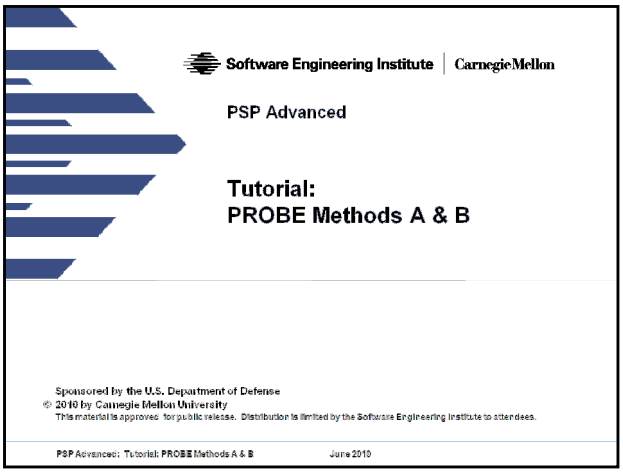
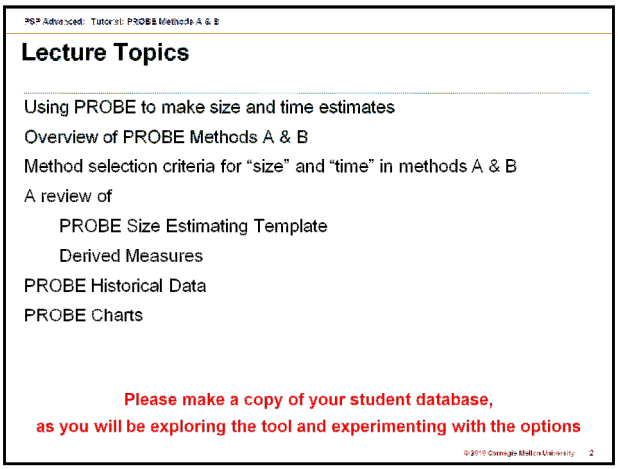


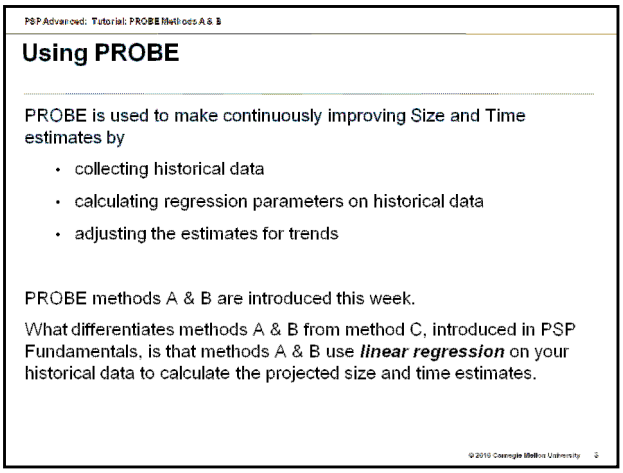
This tutorial will go into the details of how PROBE Methods are evaluated for best fit based on the individual's historical data.



We will provide a refresher for the class and go over the PSP Size Estimating Template in the student tool.

It may be a good idea to have the students bring up their student tool.

Engaging the class to look at their tool will also help keep the focus on the tutorial and eliminate internet surfing and email correspondence during the lecture.


PSP Advanced: Tutorial: PROBE Methods A & B
Using PROBE
PROBE is used to make continuously improving Size and Time estimates by
• collecting historical data
• calculating regression parameters on historical data
• adjusting the estimates for trends
PROBE methods A & B are introduced this week.
What differentiates methods A & B from method C, introduced in PSP Fundamentals, is that methods A & B use linear regression on your historical data to calculate the projected size and time estimates.
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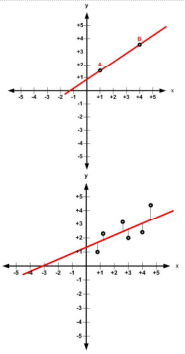
Minimum Data for Using Regression

The regression line represents the best fit (or smallest possible distance from the regression line to the data points).

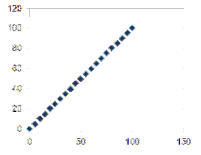
When we have only 2 data points, the regression line goes right through them for a perfect fit, but it is not meaningful.

For the regression line to act as the predictor, we need more data points (at least 3).

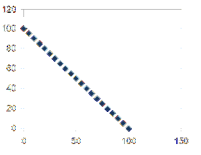


Correlation

Correlation (r) (a.k.a. Correlation Coefficient): Degree to which two sets of data are linearly related.



