

October 28, 2005

Are You an Expert?

Experts and Markets

Overall, the evidence suggests there is little benefit to expertise . . . Surprisingly, I could find no studies that showed an important advantage for expertise.

J. Scott Armstrong

*The Seer-Sucker Theory: The Value of Experts in Forecasting*¹

The Heart of the Matter

If you enter a hospital with chest pains, doctors will quickly administer an electrocardiogram (EKG) test. The EKG measures electrical impulses in your heart and translates them into squiggles on graph paper. Based in part on the readout, the doctor determines whether or not you're having a heart attack. Sometimes the readouts are clear. But often they're equivocal, which means you are relying on the doctor's expertise to come to a proper diagnosis.

So how good are doctors at reading EKGs? In a 1996 showdown, Lund University researcher Lars Edenbrandt pitted his computer against Dr. Hans Ohlin, a leading Swedish cardiologist. An artificial intelligence expert, Edenbrandt had trained his machine by feeding it thousands of EKGs and indicating which readouts were indeed heart attacks. The fifty-year-old Dr. Ohlin routinely read as many as ten thousand EKGs a year as part of his practice.

Edenbrandt chose a sample of over two thousand EKGs, exactly half of which showed confirmed heart attacks, and gave them to machine and man. Ohlin took his time evaluating the charts, spending a week carefully separating the stack into heart-attack and no-heart-attack piles. The battle was reminiscent of Kasparov versus Deep Blue, and Ohlin was fully aware of the stakes.

As Edenbrandt tallied the results, a clear cut winner emerged: the computer correctly identified the heart attacks in sixty-six percent of the cases, Ohlin in only fifty-five percent. The computer proved twenty percent more accurate than a leading cardiologist in a routine task that can mean the difference between life and death.²

Our society tends to hold experts in high esteem. Patients routinely surrender their care to doctors, investors listen to financial advisors, and receptive TV viewers tune in to pundits of all stripes. All of this may cause you to wonder: what do we know about experts?

This piece provides perspective on how to think about experts. We address some basic questions, including:

- What is an expert?
- What characteristics do experts share?
- Where do experts tend to do well and where do they do poorly?
- Does the world of investing have experts?

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Deliberate Practice and Two Sigma

Not surprisingly, we find no universal agreement as to what defines an expert. Webster's dictionary offers, "One with special skill or knowledge representing mastery of a particular subject." A more quantitative characterization suggests experts perform at a level two standard deviations or more above a population average.

Naturally, the ability to quantify expert performance varies from discipline to discipline. In areas where scientists can readily measure expert performance, including many individual sports, the standard for expertise has risen steadily over the years. Today's elite marathoners cover the 26.2-mile course roughly 30% faster than the best runners a century ago, and two great violinists of Tchaikovsky's time declined to play his violin concerto, declaring it too difficult.

Researchers have studied experts across a large range of activities for decades. An attempt to better approach problems in artificial intelligence (AI) motivated much of the early research. AI designers had little trouble with straightforward rules-based systems that humans could program readily, but found computers unable to replicate some tasks humans take for granted. Exhibit 1 provides a partial list of the experts scientists have studied.

Exhibit 1: Studied Expert Domains

Chess
Musicians
Sports
Typing
Medical diagnosis
Mental calculations

Source: LMCM.

Some expert domains are predominantly physical (sports and typing) while others are cognitive (chess and mental calculations). Intriguingly, the time required to become an expert is remarkably consistent across domains. As it turns out, expertise requires about ten years, or ten to twenty thousand hours of deliberate practice. Little evidence exists for expert performance before ten years of practice.³ Even prodigies like Bobby Fischer (chess), Amadeus Mozart (music) and Wayne Gretzky (sports) required a decade of practice to generate world class results.

Of course, pursuing an activity for ten years provides necessary, but not sufficient, background to produce an expert. Plenty of recreational athletes, musicians, and board-game enthusiasts have put in the requisite time without achieving expert-level performance.

Cognitive psychologists highlight the role of *deliberate practice* in separating experts from non experts. Deliberate practice means pursuing a well-defined task, appropriate for the individual's level, allowing for opportunities for errors, error correction, and informative feedback. Contrast deliberate practice with playful interaction, where individuals seek simply to enjoy an activity. Experts-in-training allocate about four hours a day to deliberate practice, an amount which is also very consistent across domains.⁴

Experts are not casual about their domain. They build their lives around deliberate practice and practice every day, including weekends. But experts also report sleep and rest as critical elements of their results, and they avoid overtraining or overexertion. Evidence shows that performance diminution in cognitive tasks coincides more with reductions in deliberate practice than with aging.

