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## AB Testing: Too Little, Too Early?

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Lately, everywhere you go analytics industry folks are talking about AB Testing. That's a good sign, since it means the industry is focusing on an overlooked leverage point in their web analytics investment.

But as so often happens, achieving full buzzword compliance has become the goal rather than the means; what lies behind the words is often lost. In this case, "AB testing" – the buzzword – has become a euphemism for plain old "testing", which, like ordering liver on a first date, may be good for you, but is certainly not sexy. But throw some "AB" in front of "testing" and your dour liver is magically transformed into paté de foie gras.

This is a bit disturbing, especially when you hear people sprinkling the "AB" condiment to add flavor to anything from a focus group ("Hey, did you AB Test the response to the new company logo?") to the mundane ("Suzie's lamp is out, can you AB Test the light bulb?") to the painfully comical ("Honey, let's AB test the *Lord of the Rings* Director's Cut with the Wide-Screen edition!").

Mixed in there, perhaps lost among the cacophony of buzzword hype, are the ingredients to some real AB testing and with it a future vision of how to achieve its true objective.

### What is AB Testing?

AB Testing is based on a simple principle that we're all familiar with:

1. compare and contrast alternatives;
2. based upon measurement, act accordingly.

Let's say we want to determine whether Nolan Ryan is a better baseball player than Homer Simpson? How should we proceed? First, we might set a metric for what we mean by a "better" baseball player. We can measure evidence in concrete ways, noting the two subjects' different batting averages or RBIs or the like. What we're searching for is the *right* metric—a formula that would lead us to a correct decision. Such a formula is more precisely termed a "fitness function."

We might decide that considering indirect evidence will lead us to a better decision than comparing pure statistics. In that case, our fitness function may involve such things as the difference in salary paid for services or a comparison of the prices paid for our subjects' autographs on eBay.

In virtually all such measures Nolan is the better candidate. If you were choosing a player for your team you'd certainly pick Nolan; you can be confident you've made the correct decision.

But let's think on that a moment: the reason you feel confidence in signing Nolan stems from your familiarity with the metric *and* fitness function that are implicitly applied when we speak of baseball. Your decision might be quite different if we want to pick an effective donut quality assurance taster. Suddenly, Homer Simpson is back in the running.

Even then, your confidence may be based on your understanding that "tastes better" is the donut metric and that Homer Simpson is an acknowledged expert in donut consumption. But what is the fitness function? That is, what does it mean to "taste better"? Are you relying solely on Homer's reputation as an expert? But his expertise is based on consumption quantity so perhaps you suspect he enjoys all donuts equally and actually has little, uh, "taste" at all. In other words, it's quite possible you don't have any knowledge at all of what we might call the "donut tastiness" fitness function..

Interestingly, marketers and business owners are asked – every day – to make more important decisions with less information with an undetermined fitness function.

More formally, AB Testing first requires a *metric* be identified (that is, "what will be contrasted?"). Second, a *fitness function* describing that metric is agreed upon ("how will we measure and contrast the differences?")<sup>1</sup>. And third, an optimization step where the system is tweaked based on comparison of exactly two tested solutions, which differ in only one respect of how they meet the fitness function.

You've participated in a specific AB Test of your own the last time you had your eyes examined. It went something like this:

Doctor: "Which is clearer, number 1 or number 2?"

You: "Oh, number 2".

You hear some clicking, a sure sign of adjustments being performed.

Doctor: "Now which is clearer, number 3 or number 4?"

You: "Definitely, number 3."

More clicks.

Doctor: "OK, final time: which is better, number 2 or number 3?"

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<sup>1</sup> Sometimes, we'll get lucky and the fitness function will be provided to us as an outright equation where we input some numbers and out pops a numeric answer. Most of the time, though, we'll be constrained to using experimentally-derived numerical models.

You choose, the optometri-gnomes get to work, and soon your new glasses are ready.

