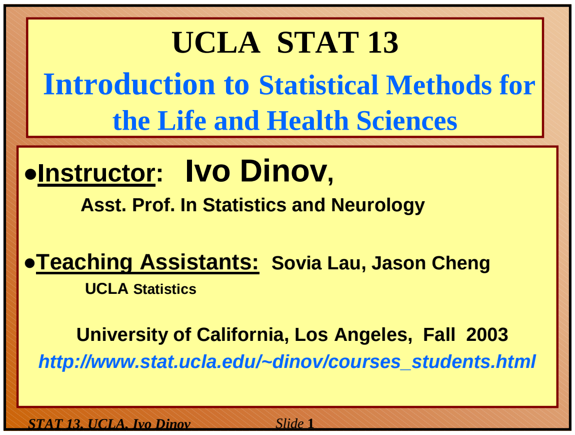


UCLA STAT 13

Introduction to Statistical Methods for the Life and Health Sciences

●**Instructor**: **Ivo Dinov**,

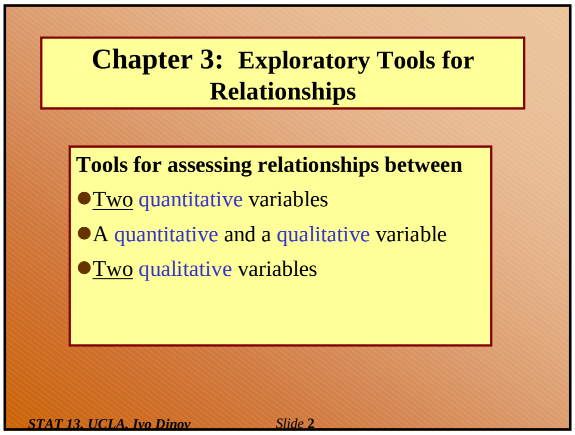
Asst. Prof. In Statistics and Neurology

●**Teaching Assistants:** **Sovia Lau, Jason Cheng**

UCLA Statistics

University of California, Los Angeles, Fall 2003

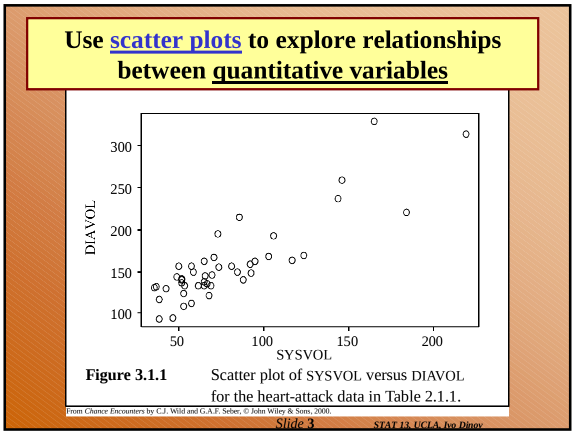
http://www.stat.ucla.edu/~dinov/courses_students.html



Chapter 3: Exploratory Tools for Relationships

Tools for assessing relationships between

- Two quantitative variables
- A quantitative and a qualitative variable
- Two qualitative variables



Use scatter plots to explore relationships between quantitative variables

Figure 3.1.1 Scatter plot of SYSVOL versus DIAVOL for the heart-attack data in Table 2.1.1.

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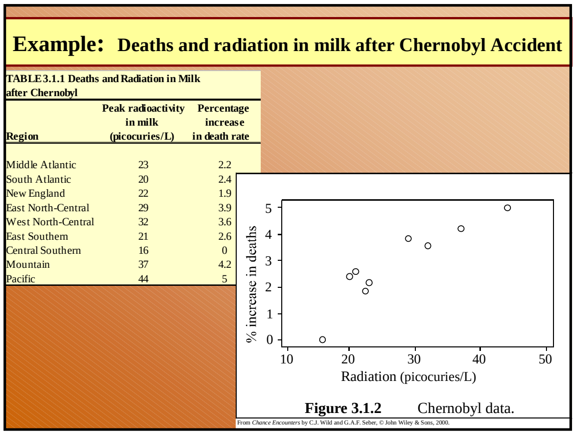

Example: Deaths and radiation in milk after Chernobyl Accident

TABLE 3.1.1 Deaths and Radiation in Milk after Chernobyl

Region	Peak radioactivity in milk (picocuries/L)	Percentage increase in death rate
Middle Atlantic	23	2.2
South Atlantic	20	2.4
New England	22	1.9
East North-Central	29	3.9
West North-Central	32	3.6
East Southern	21	2.6
Central Southern	16	0
Mountain	37	4.2
Pacific	44	5

Figure 3.1.2 Chernobyl data.

