

## Technology

*The American philosopher, Charles Sanders Peirce(1839-1914) defined objects this way: "By an object, I mean anything that we can think, i.e. anything we can talk about."*

Wouldn't it be wonderful if humans could always act with certainty?

Or would that be a dismal state of affairs in which the expectation of human achievement was as fixed as royal succession in a hereditary kingdom?

We social animals, who make most of our decisions from passionate attractions or repulsions, would not be so happy in a world without uncertainty. It would be a dull world in which the march of [events](#) would hold no mysteries, no surprises. There would be no gaming or competitive sports, since all outcomes would be transparent. No fictions would be written, for fiction, it might be said, is the child of uncertainty. No hope (the word would be obsolete) would inspire us to work for a promotion or seek the friendship of someone who attracts us, and no imagination of the future would enter our thinking, for all would be known and expected, evolving according to its order and concluding according to plan.

Thank God or Mother Nature, whichever your persuasion, that the world is instead an environment of [complex](#), even [chaotic](#), systems, which are constantly moving, changing the relationship of the [objects](#) within them, creating new [classes](#) of objects and eliminating old ones, and provoking human responses of aspiration, [judgment](#), hope, and satisfaction.

Uncertainty is what makes us think. If the world were certain, what thoughts would be necessary? We would simply do whatever was in the order of things. However, in an uncertain world, we are aroused to think freely and navigate our way through our lives.

Our free mind is forever thinking about the uncertainty of the future and the risks involved in making choices. Though we have only limited information about the influences in our environment and how they affect us, we have devised methods for collecting and analyzing information for making decisions that reduce risk.

How our mind has evolved to its present state of rationality is a question for biologists, anthropologists, philosophers, and theologians. How the human brain is anatomically composed to perform its thinking is still largely beyond our scientific understanding. But how we make decisions is something we know a lot about.

Benjamin Franklin, America's bespectacled, rotund, balding polymath, had a penchant for inventing things, like the lightning rod, the harmonica, the Franklin stove, bifocal glasses, and the flexible urinary catheter. It's not surprising that someone with such an active mind had a strategy for making decisions. He tells us that he would divide a sheet of paper by a line into two columns, one labeled PRO and the other CON. In considering a proposition, he would jot down "hints" or "motives" in one column or the other. When he felt he had gathered all the possible bits of information, he would estimate their

value, [weighting](#) them according to degrees of importance. Finding similarly valued items in opposite columns, he would cross them both out. After full consideration, he would make his decision in favor of the side with the greater remaining weight. He called this procedure [Moral or Prudential Algebra](#).

Most of us are not such methodical thinkers. However, to a degree, we all do in our minds what Ben Franklin did on paper. We recall or gather bits of information for and against a proposition, bits that Ben called hints or motives and we will hereafter call [cues](#). Then we estimate their values (weights) and arrive at a decision by tipping to the collection of [cues](#) with the greatest weight. It's a process suitable for those decisions that allow us time to consider.

When Ben was confronted with a daily decision—what to order for lunch, for example—he probably didn't write down the pros and cons of the selections on the menu. He would have used his common sense and made up his mind like the rest of us. When the waiter returned to take his order in five minutes, he would have stopped looking over the menu and made his selection. There is always a timely and reasonable point to [stop the search](#) for information and make a decision. When the waiter returned after Ben had finished his lunch and asked, "Would you care to see the dessert menu?" Ben would have decided on the spot. Judging from his purported size, his answer would likely have been a resounding "Yea!" Perhaps he had already decided before the question was put to him, or perhaps his answer was an emotional reaction to the imagined pleasure of tasting some sweet concoction.

The time allotted to decision making is sometimes set by the amount of information needed to make a comprehensive evaluation. In our complex environments, the time is often constrained by social and commercial interests. Our local weather forecaster is swamped with volumes of information about the current weather patterns, which he or she must evaluate to determine what to predict on the six o'clock news. A *timely* decision is what most people want, even though it may be imperfect or had been proved erred in prior examples.

The need to enhance our senses and reduce the time it takes to gather large quantities of information about objects in a complex environment has compelled us to invent such instruments as the telescope, microscope, speedometer, thermometer, barometer, radar, laser, and all manner of monitoring devices that provide us with streams of object data. Knowing the behavior of objects in complex systems helps us make good decisions about how we should manage ourselves in light of them.