The age of peak performance varies based on the domain. In vigorous physical activities, experts peak in their mid-20's. In cognitive activities like chess and science the peak occurs in the 30's. More creative experts, including novelists, historians, and philosophers, hit the performance apex in their 40's or 50's.

Characteristics of Experts

Given that experts exist in diverse domains, psychologists wondered whether they have much in common. The answer: a resounding yes. Research on expert performance reveals seven robust and universal characteristics.⁵

1. *Experts excel in their own domains, but not outside their domain.* Expertise is domain specific. When experts in one field shift their attention to another field, performance retreats to the novice level. The reason is relatively straightforward: experts tend to accrue significant domain-specific knowledge, which is only transferable to closely interrelated fields. The bottom line is you can feel free to ignore an expert discussing topics outside his or her domain.
2. *Experts perceive patterns in their domain.* Bill Chase and Herb Simon demonstrated this point with chess players.⁶ Rather than focusing on the position of individual pieces, expert chess players perceive clusters of pieces, or chunks. Estimates suggest that chess masters store roughly 50,000 chunks in long-term memory. Notably, this pattern recognition does not represent superior perception ability. When chess pieces are placed randomly on the board, experts remember the positions about as well as novices. The difference amounts to a database of chunks, amassed through deliberate practice, from which experts can draw.
3. *Experts solve problems much faster than novices.* Lightning chess, where players only have a few seconds to decide a move, illustrates this point well. Chess masters play much more effectively at lightning games than novices. Two factors explain the expert speed edge. First, experts are more effective at the domain's basic skills because they have practiced for so many hours. This frees up cognitive capacity for other parts of the task. Second, since experts see patterns better than novices, their solution searches are more efficient.
4. *Experts have superior short- and long-term memory.* When tested, experts appear to have recall capacity that exceeds the limits of short-term memory. While they do not have larger short-term memories than the average person, experts have internalized, and hence made automatic, many basic skills. Deliberate practice assures experts have more patterns stored in long-term memory that they are facile in retrieving.
5. *Experts represent problems at a deeper level than novices.* Cognitive psychologists tested this point by asking experts and novices to sort problems in various fields, including physics and computer programming. The results showed that experts sort by principle-based categories, while novices sort more literally, reflecting the problem's surface features.
6. *Experts spend a lot of time solving problems qualitatively.* When researchers present novices with a problem within a domain, the novices quickly go to relevant equations and solve for the unknown. In contrast, experts tend to create a mental representation of the problem, try to infer relations within the problem, and consider constraints that might reduce the search space. Domain knowledge and experience allow experts greater perspective on problem solving.
7. *Experts have a strong sense of their own fallibility.* Experts tend to be more aware of their errors, why they fail, and when they need to check their answers. Further, experts tend to judge a problem's difficulty better. Because of collective domain experience, experts are better at self-monitoring than are novices.

One helpful framework for understanding the difference between experts and non experts comes from the two systems of decision making Daniel Kahneman describes in his Nobel Prize lecture.⁷ System 1, the experiential system, is "fast, automatic, effortless, associative, and difficult to control or modify." System 2 is analytical, "slower, serial, effortful, and deliberately controlled." Through substantial deliberate practice in a particular domain, experts can train and populate their experiential systems. A well-trained experiential system, while costly, frees capacity for the analytical system.

In Kahneman’s model, System 1 uses perception and intuition to generate impressions of objects or problems. These impressions are involuntary, and an individual may not be able to explain them. Kahneman argues that System 2 is involved in all judgments, whether or not the individual makes the decision overtly. In the model, intuition is a judgment that reflects an impression.

Some authors have celebrated the power of intuition.⁸ An individual’s intuitive judgment of probabilities, however, is heavily influenced by similarities between the current situation and past situations, as well as the associations that occur to the individual. Among Kahneman’s many contributions is showing that these influences can lead to sub-optimal decisions: more bluntly, intuition is notoriously poor in dealing with uncertainty. A crucial question, to which we will return, is when does intuition work?

Where Do Experts Do Well?