Do you see how the examiner ruled out the losing candidates and moved you forward to a final choice while not indicating what the fitness function is?<sup>2</sup> But you aren't quite focused (pardon the pun) on the fitness function at that point; you just want to see clearly – and “seeing clearly” is the metric in our example. The examiner steers you toward a solution by means of a somewhat qualitative metric of “which is clearer?”<sup>3</sup>

AB Testing for web sites follows a similar pattern. Applied to pages, elements of a page, or the state of the browser at the moment you're viewing it, the metric is the success ratio (“conversion”) of one candidate page (page element) (“A”) versus another candidate (“B”). Why “A” and “B”? It's one of life's little mysteries, but it works because we want a generic label for it anyway as we don't want the results to be skewed by visitor's awareness of the testing.

A typical problem for AB testing might be: “Do more people buy when I use a RED buy-it-now button or when I use a BLUE buy-it-now button?” The data for this test will come from your web analytics. Once you know which candidate converts better, you use the winner and discard the other. You might then test again, comparing the winner to some other variant you have in mind.

### **What's Right with AB Testing?**

The good news about using AB Testing is that you're probably better off using it than if you did no testing at all. *You'll almost assuredly do no harm by doing some baseline AB Testing.* Even in its simplest application, your business is still likely to see improvement in conversion on a page-centric basis, especially if you've done no previous optimization and have not planned the site fully using persuasion architecture.

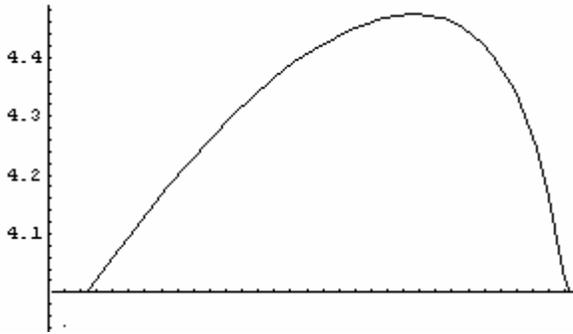
By examining incremental improvements to conversion at the page level you should be able to measurably move higher on your site's fitness profile (here, “converts more”) versus what might be expected by random chance – at least as compared to your pre-existing analytics and your non-optimized competitors. That's just another way of saying you can use AB Testing to pick the low-hanging conversion fruit.<sup>4</sup>

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<sup>2</sup> Likely, it's something semi-technical like “the focal point of the corrective lens.”

<sup>3</sup> Of course, when *you* are the examiner (business owner, analytics consultant, etc.), you actually care a good deal about the fitness function, a topic we'll return to shortly.

<sup>4</sup> Be careful, though, with low-hanging fruit; typically you don't know if you've picked a juicy apple or sour lemon until *after* it's already in your basket. More on that later.



**Figure 1**

In Figure 1, we've posited a theoretical conversion fitness function for a single page with a maximum of 4.5%. By comparing the conversion of several page variants via AB Testing, we're able to inch our way up the conversion curve closer and closer to that maximum.<sup>5</sup>

Well, I'm sure you get the general idea behind AB Testing now. In its simplest implementation, it takes only two letters to spell.

### **What? It can take more letters than "AB" to spell "AB Testing"?**

There are many questions that will arise while you perform deeper, more fundamentally interesting AB Testing but which AB Testing is not capable of dealing with. This is where things get complex, and suddenly we need an entire alphabet to spell AB Testing.

In my role as Chief Technology Officer at Future Now, I frequently come across holes in client conversion experiments.<sup>6</sup> Marketers and IT staff, the two groups involved, are typically not trained in the theory of experiment design, a field which takes some years to master.

It's through these holes that I've witnessed some of the real shortcomings of AB Testing. You should be aware of these even if your organization is not yet prepared to implement solutions to address them. Allow me to bring a handful of these objections to your attention:

*Objection #1: AB Testing is done in a vacuum, with no knowledge of the fitness function*

It's good for the experimental subjects (in web analytics, this means your visitor traffic) to be unaware of the fitness function, but deadly if the experimenters are ignorant of it. If

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<sup>5</sup> Later on, we'll examine how to determine which direction to inch up the curve.

<sup>6</sup> Actually "vast chasms" is a better description.

you don't know the fitness function, then you have no assurances that the testing and tweaking you're doing can give you anything more than a local maximum.<sup>7</sup>

In other words, without knowledge of the fitness function we might as well call it AB Feng Shui.