Positive Relationship (r = +1)

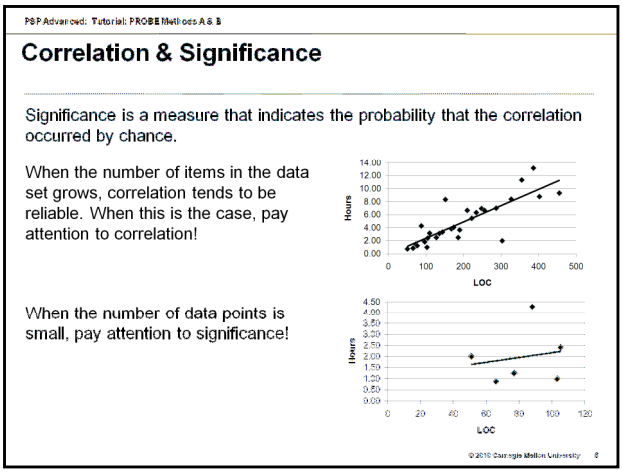


Negative Relationship (r = -1)

Correlation squared (r^2): Descriptive measure between zero and one, indicating how good one term is at predicting another.

An r^2 of 1 is considered a perfect fit!

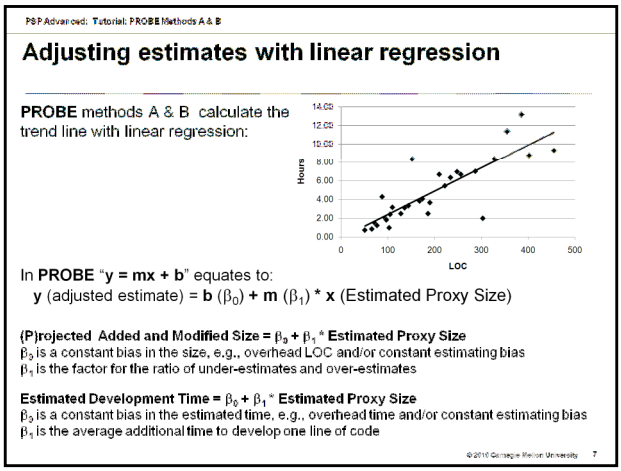
To use methods A & B, an r^2 of 0.5 or higher is required.



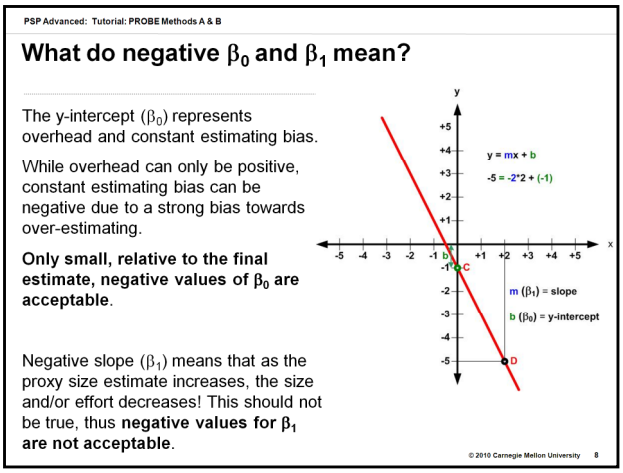
Note, there is always the possibility that a high correlation was the result of chance (just a random event) and there is not a real cause and effect relationship between the two data sets. Significance is measure of that probability.

The point here is that when you have only a small number of data points in the regression and you get a good correlation, you should also check the significance measure to determine if the relation is likely due to chance and is not a true cause/effect relationship.

The students will implement the significance calculation in assignment on day 3 of this course.

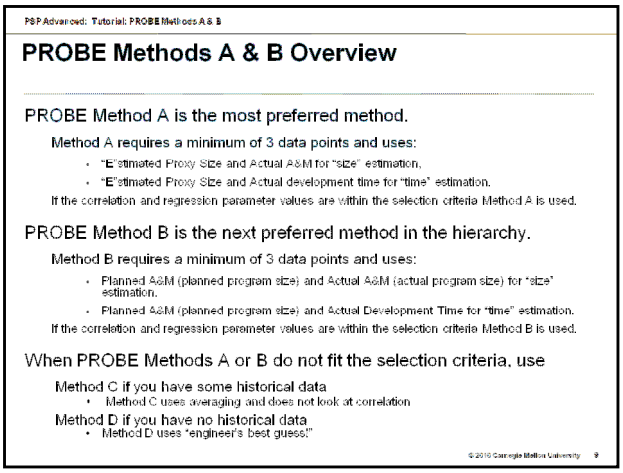


Note that beta0 is not strictly overhead (LOC or time), it also accounts for a consistent constant estimating bias.