In some domains, experts clearly and consistently outperform the average person: just imagine playing chess against a grandmaster, trading volleys on Wimbledon’s center court, or performing brain surgery. Yet in other domains experts add very little value, and their opinions are routinely inferior to collective judgments. Further, experts in some fields tend to agree most of the time (for example, weather forecasters), while in other fields they often stand at complete odds with one another. What’s going on?

Let’s narrow our discussion to cognitive tasks. One way to look at expert effectiveness is based on the nature of the problem they address. We can consider problem types on a continuum.⁹ One side captures straightforward problems inherent to static, linear, and discrete systems. The opposite side reflects dynamic, non-linear, and continuous problems. Exhibit 2 offers additional adjectives for each of the two extremes.

Exhibit 2: Edges of the Problem Continuum

Discrete	Continuous
Static	Dynamic
Sequential	Simultaneous
Mechanical	Organic
Separable	Interactive
Universal	Conditional
Homogenous	Heterogeneous
Regular	Irregular
Linear	Non-linear
Superficial	Deep
Single	Multiple
Stationary	Nonstationary

Source: Paul J. Feltovich, Rand J. Spiro, and Richard L. Coulsen, “Issues of Expert Flexibility in Contexts Characterized by Complexity and Change,” in Paul J. Feltovich, Kenneth M. Ford, and Robert R. Hoffman, *Expertise in Context: Human and Machine* (Menlo Park, CA and Cambridge, MA: AAAI Press and The MIT Press, 1997), 128-129 and LMCM.

While tens of thousands of hours of deliberate practice allows experts to internalize many of their domain’s features, this practice can also lead to reduced cognitive flexibility. Reduced flexibility leads to deteriorating expert performance as problems go from the simple to the complex.

Two concepts are useful here. The first is what psychologists call *functional fixedness*, the idea that when we use or think about something in a particular way we have great difficulty in thinking about it in new ways. We have a tendency to stick to our established perspective, and are very slow to consider alternative perspectives.

The second idea, *reductive bias*, says that we tend to treat non-linear, complex systems (the right-hand side of the continuum) as if they are linear, simple systems. A common resulting error is evaluating a

system based on attributes, versus considering the circumstances. For example, some investors focus solely on statistically cheap stocks (attribute) and fail to consider whether or not the valuation indicates value (circumstance).

Reductive bias also presents a central challenge for economists, who attempt to model and predict complex systems using tools and metaphors from simpler equilibrium systems. The bias demonstrates a number of conceptual challenges, including the failure to consider novel approaches, novelty clues, and system change.

None of this is to say that experts are inflexible automatons. Experts act with demonstrably more flexibility than novices in a particular domain. Psychologists specify two types of expert flexibility. In the first type, the expert internalizes many of the domain's salient features and hence sees and reacts to most of the domain's contexts and their effects. This flexibility operates effectively in relatively stable domains.

The second type of flexibility is more difficult to exercise. This flexibility requires an expert to recognize when his or her cognitively-accessible models are unlikely to work, forcing the expert to go outside their routine and familiar frameworks to solve the problem. This flexibility is crucial to success in nonlinear, complex systems.

So how does an expert ensure they incorporate both types of flexibility? Advocates of cognitive flexibility theory suggest the major determinant in whether or not an expert will have more expansive flexibility is the amount of reductive bias during deliberate practice.¹⁰ More reductive bias may improve efficiency but will reduce flexibility. To mitigate reductive bias, the theory prescribes exploring abstractions across diverse cases to capture the significance of context dependence. Experts must also look at actual case studies and see when rules do and don't work.

Exhibit 3 consolidates these ideas and offers a quick guide to expert performance in various types of cognitive domains. Consistent with Exhibit 2, we show a range of domains from the most simple on the left to the most complex on the right. The exhibit shows that expert performance is largely a function of the type of problem the expert addresses.

For rules-based systems with limited degrees of freedom, computers consistently outperform individual humans.¹¹ Humans perform well, but the computers are better and often cheaper. Computer algorithms beat people for reasons the psychologists have documented: humans are easily influenced by suggestion, recent experience, and how information is presented. Humans also do a poor job of weighing variables.¹² Because most decisions in these systems are rules-based, experts tend to agree. The EKG-reading story illustrates this point.

