

Good Estimates and Bad Biases:

How can we create a good work estimate despite the human biases in our judgment?

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“The fault, dear Brutus, is not in our stars, but in ourselves...”
- Cassius, in William Shakespeare’s *Julius Caesar*

Introduction

When you do a poor job of planning a project that involves a new technology or unfamiliar work, you can blame your bad estimates on the “difficulties of unfamiliar work.” However, if your work estimates remain inaccurate for subsequent projects in a familiar environment, you should wonder whether your difficulties might be caused by something other than just personal shortcomings. As it turns out, certain kinds of mental errors are innate. Over the past forty years, psychologists have unearthed what they call “psychological traps” in our thinking, places where our judgment goes awry because we are human.

This discussion will review several of these traps and show how they affect our work estimates. The theme will be, “Forewarned is forearmed.” If we are conscious of these traps, we can engage in compensating behavior that will lead to better estimates. Better estimates of effort and duration will mean a better project plan, better project control, less re-planning, and a greater likelihood of meeting the final schedule.

High or Low?

Why do we so often fail to make accurate work estimates when we try? Why do we bias our estimate one way or the other?

We estimate *high* because we are *cautious*:

- To give ourselves some freedom, some room for maneuver
- To protect ourselves against some uncertainty
- To make a commitment that we are sure we can keep
- Because we are under-confident in our knowledge about the work
- Because we are under-confident in our ability to do the work
- Because we are pessimistic in our general outlook

We estimate *low* because we are *bold*:

- To give ourselves a challenging goal
- To expose ourselves to some uncertainty
- To make a commitment that will look good when we keep it
- Because we are over-confident in our knowledge about the work
- Because we are over-confident in our ability to do the work
- Because we are optimistic in our general outlook

Looking over the two lists we might hope that the reasons would cancel each other out. Unfortunately, research shows that, left to our instincts, we will estimate *low*. If, however, we become aware of the psychological traps that cause our estimates to be low, we can overcome these tendencies and improve our estimating.

Project Planning and Human Foibles

Among the many psychological traps that affect our judgment are five that have a serious effect on project work estimation:

1. Being too sure of yourself: The overconfidence trap
2. Seeing what you want to see: The confirming-evidence trap
3. Neglecting relevant information: The base-rate trap
4. The meaning of the mean: The regression trap
5. Slanting probabilities and estimates: The prudence trap[1]

The first four traps tend to generate work estimates that are *unrealistically low*; the fifth trap, *unrealistically high*. Our goal is to end up somewhere in the *realistic middle*. We will examine each trap in turn.

The Overconfidence Trap: Being too sure of yourself

When individuals are given tests and asked how confident they are in their answers, their score for “100% certain” answers is about 80%; their score for “80% confident” answers is 50%. Different experiments over different ranges confirm that, in general, we are *overconfident* [2].

Overconfidence also leads to estimates that fall within a too-narrow range to capture some unknown number, like the birth date of a famous person, or the distance between two given cities. When given 10 unknowns to bracket with “90% confidence,” people succeed only 60% of the time.

So an estimate of work to be performed is liable to be low because we are overconfident in our estimation skill, our knowledge of the work, and our ability to do the work.

The remedy for this trap is a little humility, followed closely by curiosity about a reference class of similar work examples. Such examples are often found in old project plans and in colleagues’ experiences. By gathering relevant historical evidence, we temper our initial overconfidence with data about what has actually happened in similar circumstances.

The Confirming Evidence Trap: Seeing what you want to see

When proponents and opponents of capital punishment are presented with two scientific studies, one with supporting data and one with opposing data, everyone, on both sides, emerges from their reading assignments even *more certain of their original position*. We human beings select evidence to confirm our beliefs and we ignore that which conflicts with our beliefs.

The confirming-evidence trap takes an estimator's natural pride of work and adds the tendency to notice only reinforcing examples of how well the estimated work can be completed.

A good antidote to this trap is to remind yourself *to pay attention to data that do not agree with your beliefs* about the work. In particular, when you select your reference class of other work, try to assess *at least three* points of information:

1. What's the fastest this has ever been done? (Easy to do because it agrees with our flattering self-image.)
2. What's the slowest this has ever been done? (Hard to do because it contradicts our flattering self-image and probably requires a little extra pessimistic push on our recollection.)
3. What, in between the extremes, is the most likely single value? (Likely to drift towards the flattering end unless supported by a larger number of examples in the reference class.)