It's important to note that negative values of beta0 are valid. They can arise due to a constant estimating bias to overestimate. The regression compensates for this tendency to overestimate by a constant amount with a negative beta0.

Note that the absolute value of B0 is used in the PROBE method selection scripts. A small negative B0 is acceptable because it will not make the estimate unreasonable. The script guidelines work well enough for planning purposes.


PSP Advanced: Tutorial: PROBE Methods A & B
PROBE Methods A & B Overview
PROBE Method A is the most preferred method.
Method A requires a minimum of 3 data points and uses:
"E"stimated Proxy Size and Actual A&M for "size" estimation.
"E"stimated Proxy Size and Actual development time for "time" estimation.
If the correlation and regression parameter values are within the selection criteria Method A is used.
PROBE Method B is the next preferred method in the hierarchy.
Method B requires a minimum of 3 data points and uses:
Planned A&M (planned program size) and Actual A&M (actual program size) for "size" estimation.
Planned A&M (planned program size) and Actual Development Time for "time" estimation.
If the correlation and regression parameter values are within the selection criteria Method B is used.
When PROBE Methods A or B do not fit the selection criteria, use
Method C if you have some historical data
Method C uses averaging and does not look at correlation
Method D if you have no historical data
Method D uses "engineer's best guess!"
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Rules for Method Selection regarding Size

Check if method A can be used.

- You have three or more data points (***estimated E*** and **actual A&M**) that correlate ($r^2 \geq 0.50$).
- The absolute value of β_0 is less than about 25% of the expected size of the new program
- β_1 is between 0.5 and 2.

If method A cannot be used, check method B.

- You have three or more data points (***plan A&M*** and **actual A&M**) that correlate ($r^2 \geq 0.50$).
- The absolute value of β_0 is less than about 25% of the expected size of the new program.
- β_1 is between 0.5 and 2.

If method B cannot be used and you have historical data, use method C.

If you have no historical data, use method D.

Rules for Method Selection regarding Time

Check if method A can be used.

- You have three or more data points (***estimated E*** and **actual time**) that correlate ($r^2 \geq 0.50$).
- β_0 should be near 0 (substantially smaller than the expected development time for the new program).
- β_1 should be within 50% of 1/(historical productivity)

If method A cannot be used, check method B.

- You have three or more data points (***plan A&M*** and **actual time**) that correlate ($r^2 \geq 0.50$).
- β_0 should be near 0 (substantially smaller than the expected development time for the new program).
- β_1 should be within 50% of 1/(historical productivity)

If method B cannot be used and you have historical data, use method C.

If you have no historical data, use method D.

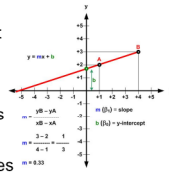
Where do the Size guidelines come from?

Rule for ***Size*** β_0

- Having the overhead and constant bias (β_0) almost as big as the finished product would not make sense. It would mean estimated proxy size has little influence on the estimate size.
- The absolute value of β_0 should be less than about 25% of the expected size of the finished product.

Rule for ***Size*** β_1

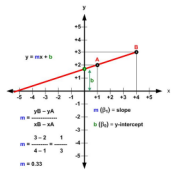
- Normally, the slope (β_1) should be near 1.0. Values between 0.5 and 2.0 are acceptable.
- A value of less than 0.5 or greater than 2.0 indicates a large proportional over or under bias and should not be used unless your instructor agrees.



Where do the Time guidelines come from? - 1

Rule for ***Time*** β_0

- Having the overhead and constant bias (β_0) almost as large as the final estimated time would not make sense. It would mean estimated proxy size has little influence on the estimated time.
- The absolute value of β_0 should be significantly smaller than the estimated development time.



Where do the Time guidelines come from? - 2

Rule for ***Time*** β_1

- "Time" β_1 needs to be within 50% of (1/Historical Productivity)

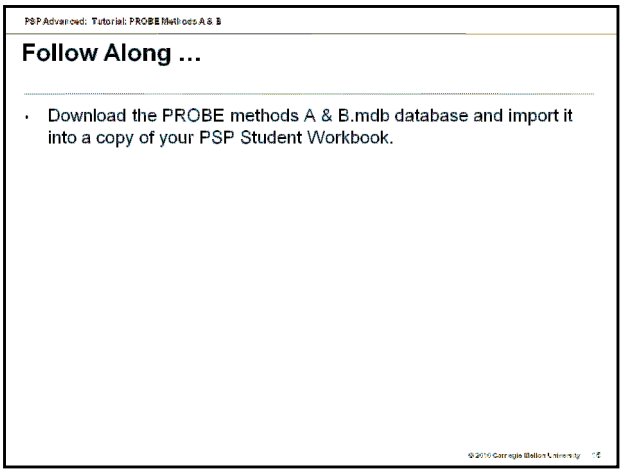
Example:

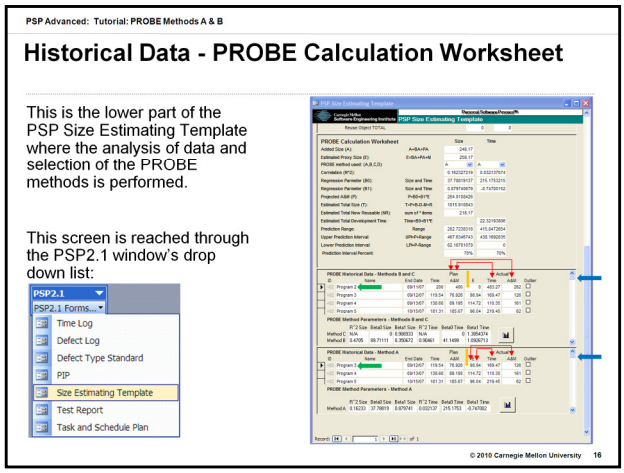
How long would it take to code one LOC if historical average productivity is at 30 LOC per hour?

30 LOC	1 hr
1 LOC	x hrs

$30x = 1 \rightarrow x = 1/30 = 2$ minutes per LOC

For this example, if b1 is not between 1 and 3 minutes per LOC (within 50%), the correction applied is too great and should not be used.





We display the lower portion of the PSP Size Estimating Template first as our journey will start in the lower portion.

This slide introduces the parts of the screen with red arrows to indicate the main topics of discussion,

While we will go into the details later, it may be a good idea here to show (with the green arrows) that Method B&C's historical data starts with Program-2 where they did estimate time for each phase for the first time, and that Method A's historical data starts with Program-3 where they started proxy based estimating. Note the first orange arrow on Program-2 and point out that there is no "E" and then point out the second orange arrow on Program-3 where there is an "E"stimate and that with Program-3 we started building historical data on "E"stimated Proxy Size.

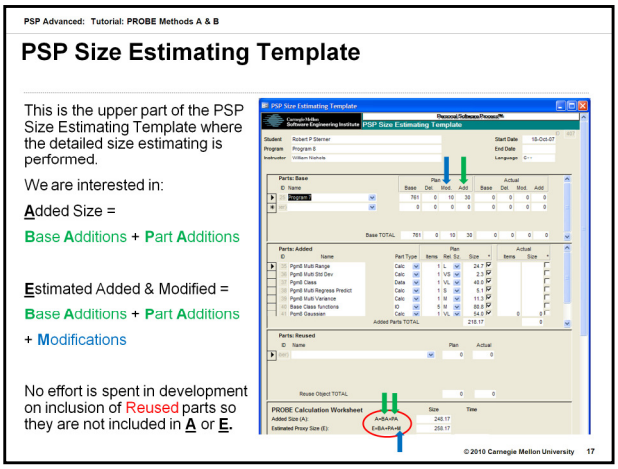
Since both Method A and Method B require a minimum of 3 data points, Method B has data starting from Program-2, and Method-A from Program-3.

Method A uses "E"stimated Proxy Size and Actual A&M for "size", and "E"stimated Proxy Size and Actual development time for "time" (The double sided red arrows in PROBE Historical Data – Method A section).

Method B uses Planned program size and Actual program size for "size", and Planned program size and Actual development time for "time" (The double sided red arrows in PROBE Historical Data – Method B and C section).

Point to blue arrows and remind that they can scroll through and view the historical data for all the programs they have developed so far.

Have the class go into their student tools and acknowledge that the entire class is now familiar with this part of the PSP Size Estimating Template.

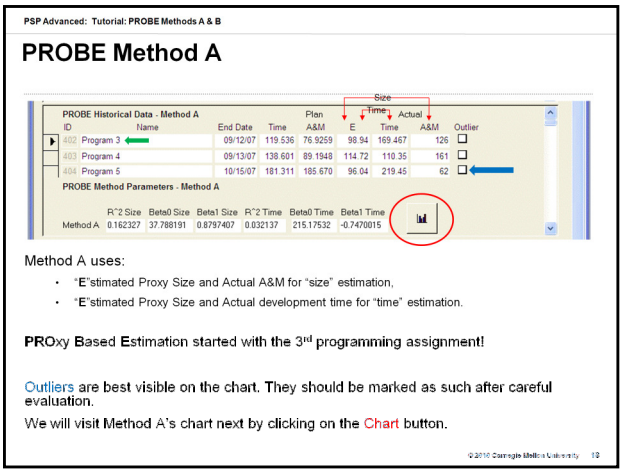


This slide is a refresher to get everyone's understanding on the same page.