Exhibit 3: Expert Performance Depends on the Problem Type

Domain description	Rules-based; limited degrees of freedom	Rules-based; high degrees of freedom	Probabilistic; limited degrees of freedom	Probabilistic; high degrees of freedom
Expert performance	Worse than computers	Generally better than computers	Equal to or worse than collectives	Collectives outperform experts
Expert agreement	High (70-90%)	Moderate (50-60%)	Moderate/Low (30-40%)	Low (<20%)
Examples	<ul style="list-style-type: none"> • Credit scoring • Simple medical diagnosis 	<ul style="list-style-type: none"> • Chess • Go 	<ul style="list-style-type: none"> • College admissions • Poker 	<ul style="list-style-type: none"> • Stock market investing • Economic forecasting

Source: Beth Azar, "Why Experts Often Disagree," *APA Monitor Online*, Vol. 30, 5, May 1999 and LMCM.

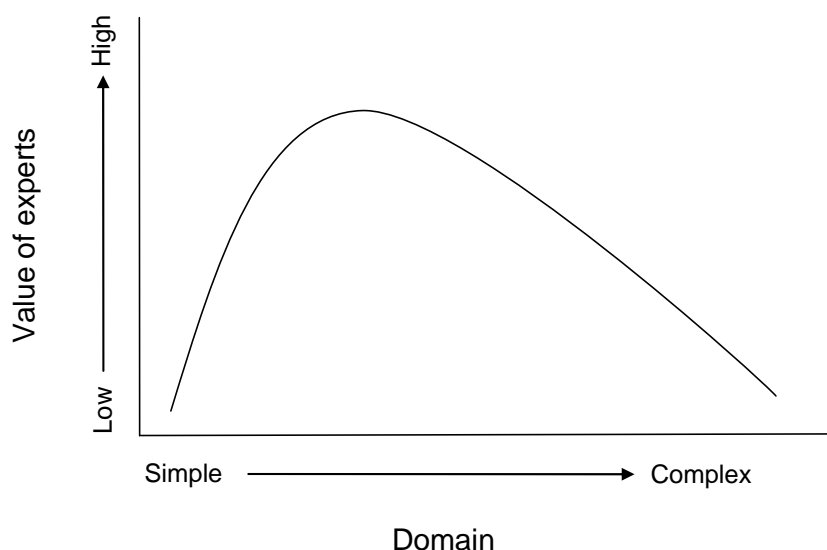
The next column shows rules-based systems with large degrees of freedom. Experts tend to add the most value here. For example, while Deep Blue narrowly beat chess master Garry Kasparov, no computer is even close to beating a top player in Go, a game with simple rules but a larger 19-by-19 board.¹³ Improving computing power, however, will eventually challenge the expert edge in this domain type. Agreement among experts in this domain remains reasonably high.

A move to the right reveals a probabilistic domain with limited degrees of freedom. The value of experts declines because outcomes are probabilistic, but experts still hold their own versus computers and collectives. Expert agreement dips again in these domains. Statistics can improve expert decision-making with these problems, a point Michael Lewis develops fully for professional baseball player selection in his bestseller *Moneyball*.

The right hand column shows the most difficult environment: a probabilistic domain with high degrees of freedom. Here the evidence clearly shows that collectives outperform experts.¹⁴ The stock market provides an obvious case in point, and it comes as no surprise that the vast majority of investors add no value. In this domain, experts can, and often do, hold diametrically opposite views on the same issue.¹⁵

Exhibit 4 shows visually where experts add value in cognitive tasks. At the extremes, either computers or collectives consistently outperform experts. But in the middle, experts can and do add value. Most of us encounter problems of every kind in our day-to-day jobs.

Exhibit 4: Where Experts Add Value



Source: LMCM.

Considering tasks along a complexity continuum also provides insight into when intuition will likely work. An expert's intuition results from training the experiential system through deliberate practice. In a stable domain, intuition is very powerful. When operating in a domain of sufficient complexity, expert intuition may prove unreliable. The experiential system is simply not flexible enough to capture the nonlinearity and nonstationarity inherent in some domains.¹⁶

Are There Experts in Investing?

Given that the stock market is a probabilistic, high-degree-of-freedom domain and the poor aggregate performance of active investment managers, there seems little reason to look for investing experts.¹⁷ However, a handful of distinguished investors have established excellent long-term records, which holds hope for expertise in investing. Economist Burt Malkiel says it this way:¹⁸

While it is abundantly clear that the pros do not consistently beat the averages, I must admit that there are exceptions to the rule of the efficient market. Well, a few. While the preponderance of statistical evidence supports the view that market efficiency is high, some gremlins are lurking about that harry the efficient-market theory and make it impossible for anyone to state that the theory is conclusively demonstrated.