Recall that in Figure 1, we saw that we could potentially use AB Testing to get closer and closer to the fitness function maximum. The brave of heart might have commented that how we planned to get to the maximum was the real art. From what direction do we approach the maximum? Does it make a difference? How can we be sure we're there until we "overshoot" a bit and the conversion begins to drop off?

If you look at Figure 1 again, you'll recognize that approaching the maximum from the left side of the graph is a longer series of steps on a gradual incline than had we approached it from the right. What we learn from this is that the direction of approach is significant: the nature of the fitness function will determine our ability to make any positive improvements with AB Testing.

Let's examine another fitness function. Before reading on, look at the fitness function in Figure 2 and ask yourself two questions:

1. Is the goal we're shooting for affected by the shape of the graph – that is, does it have at least one peak?
2. Does the direction we start in affect our ability to reach that peak?

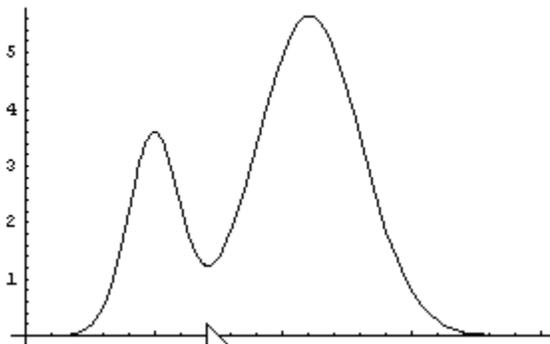


Figure 2

In Figure 2, we can see two maxima: a "local" maximum on the left and a "global" maximum on the right. If we were trying to maximize our conversion rate from web analytics, our CEO would really appreciate our reaching that global maximum ... somehow. But there are pitfalls.

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<sup>7</sup> And even that might be a stretch, as we'll see shortly.

If we start on the left of the graph, we increase conversion nicely with AB Testing. We will overshoot slightly, correct a bit, and reach what seems to be a promising solution at a local maximum near 3.5%. If the standard for our industry is 3%, we might feel justified in performing the “The Marketer’s Strut”. But without the fitness function visually presented in front of us for this example, we’d be unaware that so much more potential was being left unrealized.

If we start on the right, we get to the global maximum around 5%. Could we use another *free* 1.5 points of conversion? But in this case, too, we don’t know to pat ourselves on the back for having reached a global peak because we still didn’t know the fitness function.

What happens if we happen to start at the valley near the middle? Depending on the direction we take, we may get to the global maximum or we may get to the local maximum. Again, the topology of the fitness function, not the AB Test, determines our eventual success.

In fact, without knowing the fitness function in front of us we might suffer a midlife AB Testing crisis of “Is this all there is? Am I at a local maximum and missing some big upside? Am I at a global maximum and further testing is now wasted resources? What if my competitors know how to get to a maximum and I don’t?”!

Now let me throw an epistemological wrench in the process: if we don’t know the topology of the fitness function how do we even know there is a maximum (global, local or otherwise)? Simply put, we don’t.

How do we know the fitness function isn’t discontinuous, so that when we overshoot, we end up in an entirely different topology? Nope, not a clue.

Without answers to these questions, we’re operating in a vacuum. If we’re lucky, our conversion fitness function is continuous and has a single global maximum. But if our conversion improvements with AB Testing efforts are going to be based on luck<sup>8</sup>, what’s the point of calling it “testing”?

### *Objection #2: AB Testing ignores Variance*

Imagine looking at a sample of some measurements—perhaps the conversion rate from your web analytics. You are already familiar with the concept of an “average” representing a single number summarizing some “middling” value of the sample. Statisticians refer to this as the “mean”.

If the mean expresses the average of the population as a single number, the *variance* describes how spread out the individual numbers in the sample are.

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<sup>8</sup> Remember Clint Eastwood in *Dirty Harry* asking “Are you feeling lucky, punk?” Do *you* want to be the “lucky” person at your organization reporting your luck-based conversion improvement efforts to the CEO?

Let's say that our friends, Bryan, Jeff, and Hal are standing in a room. Bryan is 6'1" tall, Jeff is 6'2", and Hal is 5'9". Their average height (the mean) is 6'-0" .