The classic method of forecasting the future of objects in complex systems was introduced by Descartes in 1637 in part 5 of his *Discourses*. It has become known as *reductionism*. Descartes viewed the world as a machine and proposed that the machine could be disassembled, studied, and then put back together. From the ideas of reductionism a decision making method much like Franklin's prudential algebra was formalized. We know it as [regression analysis](#). With it, one gathers a collection of information (cue data) about an object until the cost of time or computation exceeds the benefits. Then an equation is calculated that maps the direction of the cue data, which is then used to predict the object's future direction. This method is widely employed today as a statistical approach to decision making. It is commonly used to forecast the investment markets. The key point here is that regression analysis depends on calculating from a complete collection of historical information—or at least a history that is as complete as possible.

Routinely, however, we all use a faster, common-sense method of decision making, one that views real-world environments intuitively. By employing *heuristics*—notions, opinions, and rules that we learn through our experiences and store in our memory—we manage to expedite our decision making. An example of a heuristics-based decision could be this: You must choose a wine to buy for a dinner party. Narrowing the candidates down to two bottles, you decide on the more expensive one because you believe it must be of higher quality and therefore taste better. You most likely learned this heuristic (price denotes quality) early in life, perhaps from your parents, and it has become a bias in your decision making.

Heuristics become biases that help us make decisions quickly, without taking into account the full depth of information that might be available—the vintage year of the wine, the country and region of its origin, the type of grape, the estate that created it, and so forth. The validity of the “price denotes quality” heuristic is measured by how well the wine satisfied you. If it turned out tasting like vinegar, you might be inclined to modify that heuristic rule when buying the next bottle of wine, or any other product.

Heuristic decision making is the means by which we navigate the future. As we experience the real world, each of us creates a depository of rules, notions, and opinions, which seem to be stored in our memory in an ordered hierarchy. When two or more heuristics are used to make a decision, they may be of equal weight and therefore create conflicts that cause indecision.

Heuristics evolve in our uncertain world, wherein the systems are complex: They normally have a history of irreversible and unexpected events, and the forces that influence them are intricately interwoven. Who can actually predict the weather more than three days hence; and to what degree of accuracy? Thus, complex systems are called nondeterministic: We can not predict the exact behavior of their component objects. We can only make calculated guesses about their future behavior. Within them, we can determine an object’s present circumstance in *space-time*, but its future is obscured by an incomplete knowledge of the changing environment affecting it. For ages, the need to make *predictions* about objects in our environments has tantalized scientists’ logic and everyone’s intuition, for, right or wrong, predictions about the objects around us guide our lives.

Analysis of complex systems is essential to formulate heuristic rules for economics, biology, sociology, chemistry, psychology, and all other sciences. NeuroFission (NF) was created to analyse and make predictions for such systems. NF software is a virtual aide that simulates human decision making, which can be called *intuitive rationality*. Its decision-making method departs from orthodox statistical methods like regression analysis, which relies on optimizing historical data. In contrast, NF focuses on information in real-world environments and uses common-sense heuristics to make *fast and frugal* decisions. (The phrase “fast and frugal” was coined by Daniel Goldstein to describe a family of decision-making heuristics.)

## **2. Depth of History and Ecological Validity**

(Previous sections may need to be read to understand references in this section)

To control the risks arising from our decisions, we seek to prepare ourselves and remain alert for opportunity. For example, when the power goes out in your home and you are left in the dark, you might have been prepared with a store of candles and flashlights. When a traffic jam clogs your usual route on the freeway, you might have used the navigation system in your car to take an alternate road.

When the power fails in your home or you encounter a traffic jam on the freeway, you can bet that although similar events had happened in the past, they had little or no effect on the present one. Although an object's current status may be similar to its status at a certain time in the past, the causes cannot be understood with perfect certainty by a system of reduction, because all the relevant information can never be known. Even if a total reduction of causes were possible, they could not define the true disposition of the object, for by definition an object is something more than the sum of its parts.

It is certainly true that historical information is needed to make good decisions, but it is also certain that the success or failure of decision making depends on the method used for gathering and analyzing information. Regression analysis (orthodox statistical analysis) and NF's intuitive rationality (heuristic reasoning) are contrary methods of decision making. The former objectively optimizes a collection of historical information, and the latter subjectively reacts to real-world experiences. When the lights go out, regression analysts would seek all the causes of the power failure, rather than acting quickly and efficiently to provide alternate sources of light. So too, would they sit in a traffic jam recalling all the similar events from the past before making a decision about what to do. When trying to make decisions in a complex system, recalling and optimizing deep history leaves us flat-footed, unable to react quickly to sudden changes in an object's circumstance and environment. Intuitive rationality, on the other hand, keeps us on our toes.