The Base-Rate Trap: Neglecting relevant information

When a publisher is asked about the future sales of a new novel, she tends to extrapolate from information about the particular book, its author, plot, and style, rather than from general statistics about the sales of similar novels. Repeated experiments confirm that we tend to focus on the *singular information* about the particular case under consideration and pay little or no attention to the base-rate data about the *distributional information* of outcomes in similar situations.

Here's an experiment that illustrates this tendency. A person is asked to identify "Steven's profession" as either a librarian or a sales rep. Steven is described as "Very shy and withdrawn, invariably helpful, but with little interest in people or in the world of reality. A meek and tidy soul, he has a need for order and structure and a passion for detail." Most of the time, people guess that Steven is a librarian.

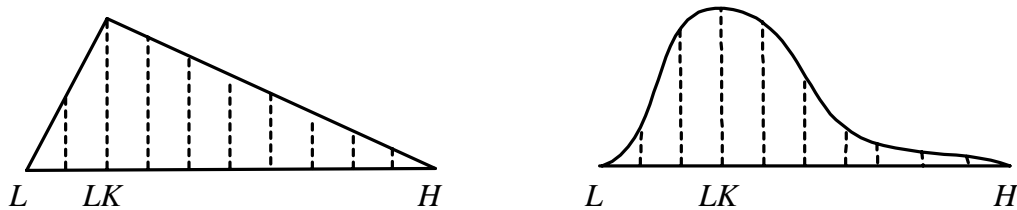
Even after we are told that in our society there are 100 male sales reps for every male librarian, we still choose librarian. We ignore the overwhelming odds that a small percentage of shy sales reps will significantly outnumber the scarce male librarians and we continue to choose the wrong answer.

In other experiments, if Steven's choice of professions is lawyer or engineer, people's answers will split 50-50. If told that the lawyer/engineer ratio is 70-30 (either way!), people will *still* split in their answers 50-50! Again, our behavior illustrates the base-rate trap where we focus on *singular* data with a wealth of detail about one individual and neglect *distributional* data.

For our work estimate, the way to avoid to the base-rate trap is to ask an additional question of the reference class (after we have good values for low, likely, and high). The question is "What is the weighted center (also called the mean) of the whole distribution?"

For example, if the reference class is distributed over the range like a “triangle,” with a low of 2, a likely of 4, and high of 8, it has mean a equal to $(2 + 4 + 8) / 3$ or 4.7. If the distribution is like a “beta” distribution, the mean is equal to $(2 + 4 \times 4 + 8) / 6$ or 4.3. In both distributions [3] the mean is *higher* than the “most likely” and represents a full acknowledgment of the entire base-rate distribution of the data.

Figure 1. Triangular and Beta Distributions.



The Regression Trap: The meaning of the mean

Over one hundred years ago Francis Galton discovered that tall parents have shorter children and short parents have taller children. Any group with an average that differs from the overall population will have offspring that, on average, are closer to the overall population’s average. The offspring’s average will “regress towards the mean” of the population.

Yet when we are informed that Group 1 consists of everyone who scored in the top 10% of History Test A and we are asked where Group 1’s average score will fall when presented with History Test B (of equal difficulty), we answer “in the top 10%.” We forget that the group average will regress towards the mean and probably be lower than the top 10%. The likelihood is that any group whose average was above (different from) the mean the first time will be closer to the mean the second time. (The score may still be above the mean, but it will probably be below the high first score and closer to the mean.)

To include an initial, intuitive guess in our final estimate, we need to counteract the regression trap by taking some final steps. After we have established a reference class, a range of values, an assumption about the distribution, and a mean value, the final steps begin with a look back at our initial guess and at our level of confidence in that guess. If our initial guess equals the mean, we are done. If the guess is off the mean we should move it back towards the mean. (If we are very sure of our guess, we should only move it back a little bit; if we were wildly guessing, we should move it back most of the way back to the mean.) In short, our steps should *regress our estimate* towards the mean [4].

The Prudence Trap: Slanting probabilities and estimates

We have been low before and we wish to avoid being wrong again, so after we have completed our analysis, we “pad” our estimate a little. Our boss does the same thing. Somewhere up the decision chain, someone arbitrarily cuts the estimate. Prudence, “worst-case” anxiety, and “fear of padding” lead to an estimate that has become completely unhinged from reality.

The prudence trap in estimation is *altering an estimate by an amount that is not supported by the evidence* of the reference class you have assembled. To compensate, keep your estimates *honest*, stay with what you know, and be sure that others know that your estimate is *not* padded.