Now Bryan meanders into the next room, and meets Antonio who is 5'4" and Shaq who is 6'7". The average height of these three is also 6 foot—but what a spread in the numbers! Variance is how we represent this spread numerically. The more varied the range of numbers that went into the average, the larger the variance.

Variance leads directly to other measures such as “standard deviation,” which you might think of as the average variance of each item. You're likely to see it quoted after an average as the number following the phrase “plus or minus”, as in “6 feet plus or minus 2 inches”. You may hear standard deviation used in conjunction to an “expectation” interval or repackaged slightly to reflect how “confident” we are that a given value is correctly within some number of standard deviations.

If you prefer a visual interpretation, imagine a bell curve as in Figure 3, sometimes called a “normal” distribution. Here, the average is the highest point on the graph and the standard deviation describes the width of the curve.

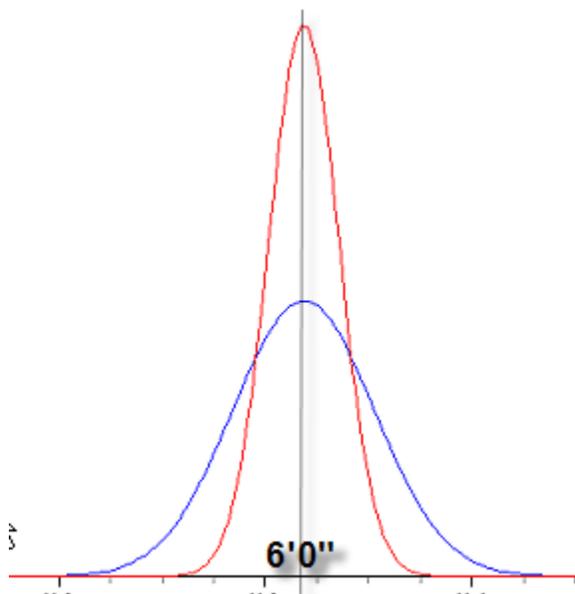


Figure 3

If the standard deviation is low, the curve will be sharp and narrow. If the standard deviation is larger, the curve is correspondingly wider.

Knowing the average value of something is not terribly meaningful if we don't also get a sense of the variance. So when someone tells you that in the first room, the average height was 6 feet, you're only getting half the story. Plus or minus what?, you might ask.

Or “What’s the variance?” Or even “Did you calculate the standard deviation?” Be very wary of quoted averages when they don’t include this key assessment of how spread out are the data that went into the average.

Quoting only an average is the most common mistake I see at companies performing web analytics testing. Significant weight is placed on the reported mean results of testing, but often with no corresponding emphasis on the variance of those results.

Of course, this doesn’t mean the results are wrong. If anything, the results have virtually no meaning: they are neither right *nor* wrong. Being incomplete, there is insufficient information to interpret them in a useful way and so they are of dubious value. And if you’re planning marketing campaigns based on such results, they may even be dangerous.

Now let’s bring this back to AB Testing.

The field of Game Theory uses a classical thought problem called the Two-Armed Bandit. Imagine a machine similar to a Vegas slot machine, but with two arms instead of one. Let’s call these Arm A and Arm B. You’ll be given a certain amount of money to play this machine over a series of “pulls” of one arm or the other. How do you determine which arm to play?

The two arms have different payouts:  $P_A$  and  $P_B$  but the casino is not going to tell you whether Arm A or Arm B has the higher payout. Your job is to decide how to apportion your money after each bet so that as your testing continues, you will maximize the amount of money you win (or, more realistically, to minimize the amount of money you lose). Clearly you want to minimize the amount of money it takes for you to determine which arm is better in order to dedicate the maximum amount of remaining money toward playing only the better arm. How do you decide to do this?

Most people who do AB Testing would dedicate a certain portion of their bankroll to test each arm for a certain number of pulls. After this test, whichever one pays off better will be judged the winner, and then they’ll commit the rest of their bankroll on it. The problem is, it turns out this solution is fairly non-optimal and carries a rather significant amount of cost *and* risk. H.L. Mencken once famously quipped, “For every complex problem, there is a solution that is simple, neat, and wrong.” That’s exactly the solution AB Testing would lead you to here.