We are interested in two derived measures: A = BA + PA and E = BA + PA + M.

It is a good idea to remove any confusion about "base" and "reused" here, if there is any!

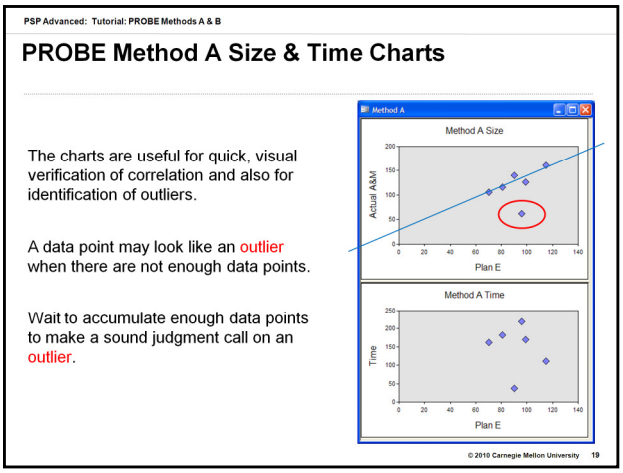
Also remind the students that if most of the newly added parts are of medium size it is indicative of a good conceptual design, not too detailed where many parts are too small, and not too high level where many parts are too large.



We show on the slide where the data is coming from for use in Method A.

Also mention that it is discouraged to mark a data point as an outlier as fluctuation is normal and evaluation should be deferred until substantial amount of data is collected.

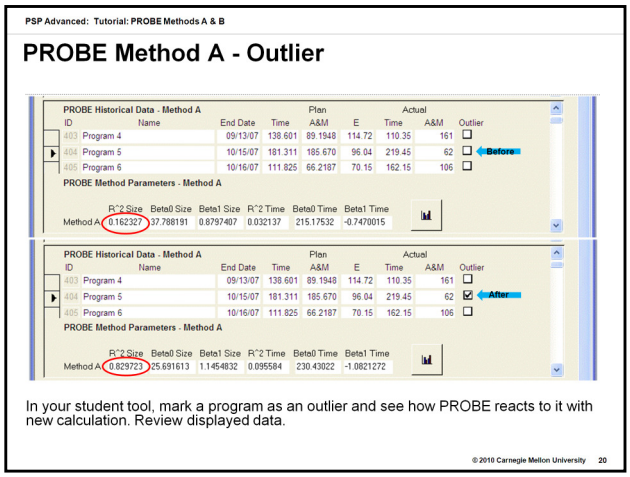
Method A's historical data starts with Program-3 where they started proxy based estimating.



Note that based on an individual's perception a visually drawn regression line may or may not be accurate!

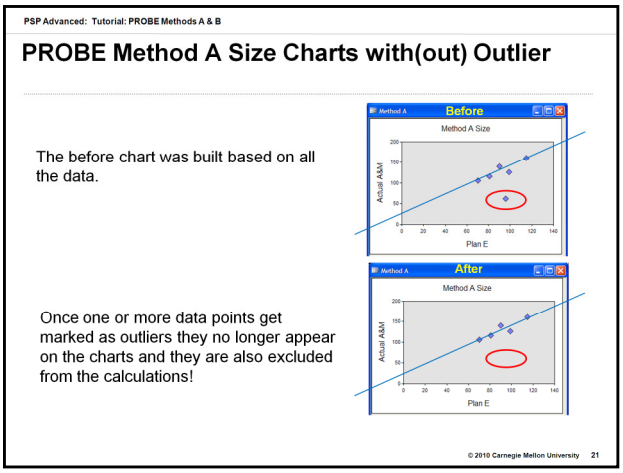
On this example explain that when the data point circled in red is marked as an outlier we get a pretty good regression, but this would be the wrong approach as there are too few data points to make a sound judgment call!

Note: Student tool does not draw a regression line. It is best to go back to PROBE Size Estimating Template and look at the calculated correlation value and regression parameters!