Conclusion: Work in Process

In order to combat our inherent tendencies to make an overconfident, prejudicial, singular-focused, regression-ignoring estimate we can use this process:

1. Select a reference class (historical results of similar activities to establish base rates for this work).
2. Assess the distribution of outcomes by asking:
 - a. What’s the best this has ever been?
 - b. What’s the worst this has ever been?
 - c. What’s the most likely single value for this?
3. Find the *mean* (the weighted center) of the distribution.
4. Position your intuitive, original, (optimistic?) estimate in the distribution.
5. Assess the *reliability* of your original estimate. (It’s very reliable, 0.9 [tomorrow’s weather]; it’s very unreliable, 0.1 [total runs in tomorrow’s baseball game]).
6. If your original estimate is not the mean of the distribution, adjust your estimate by regressing towards the mean.
 - a. When your reliability is 0.3, correct by going 70% of the way back to the mean;
 - b. When 0.4, 60% and so on...

This process improves our work estimates by compensating for our very human biases. If we treat these new estimates honestly (without added padding), our project’s plan has a much higher likelihood of being true, our project work can be better managed against the plan, and our results can arrive on time!

Notes

1. The language for all the traps but “regression” is taken from Hammond, et al., below. Regression is found in Kahneman and Tversky, 1982.
2. The data on the experiments for all of these traps can be found in Kahneman and Tversky, 1982. Several anecdotes are also recounted in Hammond, et al., with additional references.
3. Details on the Beta distribution, the Triangular distribution, and general work estimation are in Nevison.

4. This regressing towards the mean is described in Kahneman and Tversky, 1982, and how to deal with regression is described in Lovallo and Kahneman, 2003.

References

1. Hammond, John S., Ralph L. Keeney, and Howard Raiffa, (1999) *Smart Choices*, Boston, MA: Harvard Business School Press.
2. Kahneman, Daniel, Paul Slovic, and Amos Tversky (editors), (1982) *Judgment under uncertainty: Heuristics and biases*, New York, NY: Cambridge University Press.
3. Lovallo, Dan, and Daniel Kahneman, (July, 2003) "Delusions of Success: How Optimism Undermines Executives' Decisions," *Harvard Business Review*.
4. Nevison, John M., (2010) *Embracing the Dragon's Tail: Range Estimation of Project Cost and Schedule*, White Paper, Concord, MA: New Leaf Project Management.
5. Tversky, Amos and Daniel Kahneman, (October, 1992) "Advances in prospect theory: Cumulative representation of uncertainty," *Journal of Risk and Uncertainty*, Volume 5, Number 4.

About the Author

John M. (Jack) Nevison, PMP, is the author of six books and numerous articles on computing and management. During the course of his business career, Nevison has built and sold two businesses, managed projects, managed project managers, and served as both an internal and external consultant to Fortune 100 companies. He is a past president of the Mass Bay Chapter of the Project Management Institute (PMI®) and a past president of the Greater Boston Chapter of the Association for Computing Machinery (ACM). Nevison is a certified Project Management Professional (PMP), and a Phi Beta Kappa graduate of Dartmouth College.

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PDU Questions: Good Estimates and Bad Biases

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1. Compensating behavior will NOT lead to:
 - a. Better estimates
 - b. Better project plan
 - c. Less re-planning
 - d. Missed schedules

2. We estimate high because we are:
 - a. Bold
 - b. Cautious
 - c. Optimistic
 - d. Over-confident

3. We estimate low because we are:
 - a. Bold
 - b. Cautious
 - c. Pessimistic
 - d. Under-confident

4. Failure to estimate a broad-enough range for an uncertain quantity is an example of which trap?
 - a. Overconfidence
 - b. Confirming-evidence
 - c. Ignoring base-rate
 - d. Regression

5. Ignoring evidence that does not agree with your opinion is an example of which trap?
 - a. Overconfidence
 - b. Confirming-evidence
 - c. Ignoring base-rate
 - d. Regression

6. Failure to pay attention to the distributional information about an estimate is an example of which trap?
 - a. Overconfidence
 - b. Confirming-evidence
 - c. Ignoring base-rate
 - d. Regression

7. Failure to reconcile your original guess with your reference distribution of related examples is an example of which trap?
 - a. Overconfidence
 - b. Confirming-evidence
 - c. Ignoring base-rate
 - d. Regression

8. Which trap would make your estimate high?
 - a. Regression
 - b. Overconfidence
 - c. Prudence
 - d. Ignoring base-rate

9. The two distributions for three-points mentioned in the discussion are:
- Triangular and beta
 - Triangular and exponential
 - Exponential and beta
 - Constant and triangular
10. The steps in the recommended work process that are uniquely devoted to addressing the regression trap are:
- Steps 1-2
 - Steps 1-4
 - Steps 3-6
 - Steps 4-6

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