It is the success of our decision making by which we measure our ability to predict the future behavior of objects in complex systems. We call this *ecological validity*. When you quickly restore light in your home or avoid a traffic jam, you feel a sense of accomplishment, one which may be reinforced by your trusted loved ones who had shared the events. Our successful decisions add validity to the heuristics that we used in making them. As you intuitively feel that your decisions were successful, your heuristics gain validity and your confidence.

Confidence in our heuristics is the measure we resort to for making most decisions. Studies have shown that human confidence affects decision making by a twenty percent (20%) margin. It is exemplified in an athlete or team playing with a high level of confidence—their past success promotes their future outlook.

NF is like an athlete who thinks on its toes. It uses common-sense heuristics that are grounded in the real world and have been proven by prior successes. NF simulates the human ability to analyze an object's recent and present behavior, react quickly to it with a margin of confidence, and then forget. It thrives on speed and keeps its mind on the game. Coaches always tell their athletes to clear their minds of everything that has happened before, which has little bearing on the present and future. Roger Federer, the Swiss tennis star, was once asked to predict his chances against a rival in an upcoming match. "Your record is seven wins and one loss against him," the interviewer said.

"Yes," replied Roger, smiling, "but I don't think that helps me with this one."

### 3. Casey's Dilemma: the ball is in the air

(Previous sections may need to be read to understand references in this section)

Imagine that Casey is at the bat. Most of us have read or heard the popular poem by Ernest Thayer about an eventful baseball game in Mudville. Overconfident in his ability to hit the ball and win the game, mighty Casey took the first two pitches, then struck out with a swing and a miss, ending the game. Consequently, there was “no joy in Mudville.” Overconfidence can lead to overlooking the facts—a good heuristic to retain.

A baseball in the air is a [high-velocity](#) object traveling through a complex system. The pitcher has applied spin, velocity, and direction to it. As it buffets wind, temperature, humidity, fog, atmospheric pressure, gravity, and even the influence of the planets, and as it wobbles from the variations in the ball itself—the stitching of its seams, the dirt, sweat, and spit on it, and from its out-of-roundness (no ball is perfectly round)—its flight is effected. All combined they are far too many influences for the hitter to judge exactly where the ball will be when he swings his bat. Moreover, during the half second of the ball's flight, it is doubtful that the hitter can consciously decide to swing. A pitch at 85 mph takes less than half a second to reach the catcher—about 485 milliseconds. Humans don't decide that quickly. Experiments conducted by Benjamin Libet, a pioneering scientist in the field of human consciousness, measured a time delay of 500 milliseconds between a stimulus and the conscious awareness of it. Even though some studies suggest that conscious response time can be much faster (perhaps by athletes), a decision to act and the action itself would add time to a response. In such high-velocity situations, we humans recall [procedural memories](#), nonconscious reactive skills and procedures stored in memory for managing a task like riding a bike or hitting a baseball.

Just like Casey in the batter's box, we rely on procedural memories to react to high-velocity objects in a complex system, without making a decision. However, when a provisional decision has been made prior to the moment of truth, there is evidence that it can be aborted rather quickly. Think of the professional baseball hitter who has decided to swing at a pitch, but is able to check his swing as he sees the ball drop out of the strike zone. Even before the first two pitches were thrown, Casey had probably decided to take them, to see what kind of stuff the pitcher had. Then, he decided to swing for the fences on the third pitch before the ball was in the air.

Any complex system can include unforeseeable influences. For example, imagine that Casey does hit that third pitch. It's a hard grounder, but just as the shortstop is about to glove the ball, it strikes a grasshopper that happened to be in the wrong place at the wrong time, squashes the insect, which causes the ball to skid rather than bounce, and scoot under the glove. The shortstop simply could not react in time to this change in direction of the high-velocity object. In this scenario, Casey, more lucky than mighty, wins the game, and everybody in Mudville congratulates him and celebrates.

Unfortunately, we humans think too slowly and our empirical faculties are subject to too many misconceptions for us to respond timely and accurately in all situations, especially when faced with analyzing influences on high-velocity objects in complex systems. Like streaming currency prices in the foreign exchange market, a high-velocity object overwhelms the rate of human thinking.

Because of our cognitive and sensory limitations, the many influences affecting objects in a complex system causes the human mind to reach a state of [hrrair](#), the point at which the human mind is

overwhelmed by concepts or information. The term was coined by Richard Adams in his classic novel, *Watership Down*.

When the ball is in the air, a hitter does not have the time to reason about whether to swing. The ball would smack the catcher's mitt before he could decide. Rather, he resorts to his instinctive training (procedural memory) and takes a swing. Most of us use reason and procedural memory in tandem—like Casey deciding to swing at the third pitch and then the swing.