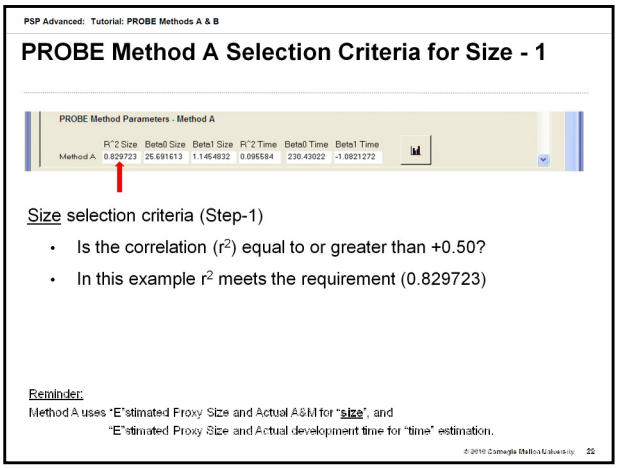


Explain that this is the “advanced” course and the students should feel pretty comfortable exploring the options on the tool and get familiar with them.

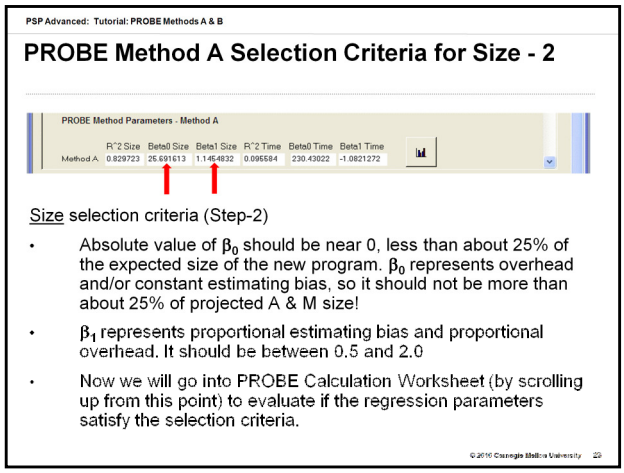
Note: **Correlation changed drastically in this example!**



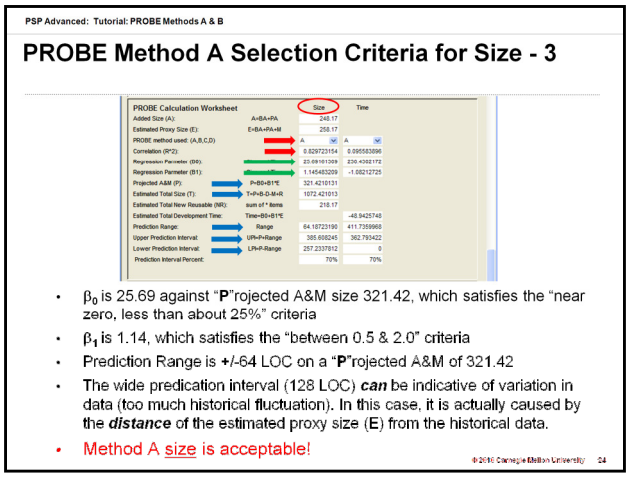
Tell the students that marking a data point as outlier does not delete the historical data on that program, the PROBE will be blind to that program's data.



Note that the correlation should be a positive number. If there is a negative correlation for example, between size and time, then it would mean that it takes less time to write larger programs!



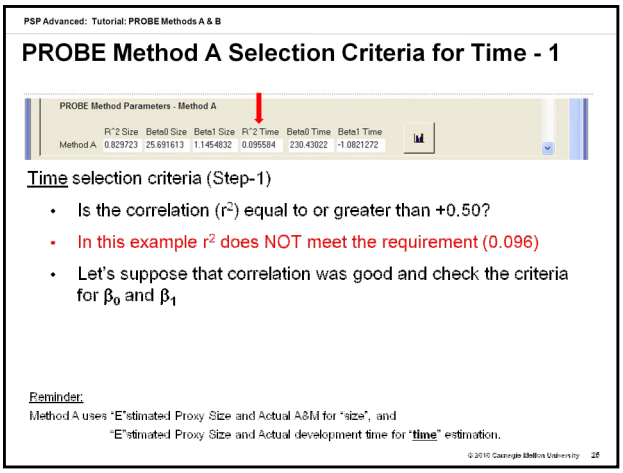
β_1 represents proportional estimating bias and is used to correct the estimated LOC. If we are correcting it by more than 100% as is the case with 2.0, then we should not be using these regression parameters as the tool thinks that the finished product will be two times the size of our estimate. In contrast if we are reducing our estimated LOC by more than 50% as is the case with 0.5, then again we should not be using these regression parameters as the tool thinks we are being overly cautious.



Method A fits the selection criteria, so it should be selected.