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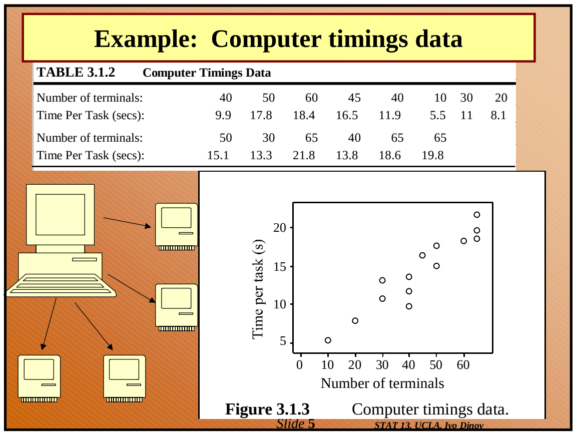
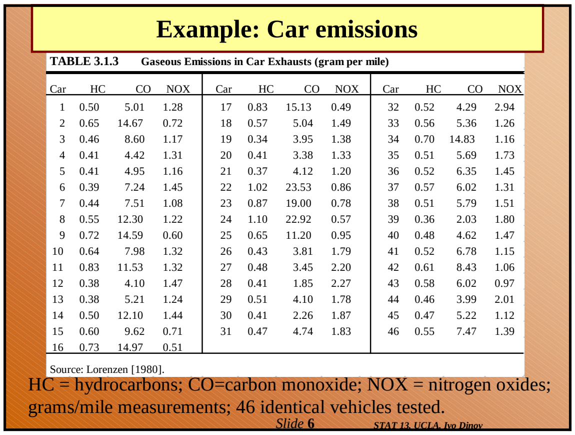


Example: Computer timings data

TABLE 3.1.2 **Computer Timings Data**

Number of terminals:	40	50	60	45	40	10	30	20
Time Per Task (secs):	9.9	17.8	18.4	16.5	11.9	5.5	11	8.1
Number of terminals:	50	30	65	40	65	65		
Time Per Task (secs):	15.1	13.3	21.8	13.8	18.6	19.8		

Figure 3.1.3 Computer timings data.



Example: Car emissions

TABLE 3.1.3 **Gaseous Emissions in Car Exhausts (gram per mile)**

Car	HC	CO	NOX	Car	HC	CO	NOX	Car	HC	CO	NOX
1	0.50	5.01	1.28	17	0.83	15.13	0.49	32	0.52	4.29	2.94
2	0.65	14.67	0.72	18	0.57	5.04	1.49	33	0.56	5.36	1.26
3	0.46	8.60	1.17	19	0.34	3.95	1.38	34	0.70	14.83	1.16
4	0.41	4.42	1.31	20	0.41	3.38	1.33	35	0.51	5.69	1.73
5	0.41	4.95	1.16	21	0.37	4.12	1.20	36	0.52	6.35	1.45
6	0.39	7.24	1.45	22	1.02	23.53	0.86	37	0.57	6.02	1.31
7	0.44	7.51	1.08	23	0.87	19.00	0.78	38	0.51	5.79	1.51
8	0.55	12.30	1.22	24	1.10	22.92	0.57	39	0.36	2.03	1.80
9	0.72	14.59	0.60	25	0.65	11.20	0.95	40	0.48	4.62	1.47
10	0.64	7.98	1.32	26	0.43	3.81	1.79	41	0.52	6.78	1.15
11	0.83	11.53	1.32	27	0.48	3.45	2.20	42	0.61	8.43	1.06
12	0.38	4.10	1.47	28	0.41	1.85	2.27	43	0.58	6.02	0.97
13	0.38	5.21	1.24	29	0.51	4.10	1.78	44	0.46	3.99	2.01
14	0.50	12.10	1.44	30	0.41	2.26	1.87	45	0.47	5.22	1.12
15	0.60	9.62	0.71	31	0.47	4.74	1.83	46	0.55	7.47	1.39
16	0.73	14.97	0.51								

Source: Lorenzen [1980].