It is not surprising that we have invented all kinds of devices to aide our cognitive and sensory limitations. For our reaction time is at stake when making decisions about high-velocity objects in complex systems. NF is a computer device that reduces the time of decision making.

Perhaps, the speed of human decision making is slowed by our reasoning. The many heuristic biases that we store in our memories tend to [inhibit](#) our rational thinking. As we consult them, they make us favor or disfavor certain types of information. Often they cause us to ignore relevant information. Certainly, they complicate our reasoning. Here are some of our most common heuristic biases:

- **Confirmation bias**—validating information according to a preconceived conclusion and disregarding facts that are contrary to that conclusion.
- **Exaggeration bias**—inflating the quantity or quantity of information that supports a preconceived conclusion.
- **Anchoring**—a tendency to rely too heavily, or anchor, on one trait or piece of information.
- **Framing**—setting up arbitrary boundaries and then thinking only inside that box.
- **Hindsight bias**—thinking that we knew it all along after the conclusion of an event. This tends to prevent coming to a different conclusion in similar situation in the future.
- **Salient events bias**—remembering big events from the past and forgetting lesser ones.
- **Conforming bias**—favoring opinions that are held by a group.
- **Prejudice bias**—not believing information associated with or coming from persons, organizations, or groups we do not like.
- **Pride bias**—attributing our successes to skill and performance and our failures to bad luck and external factors.
- **Prediction bias**—overvaluing our predictions because we think we know more than we really know.
- **Overconfidence bias**—believing that we have control over the future

Casey, for example, would seem to have been a victim of overconfidence bias. The author tells us:

**There was ease in Casey's manner as he stepped into his place;  
There was pride in Casey's bearing and a smile on Casey's face.**

Then, after he takes the first two pitches for strikes, urgency and determination have replaced Casey's self-infatuated nonchalance, as we read:

**The sneer is gone from Casey's lip, his teeth are clenched in hate;  
He pounds with cruel violence his bat upon the plate.**

Of course, the list could be much longer, and it would vary in different cultures. Doubtless these biases also have emotional correlates that stimulate their activity.

Heuristic biases might seem unsuited to good decision making, but this is not always the case. Choosing a bottle of wine solely on the basis of its price (the anchoring bias) might be the best [criterion](#) for a person with little knowledge of wine. The degree of his confidence in that bias is increased by its real-world results, not only by the decision maker but by all those affected by the decision.

Because it is natural for us to be inhibited by heuristic biases when making decisions, the decision making process consequently bogs down. But by limiting the number of heuristic biases, we might have the freedom of uninhibited decision making. Holding to that notion, NF is uninhibited as it parses information. It uses only a few heuristics, and therefore, is not rule stressed.

Also, because we know of the benefits of confidence when making decisions, NF simulates a confidence value based on the human confidence benchmark of one-hundred and twenty percent (120%). In other words, decisions that are made based on one-hundred percent of the heuristic rules and twenty percent on the confidence in those rules. Through these two measures, NF simulates human decision making, first by reducing inhibiting biases and second by simulating human confidence.

NF is a decision maker using the ever increasing processing speed of computers to evaluate information faster than is humanly possible. It could easily exceed the quickest humans, such as Ted Williams (the last 400 hitter, who hit 406 in 1941) who had the ability to concentrate on the pitch with singular attention—in other words, to keep his eye on the ball—and to make a critical, split-second decision while the ball is in the air. Of course, there has not been another four-hundred hitter in over sixty years. It would be interesting to see how a hitting machine (if one were invented) with NF at the controls would perform against major league pitchers.

#### **4. Johnny's Problem: attention and attention deficit**

(Previous sections may need to be read to understand references in this section)

Johnny, with a mind as keen and impressionable as the minds of his contemporaries, has a problem. He sits in the classroom listening to the teacher explain the phonics of words while through the window he watches the vapor trail from a jetliner and thinks about the time he flew to Florida with his parents. He is daydreaming, rather than learning to read, something we all do because of our entertaining imaginations. A few rare individuals have the ability to sustain such absolute concentration that they can fixate on the exact nature of whatever they are studying. We call these individuals geniuses or savants. But, like Johnny, most of us are not so focused in our thinking. Our attention is forever being drawn from one thing to another. This makes us more interesting—but not geniuses.

We might wonder why Casey missed the third pitch. Was his eye diverted from the ball for a few milliseconds? Was he listening to cheers of the crowd? Was the thought of being a hero dancing on his vanity? To totally eliminate all mental distractions is not a natural human ability. To track a baseball for even half a second, a player must gather all his mental faculties. Tracking a high-velocity object

that produces streaming data is beyond the limits of our concentration, so it is not surprising that we rely on electronic devices for assistance. Even in sports, as a judge's aid to making calls, we employ electronic devices to show in slow motion what has taken place. In tennis, the MacCAM (a ball-tracking device) is used to validate or invalidate calls made by the line judges. In the NFL, instant replay is used to challenge the referees. Such tasks require the dedicated attention that only an electronic monitoring device can sustain with undivided focus.