What’s wrong with that approach? Well, what does it mean to pay off “better”? Doesn’t that entail examining the actual results of each arm to determine their average calculated payoff,  $Avg_A$  and  $Avg_B$ , and then go with the higher? Yes, and that’s what our AB Test on the arms did for us.

But we discussed earlier that quoting an average only has useful meaning if we also measure the standard deviation for the measured payoff of each arm. How would we know if the average payout results from our AB test is anywhere near the true payouts  $P_A$  and  $P_B$ ?

A better testing method must correctly determine both the mean and the variance. Remember, we don't get to do an infinite amount of free testing to determine which arm has the best payoff; we have to bet in real-time with real dollars. We must carefully conserve our resources while some sense of confidence emerges as to which arm is better.

AB Testing (as it is typically practiced) does not provide us enough information to do this rationally because it ignores variance.<sup>9</sup>

*Objection #3: AB Testing isolates only one degree of freedom*

A “degree of freedom” is a single aspect of a complex system that is allowed to vary in some significant way. You can think of this as similar to an allowance for doing your chores – you earn one dollar for each chore you complete (for our purposes, “each piece of data you collect”) and you spend one dollar for each candy you eat (for our purposes, “each parameter you estimate”). Since you're earning 2 dollars for collection data A and B and spending one to see how they compare, you have  $2-1 = 1$  degree of freedom.

In our earlier example, we wanted to measure both the efficacy of the red and blue buy-it-now buttons as well as determine whether they should be presented as a button or as a hyperlink, AB Testing would yield no information for us, since our income is the same but our spending has increased to 2, and  $2-2=0$  information.

How could we deal with that? One solution is to perform one AB Test for the colors and another AB Test for the click-method. This brings up its own set of issues, such as the order in which the test is performed. We might assume that the order taken does not matter (a fancy word for this is “commutative”) but we have no particular proof on which to base this assumption: an astute web analyst may have already divined that “blue” plus “hyperlink” carried more impact combined than either separately. We'll also be forced into doing some cross testing because *someone* is going to ask the really interesting question of “Red Hyperlink versus Blue Button”. So even if colors and methods testing were commutative, there's a good shot we're end up having to test that assumption anyway.

Another solution is that we perform what we might call “ABCD Testing”, which is entirely legitimate because the degrees of freedom will be higher. But this leads to testing

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<sup>9</sup> Yes, of course you can calculate variance when you do AB Testing! And then perform an entire suite of statistical tricks to measure your confidence in the experimental results. The point is, virtually no one does it. No doubt dentists comment the same about flossing.

a larger number of candidate solutions spread over an exponentially larger search space. You can imagine how much more complex this will grow after we start adding in other variations such as “Green” and “Purple” and “Aligned Center” and “Font=Sans Serif” and so on. Where does it end? We will quickly run out of letters in the alphabet, and long before that we’ll long since have left the realm of “AB” testing.

What we’re really looking for here is *multivariate* testing, which brings us to the next objection.

*Objection #4: AB Testing is neither Multivariate nor Orthogonal*

To discuss this objection, I’ll be introducing a few ten-dollar words. These sorts of problems and solutions have cropped up in many other fields and a specific vocabulary has grown up to support those discussions. It benefits us if we stick to some conventional, known definitions. But I’ll try to keep us on a vocabulary budget, since I’d prefer you come away with some new ideas, not just new words.

With AB Testing you only change one thing at a time, testing between two alternates. Which converts better, the red button or the blue button? Which garners more sales, “Buy It Now” or “Add To Cart”? This is directly related to the degrees of freedom we discussed earlier.

Yet, the most interesting and meaningful tests take place across an entire spectrum of variation. AB Testing has no mechanism for handling such cases. What happens to poor yellow and green and purple and “Get My Stuff”? We can’t just leave these out of testing simply because they’re inconvenient to test in tandem. What is required is a multivariate approach, using something I call the “conversion calculus”.

Simple testing in an earlier example examined a single degree of freedom as we varied two variables, A and B. We measured that against the actual conversion result (our *metric*) and produced a two dimensional graph (one degree of freedom plotted against the metric).