Since we don't yet understand all the issues around expertise and have yet to study successful investors in great detail, our conclusion that there are expert investors is tentative. However, it does not appear expert-investor skill sets are transferable. Here are some of the characteristics expert investors share:

- *Successful investors put in plenty of deliberate practice.* In investing, this generally means lots of time reading, often across diverse fields. For example, the highly-regarded head of GEICO's investments, Lou Simpson, says, "I'd say I try to read at least five to eight hours per day. I read a lot of different things . . ." ¹⁹ Berkshire Hathaway's Charlie Munger makes the point more emphatically, "In my whole life, I have known no wise people (over a broad subject matter area) who didn't read all the time—none, zero. You'd be amazed at how much Warren reads—at how much I read. My children laugh at me. They think I'm a book with a couple of legs sticking out." ²⁰
- *Great investors conceptualize problems differently than other investors.* As a group, these experts go beyond the near-term obvious issues, can identify relevant principles because of their experience, and see meaningful trends. These investors don't succeed by accessing better

information; they succeed by using the information differently than others. As an illustration, star investor and Sears Holdings chairman Eddie Lampert carefully studied Warren Buffett's past investments to understand the logic. By reading annual reports in years preceding Buffett deals, Lampert sought to reverse engineer Buffett's thought process. In a *Business Week* article, Lampert noted, "Putting myself in his shoes at that time, could I understand why he made the investments? That was part of my learning process."²¹

- *Long-term investment success requires mental flexibility.* Just as markets constantly evolve, so too must investors. Further, expert investors possess the second type of flexibility—an ability to recognize when their easily-accessible mental models no longer apply. This recognition requires a return to basic principles to think carefully about a topic. Bill Miller's investment-process evolution is a good case:²²

The [conventional value investing] approach that had been so successful for us . . . had serious shortcomings when the economy peaked and began to head down. I decided to see if the academic literature offered any insights into how we might improve our investment process. After reviewing the data . . . it became clear that the conventional wisdom about value investing was wrong. Our experience in the late 1980's and the changes we implemented in our process allowed us to sidestep that [performance] pothole in the late 1990s.

- *Not pattern recognition but process recognition.* As scientist Norman Johnson notes, in complex systems an expert can create a mental simulation, fueled by diverse information. An idea or problem solution emerges from the simulation, leaving the expert unable to explain how he or she arrived at the solution.²³ A colleague's description of legendary hedge fund manager George Soros makes this point:²⁴

[Gary] Gladstein, who has worked closely with Soros for fifteen years, describes his boss as operating in almost mystical terms, tying Soros's expertise to his ability to visualize the entire world's money and credit flows. "He has the macro vision of the entire world. He consumes all this information, digests it all, and from there he can come out with his opinion as to how this is going to be sorted out. He'll look at charts, but most of the information he's processing is verbal, not statistical."

The research on expertise is ambiguous on how much of expertise we can attribute to innate characteristics versus deliberate practice. For example, Ericsson and Smith report, "the research approach of accounting for outstanding and superior performance in terms of general inherited characteristics has largely been unsuccessful in identifying strong and replicable relations."²⁵ Our view, in contrast, is there is clearly a hard-wired element to investing success. That most investors with outstanding long-term records share a similar personality profile supports this view.²⁶

Summary

Some skepticism about the value of experts is clearly warranted. An expert's ability to solve a problem appears largely dependent on the problem type. Computers tend to solve simple problems better, and cheaper, than experts, while collectives outperform experts for complex problems.

Here are a few summary points:

- What it takes to become an expert appears remarkably consistent across domains. In field after field, researchers find expertise requires many years of deliberate practice. Most people don't become experts because they don't put in the time.
- Experts train their experiential system. Repeated practice allows experts to internalize many facets of their domain, freeing cognitive capacity.
- Intuition is only reliable in stable environments. In domains that are nonlinear or nonstationary, intuition is much less useful.
- Expert investors exist. Unfortunately, it is not clear that their skill sets are transferable. Expert investors are likely a product of both mental hard wiring and hard work.

Endnotes

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- ¹⁹ Robert P. Miles, *The Warren Buffett CEO: Secrets from the Berkshire Hathaway Managers* (New York: John Wiley & Sons, 2002), 58.
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