thereas and second average the y Walne in Crease if we in Crease it and of Convenience Setwen It is regative, then the y-value decreas, if we increas can wonder Co-vonane Setween Lady es Do, her essioned 1, y have nothing to do with each offer, her essioned.

The Co-varance Metrixis always symmetrical, positive defenutive matrix, with variance on the diagenal, deagen al, If we now, look at D Dunerson al datast, we have data set Consesting of in vectors  $D = \{\chi_1, \dots, \chi_N\}$ , and every  $\chi_i$  is in RDHer we can compite the vorace of their dataset as 1 over N times Sum, 1=1 to Copital N, Ho menus u (mu), times x,0 minus u transpore where is the mean of data set VAR  $[D] = \frac{1}{N} \sum_{i=1}^{N} (x_i - u)(x_i - u)^T$   $\int_{XD} mahx$