HC = hydrocarbons; CO=carbon monoxide; NOX = nitrogen oxides; grams/mile measurements; 46 identical vehicles tested.

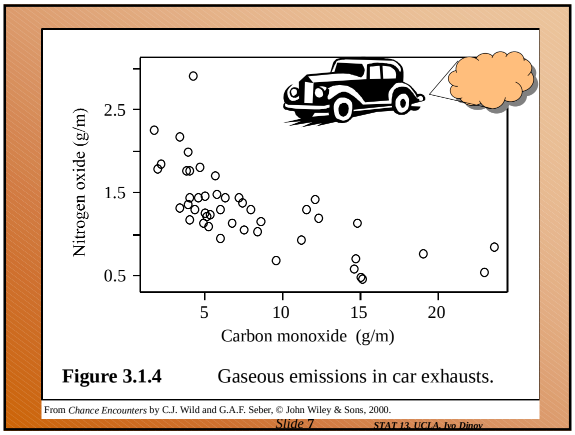


Figure 3.1.4 Gaseous emissions in car exhausts.

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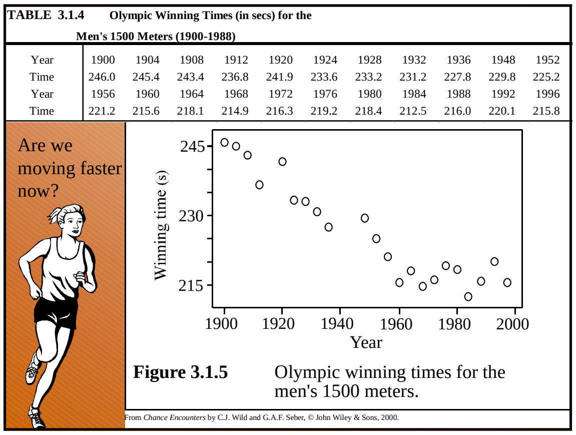

TABLE 3.1.4 **Olympic Winning Times (in secs) for the Men's 1500 Meters (1900-1988)**

Year	1900	1904	1908	1912	1920	1924	1928	1932	1936	1948	1952
Time	246.0	245.4	243.4	236.8	241.9	233.6	233.2	231.2	227.8	229.8	225.2
Year	1956	1960	1964	1968	1972	1976	1980	1984	1988	1992	1996
Time	221.2	215.6	218.1	214.9	216.3	219.2	218.4	212.5	216.0	220.1	215.8

Are we moving faster now?

Figure 3.1.5 Olympic winning times for the men's 1500 meters.

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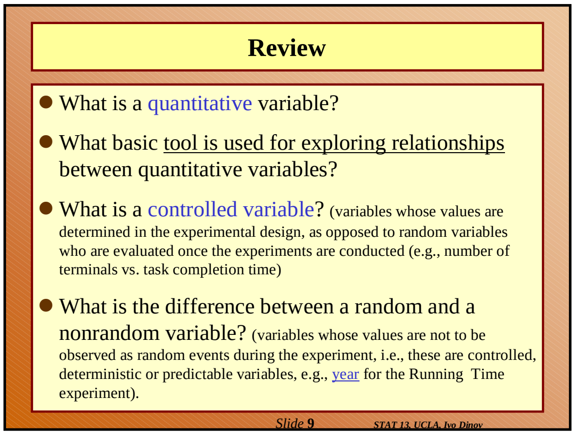
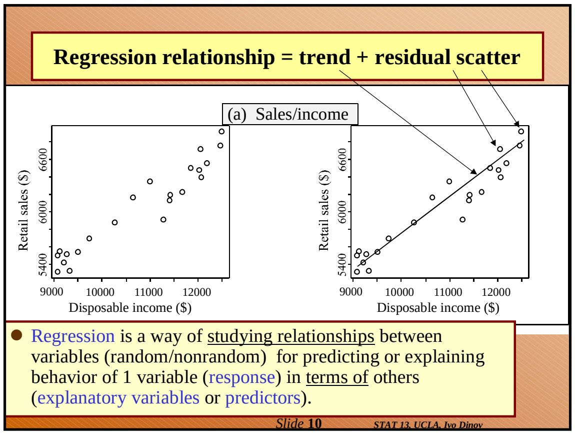