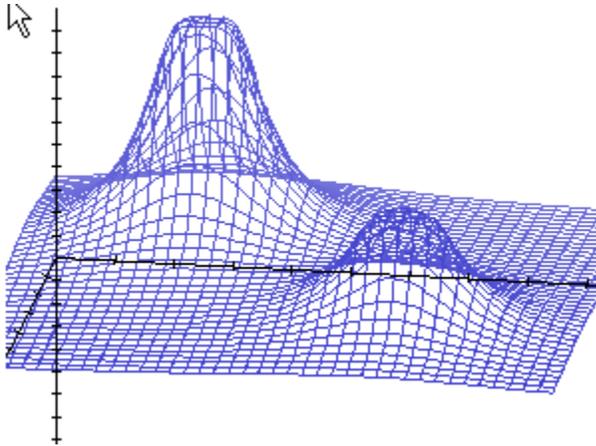


Figure 4

Now we add a third variable and we have two degrees of freedom, so we'll expect a three-dimensional plot (two degrees of freedom plotted against the metric). So, in a hypothetical fitness function shown in Figure 4, we added only one additional way to vary the testing and now we have a 3D plot.

You'll recall that when we discussed Figure 2, we risked finding only a local minimum and getting stuck there. Now we must find the correct path in *two* directions to successfully find the global maximum—will you be able to do this if you don't have the fitness function in front of you? Try to imagine where we will be in N-dimensions (which we can't even visualize) and a correspondingly more complex fitness function (which we don't even have access to). Now you'll understand why a conversion calculus is required. This is as complex a problem as Mencken envisioned, and quite frankly AB Testing as a solution truly is “simple, neat and wrong”.

To address multivariate testing, we'll need to examine the issue of *heterogeneity*—or whether the candidate solutions we are testing may be diverse and not comparable in kind. The layman's term for this is “comparing apples and oranges.” Have you ever noticed that whenever a discussion gets to that point, people often stop comparing altogether? They just shut down. That's a sure sign that the comparison technique being used is insufficient to handle the job.

But even that doesn't get at the heart of the matter since the diversity may span a much larger gap. We may, perhaps be comparing apples with carburetors. Will it even make sense to AB test a red button “Buy It Now” with a blue button “Add To Cart”? Or what about more complex and subtle testing, such as the conversion efficacy of “Buy One Ticket, Your Companion Flies Free” versus “Frequent Flyers Get Seat Upgrades and Free Booze”? Do we even have a method to classify this sort of diversity?

For this, we introduce the concept of *orthogonality*. One way to think of orthogonality is to consider ways of measuring along an axis. The typical XY axis uses an X axis that is

independent or *orthogonal* to the Y axis, allowing us to measure along one axis independent of the other<sup>10</sup>.

We could do multivariate testing if we could express the variants to be tested in terms of orthogonal axes. Determining what those axes are is, of course, the nub of the problem. In a closed system (such as your web site), an object in the system is orthogonal to other objects in the system if it serves one specific function in the system and no other object serves that same specific function. Do we have this in web analytics? No, because a given page (or an element within a page) may serve multiple uses: an element could be part of several pages, and a page it's part of may be part of multiple scenarios, or that same page may act as a point of resolution for one type of visitor coming to the site whereas for another visitor the page is an absolutely essential call-to-action point for her to buy from you.

Don't lose any sleep over orthogonality – there isn't much you can do to prevent it anyway – but do realize that *how* testing is designed is a very complex problem.

*Objection #5: AB Testing without Persuasion Scenario design is like lipstick on a Pig*

Imagine you're at the State Fair and out comes Blue Ribbon Beulah, vying for first prize in Most Beautiful Pig contest. You can AB Test the efficacy of bubblegum pink lipstick versus sultry burgundy lipstick on porcine Beulah lips, *but she's still a pig*. You can sure make the pig more attractive (perhaps more so to some lonely cowboy) but the pig is still not going to win a Miss America contest. I think something akin to this occurs a lot more frequently with online businesses than we might guess.