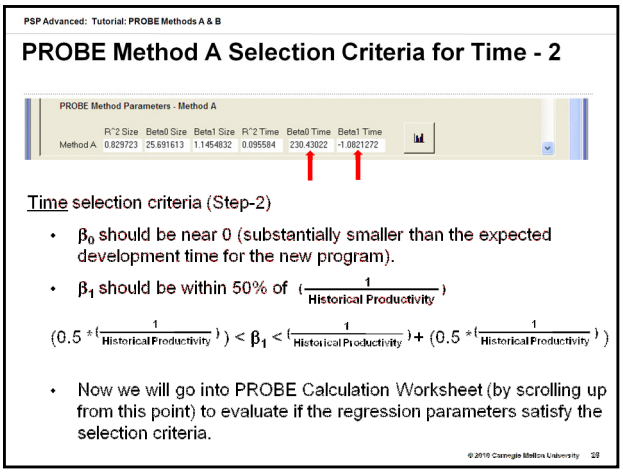
A couple things to note about the prediction interval

- It is not part of the selection criteria for the method choice.
- The magnitude of the prediction interval is mainly affected by 2 items
  - the variation of the historical data about the regression line
  - The "distance" of the new estimated proxy size (E) from the historical data
- The larger either of these is, the larger the prediction interval is
- In this example, the variation of the historical data about the regression line is "small" – see the earlier charts. But the "distance" of the new estimated proxy size from the historical data is "large". So although the historical data has little fluctuation, because the new estimated proxy size (e) is well outside the range of the existing data, the prediction interval is large.



Note that the slope (β_1) should be a positive number. For example, if the slope, between size and time, is negative, then it would mean that it takes less time to write larger programs!

In this case, the slope (b1), is negative so we could immediately conclude that Method A is not usable for time!



β_0 and β_1 should be explained here as to what they mean regarding "time". In LOC/Size, β_0, represented overhead such as declarations, setting up development environment and/or constant estimating bias.

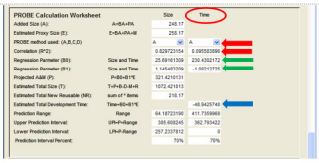
In "time" β_0 represents time spent that isn't related to size (possibly planning and/or postmortem and/or overhead items) and constant estimating bias.

β_1 should be within half of 1/"Historical Productivity". The rational for this is that since the B0 should be substantially smaller than the expected development time and that the Projected A&M should be somewhere between ½ and 2x the estimated proxy size, b1, which is the main determinate of the time estimate, should be within 0.5 and 1.5 the reciprocal of the historical productivity expressed in minutes/LOC.

NOTE, however, this is an academic exercise in this case since b1 is negative, we can immediately conclude that method A is not usable for time!

NOTE: The historical productivity needs to be converted to minutes per LOC instead of Hours per LOC before making the comparison.

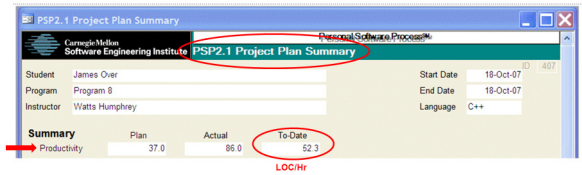
PROBE Method A Selection Criteria for Time - 3



- β_1 is -1.08. A ***negative*** slope is not acceptable! We can immediately conclude that method A is not usable for time.
- β_0 is 230.43 against total development "Time" of -48.94, which is totally outside of acceptable parameters
- β_0 also does NOT satisfy the selection criteria
- "Time" is -48.94 minutes, which is meaningless!
- If β_1 was good, how do we check the selection criteria for β_1?

PSP Advanced: Tutorial: PROBE Methods A & B

PROBE Method A Selection Criteria for Time - 4



- If β_1 were positive, you would then check if it met the criteria.

  reciprocal of productivity = (1/52.3) * 60 = 1.14 min/LOC

  $1.14 - (1.14/2) < \beta_1 < 1.14 + (1.14/2)$

  $0.57 < \beta_1 < 1.71$

(From previous slide) β_1 does not satisfy Method A's selection criteria for Time!

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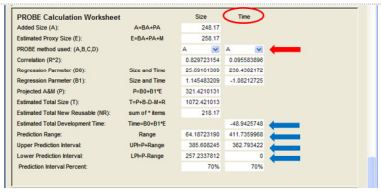
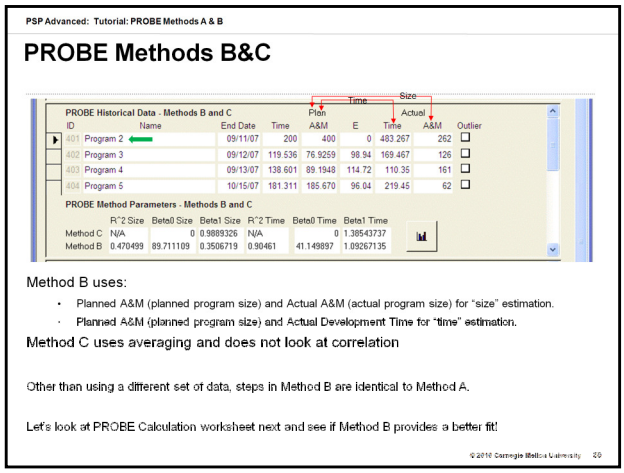
Note that historical productivity is LOC/Hr, so we multiply the result by 60 to get the per minute value!