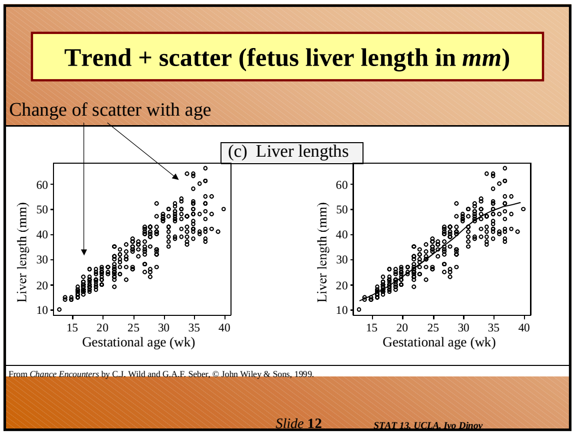
Review

- What is a quantitative variable?
- What basic tool is used for exploring relationships between quantitative variables?
- What is a controlled variable? (variables whose values are determined in the experimental design, as opposed to random variables who are evaluated once the experiments are conducted (e.g., number of terminals vs. task completion time)
- What is the difference between a random and a nonrandom variable? (variables whose values are not to be observed as random events during the experiment, i.e., these are controlled, deterministic or predictable variables, e.g., year for the Running Time experiment).



Regression relationship = trend + residual scatter

- Regression is a way of studying relationships between variables (random/nonrandom) for predicting or explaining behavior of 1 variable (response) in terms of others (explanatory variables or predictors).



Trend + scatter (fetus liver length in *mm*)

Change of scatter with age

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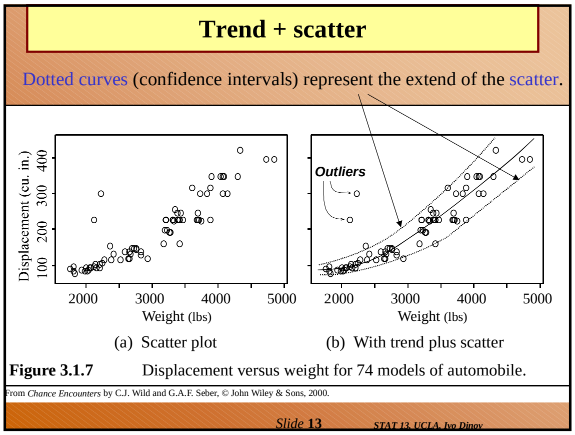

Trend + scatter

Dotted curves (confidence intervals) represent the extend of the scatter.

(a) Scatter plot (b) With trend plus scatter

Figure 3.1.7 Displacement versus weight for 74 models of automobile.

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Outliers – odd, atypical, observations (errors, B, or real data, A)

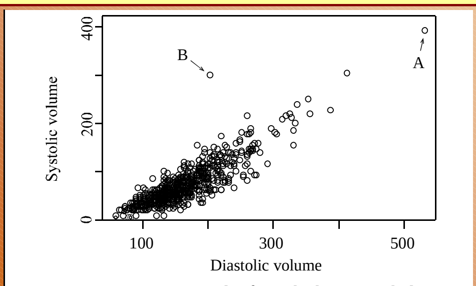

Figure 3.1.9 Scatter plot from the heart attack data.

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A weak relationship

58 abused children are rated (by non-abusive parents and teachers) on a psychological disturbance measure.

How do we quantify weak vs. strong relationship?

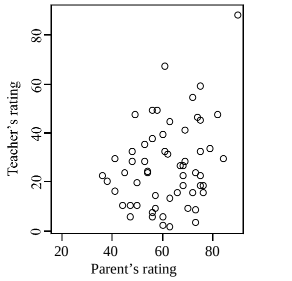

Figure 3.1.10 Parent's rating versus teacher's rating for abused children.