Frankly, I'm surprised that more AB Testing folks aren't spending at least as much time on their Persuasion Architecture process as they do on AB Testing. Yes, AB Testing for the low-hanging fruit is easier, but it isn't going to help the bigger problem if you're in the wrong grove and it's long past picking season. Without initial planning on how we will persuade, AB Testing may not uncover any truly optimal situations. More likely, they will get stuck at a local maximum. Or put in terms of our contest, all AB testing can show us is which lipstick looks better on Beulah.

How can we optimize for results if we have not planned out the persuasion scenarios visitors will follow? How can we plan out persuasion scenarios if we treat all visitors as having the same averaged out goals? How can we persuade toward goal-achievement if we treat all visitors as the same persona making all decisions similarly and being emotionally persuaded in the same fashion as everyone else?

People make decisions differently; they may arrive at the same decision via entirely different mental processes. These processes can be mapped out into a persuasive

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<sup>10</sup> Thinking visually, their orthogonality is manifested in the axes being at right angle (90 degrees) to each other

architecture by understanding motivation and then applying goal-based scenarios specific to those decision mechanisms. At that point web analytics can be used for optimization. That, finally, is where AB testing becomes useful.

*Objection #6: AB Testing cannot capture the temporal component of conversion*

When we examine the temporal aspects of conversion, we begin to ask questions such as “How much is this customer worth to us over her entire lifetime of interacting with our site?” and “What was the eventual conversion rate of those who did not buy the first time but returned much later?”

Suppose that after optimizing your conversion on a given page (or even a set of pages), you feel you’ve really achieved as much as you can: conversion has gone from 4% to 7% and every test you’ve run shows that 7% is some sort of ceiling for your business or your industry. That is, you feel confident you’ve found a global maximum of the conversion fitness function we talked so much about.<sup>11</sup>

But now you wave a magic web analytics wand which allows you to tie together all visitor interactions with your site over time, banishing cookie killers and giving us infinite precision of visitor actions on our site. You now know that some group of candidate solutions which we previously discarded in favor of the magical 7% maximum, in fact, lead to a much higher conversion rate of, say, 10%, when you account for long-term affects such as retention and extended-period-visits. Where do you go to get your 3 extra points from? AB Testing can’t answer this.

You can imagine that companies with long sales cycles or highly complex sales processes or products with regular repeat purchases are all interested in this. And it can be difficult to measure using pure web analytics in their current form, especially based on browser visitor identification.

So we’ve learned another lesson, similar to the issue of “local” versus “global” maxima: without a mechanism for analyzing long-term conversion over time, we may AB Test ourselves into a “temporal” local maximum and not even know it.

## **Summing Up**

I’d like to reiterate: if you’re doing some AB testing, congratulate yourself. You’re already doing more than most of your competitors.

I’ve heard a number of marketers at analytics conferences quip: “Oh well anything more than AB Testing is too hard” or “We’re using State of the Art AB Testing”. I suspect is a

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<sup>11</sup> And, rightfully, if you get this far you should be quite proud. No doubt profitability is up, and you can take some measure of pride of achievement that you’re doing things that very few of your competitors are likely doing.

euphemism for “We’re doing the same thing as everyone else”. The real question is what sort of other solutions are available to us?

First, we need to understand that AB Testing will only get us so far. If we can take a larger view, outside of page-centric testing, we’ll have a much better sense of what sort of AB Testing you should be doing.

Next, mentally move to multi-interaction-point, multi-persona segmented persuasion scenario testing so that you will be in a better position to know the character of the search space you’re dealing with. Non-existent or poorly designed scenarios that are not based on personas will not be solved by cosmetic AB Testing.

Finally, consider some long-term approaches that deal with the issue of multivariate testing and the pitfalls of examining extremely large search spaces. Many large companies already do this when they deal with issues such as “relevance” and “other customers who bought what you did, also enjoyed...” Typically, they get wild results because vast search spaces like that are very prone to over-optimized solution sets and “back-fitting” of data.

Such multivariate testing over an extremely large search space is the real problem to be confronted and the solutions for this problem are not trivial. I hope to talk about some of those techniques in the future. Feel free to contact me directly in the meantime if you have any questions or comments or disagreements.

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### **About the Author:**

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