PROBE Method A Selection Criteria for Time - 5



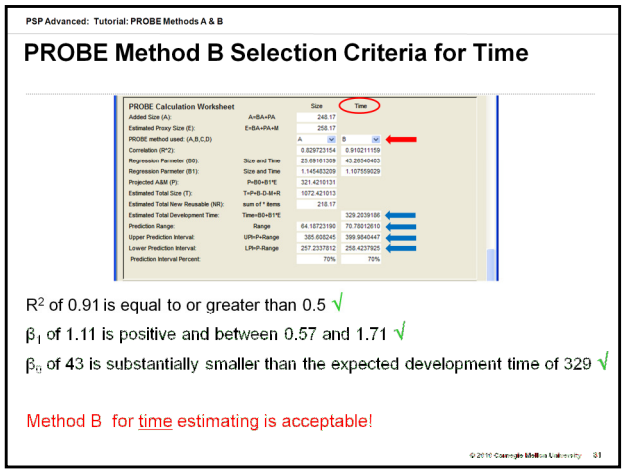
PROBE Calculation Worksheet		Size	Time
Added Size (A):	A=BA+PA	248.17	
Estimated Proxy Size (E):	E=BA+PA+M	258.17	
PROBE method used: (A,B,C,D)		A	A
Correlation (R^2):		0.829723154	0.095583896
Regression Parmeter (B0):	Size and Time	25.09101099	236.4362172
Regression Parmeter (B1):	Size and Time	1.145483209	-1.08212725
Projected Add (P):	P=B0+B1*E	321.4216131	
Estimated Total Size (T):	T=P+B-D-M+R	1072.421613	
Estimated Total New Reusable (NR):	sum of * items	218.17	
Estimated Total Development Time:	Time=B0+B1*E		-48.9425746
Prediction Range:	Range	64.18723199	411.7359968
Upper Prediction Interval:	UPI=P+Range	385.608245	362.793422
Lower Prediction Interval:	LPI=P-Range	257.2337812	0
Prediction Interval Percent:		70%	70%

- Range is 411.74 minutes against estimated development "Time" of -48.94, which is totally meaningless,
- Upper and Lower prediction intervals therefore are meaningless too.
- Our next option for time is Method B.

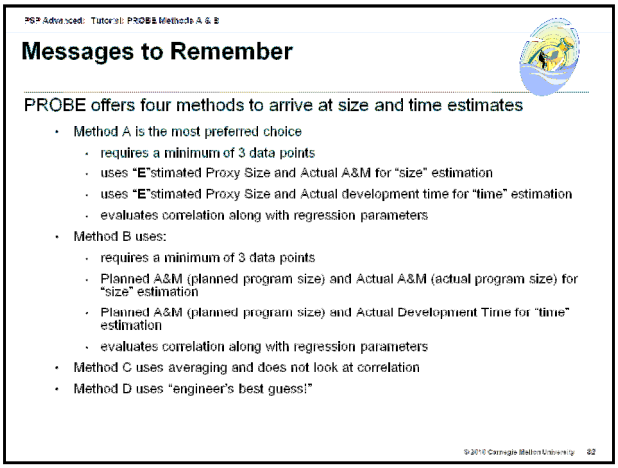


We show on the slide where the data is coming from for use in Method B.

Also mention that it is discouraged to mark a data point as an outlier as fluctuation is normal and evaluation should be deferred until substantial amount of data is collected.



In this example, the Time selection criteria was not met by Method A, then we came into Method B and found it to be acceptable


PSP Advanced: Tutorial: PROBE Methods A & B
Messages to Remember
PROBE offers four methods to arrive at size and time estimates
Method A is the most preferred choice
requires a minimum of 3 data points
uses "E"stimated Proxy Size and Actual A&M for "size" estimation
uses "E"stimated Proxy Size and Actual development time for "time" estimation
evaluates correlation along with regression parameters
Method B uses:
requires a minimum of 3 data points
Planned A&M (planned program size) and Actual A&M (actual program size) for "size" estimation
Planned A&M (planned program size) and Actual Development Time for "time" estimation
evaluates correlation along with regression parameters
Method C uses averaging and does not look at correlation
Method D uses "engineer's best guess!"
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