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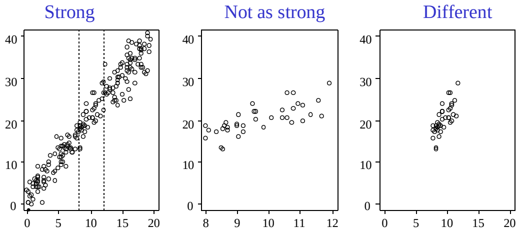
Looking at plots



(a) Full data set (b) Middle portion (c) More white space

Figure 3.1.11 Visual impressions from scatter plots.

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Strong and weak relationships

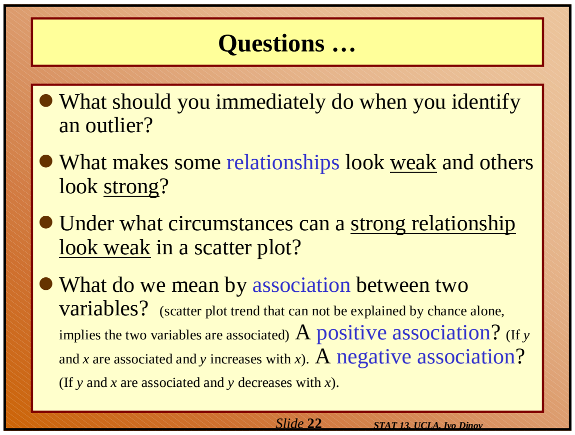
- Plotting a strong relationship only on a small X-range will make the relationship much weaker (So, be ware sample size and sample representativeness do matter).
- The x-range scale and y-range scale need to be taken into account when investigating strong/weak relationships (extending or compressing any of the axes could significantly change the relation trend).

Questions …

- When people talk about plotting *Y* versus *X*, which variable is conventionally represented on the horizontal axis and which on the vertical axis?
- What are the roles of the response variable and the explanatory variable in regression?
- On a scatter plot, which axis is conventionally used for the explanatory variable and which for the response?

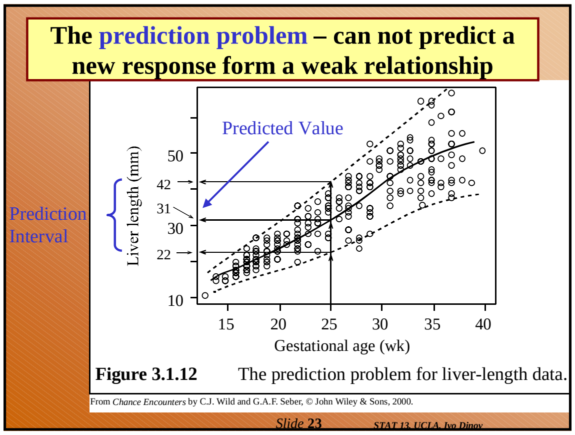
Questions …

- What are the two main components of a regression relationship?
- What do we call observations that are further from the trend curve than expected when compared with the usual level of scatter?
- Should outliers simply be discarded when analyzing data?



Questions …

- What should you immediately do when you identify an outlier?
- What makes some relationships look weak and others look strong?
- Under what circumstances can a strong relationship look weak in a scatter plot?
- What do we mean by association between two variables? (scatter plot trend that can not be explained by chance alone, implies the two variables are associated) A positive association? (If *y* and *x* are associated and *y* increases with *x*). A negative association? (If *y* and *x* are associated and *y* decreases with *x*).



The prediction problem – can not predict a new response form a weak relationship

Figure 3.1.12 The prediction problem for liver-length data.

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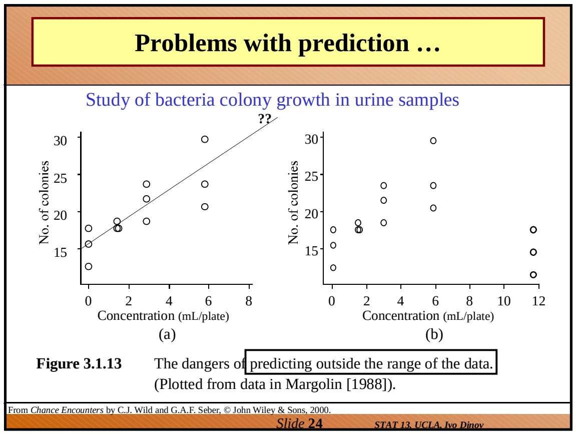

Problems with prediction …

Study of bacteria colony growth in urine samples

Figure 3.1.13 The dangers of predicting outside the range of the data. (Plotted from data in Margolin [1988]).

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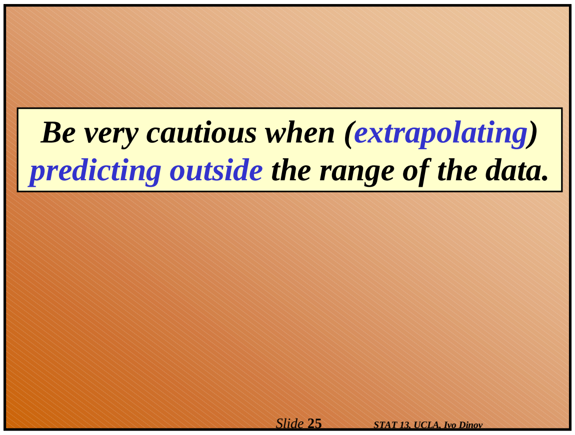
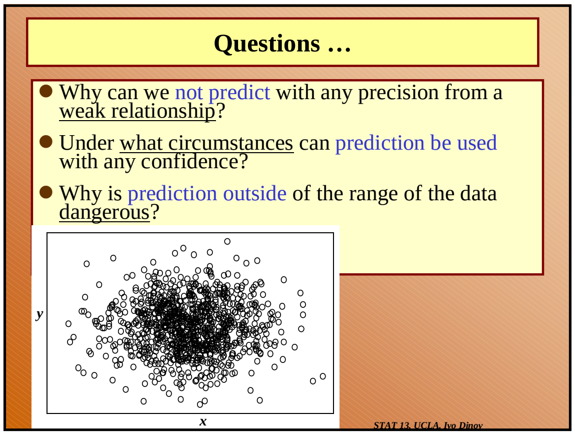
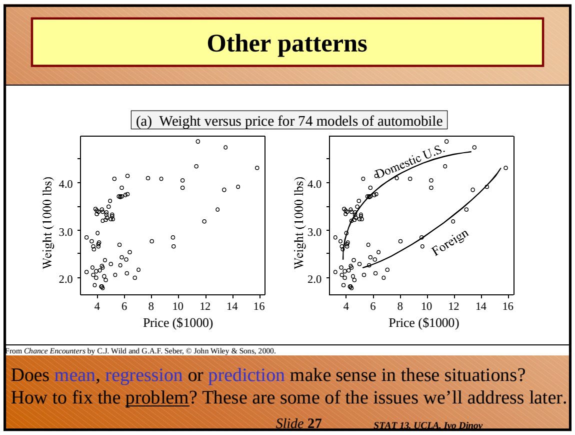


Be very cautious when (extrapolating) predicting outside the range of the data.



Questions …

- Why can we not predict with any precision from a weak relationship?
- Under what circumstances can prediction be used with any confidence?
- Why is prediction outside of the range of the data dangerous?

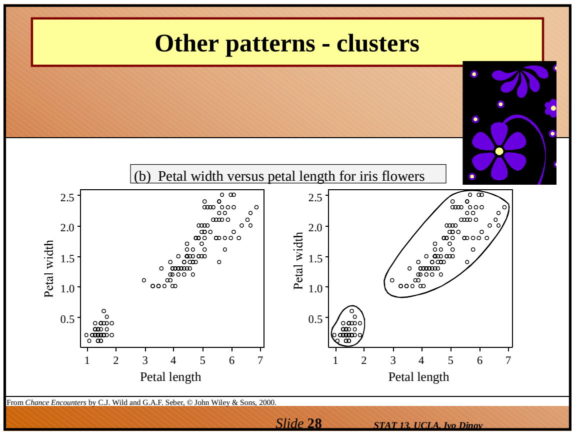


Other patterns

(a) Weight versus price for 74 models of automobile

From *Chance Encounters* by C.J. Wild and G.A.F. Seber, © John Wiley & Sons, 2000.

Does mean, regression or prediction make sense in these situations? How to fix the problem? These are some of the issues we'll address later.



Other patterns - clusters

(b) Petal width versus petal length for iris flowers

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