When we say that NF simulates human decision making, we mean that it performs like a genius or savant in its rapt attention rather than like one of us distracted souls. Its attention can not be attracted away from the object or the [environment](#) that it observes.

## 5. Jane's Decision: common-sense heuristics

(Previous sections may need to be read to understand references in this section)

Ben Franklin's strategy for decision making was to objectively weigh the pros and cons of a proposition. Of course, he was not, and none of us can be, wholly objective in doing so, because the selection and weight of information is subject to human judgment. Therefore, it is always to some degree that we use common sense heuristics when gathering and processing information. However, common sense is mitigated with a system of regression analysis, which evaluates recent information with equal weight as it does historical information. Such an objective optimization process tends to level out more recent eventful data with that of aged data. Thus, historical objectivism reduces information to a timeless, mathematical value that has little relationship to the real, common sense, temporal world.

As a virtual assistant, NF uses a subjective, common-sense, human approach to decision making. It gathers data, evaluates it on a time-based scale, plausibly extrapolates it into the future, and expeditiously recommends decisions.

In various tests of decision making, heuristics has been shown to perform as well as, and frequently better than, regression analysis and other statistical optimization methods of decision making. A recent study of decision making strategy was conducted by the ABC Research Group under Gerd Gigerenzer and Peter M. Todd; it is described in their book *Simple Heuristics That Make Us Smart*. In comparative testing, the researchers recorded surprising performance by the heuristics method. The success of their heuristic decision making tests might be attributed to the way cues are codified (put in order of their weights) and the use of a frugal stopping rule to end the search and make a decision. NF has adopted a similar fast and frugal heuristics method of arranging cues in a [lexicographic](#) order and then using a stopping rule to search those cues for [inferences](#) of behavior to make a decision. The word "lexicographic" signifies that the cues are arranged in a fixed logical order, for example the alphabetic order for looking up words in a dictionary. A lexicographic order indexes cues for reducing the time needed to find a desired result.

Here is a fictitious example of a decision making situation in which NF's intuitive rationality method is compared to the regression analysis method (polynomial to the 6th order):

Jane is employed by the CIA as a statistical analyst. Because she suspects that her husband, Harry, is cheating on her, she pilfers one of the agency's microelectronic tracking devices (the kind that James

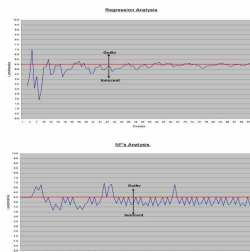
Bond uses) and plants it each morning in a seam of Harry's pants. Harry, a salesman for an advertising agency, is known to be out of the office a lot. Each day, while Harry is at work, Jane receives streaming cue data (GPS positions) showing his whereabouts. She has devised a program that relates landmarks (which she knows or suspects Harry frequents) to the GPS positions of the incoming cue data. She assigns ratings to the landmarks from 0 to 10, with 5.5 as a midpoint. Thus, those places with ratings above the midpoint tend to show Harry's guilt and those with ratings below it tend to show his innocence.

### Jane's Landmarks

- Looking guilty >** 10 Secretary's Apartment
- 9 Ritz Hotel
- 8 Cottage on Lake
- 7 Lola's Massage Pallor
- 6 Roxy Bar and Grill
- 5 Golf Club
- 4 Hair Solon
- 3 Company Cafeteria
- 2 ABC Industries
- 1 Office
- Looking Innocent >** 0 On the road

Harry's being at his secretary's apartment would be the most incriminating evidence that he was guilty. Visits to the Ritz Hotel, the cottage at the lake, Lola's Massage Parlor, or the Roxy Bar & Grill would be incriminating, but to lesser degrees. When he is on the road or at the office, Harry is looking innocent. Each day Jane computes the cue data to find the probability of Harry's guilt or innocence. She has prearranged to call a private investigator when she has evidence that Harry is about to engage in an adulterous tryst, hoping that the PI will catch Harry in the act and take photographs. Wanting to be certain that her suspicion is well founded, she computes the same cue data using both the regression analysis (RA) and NeuroFission (NF) methods. Below are Jane's charts of Harry's movements after one hundred days (100 events) of tracking him:

### Harry's Charts



[\(click to enlarge\)](#)

Jane studied the two charts each day, looking for the best opportunity to catch Harry in the act. After the first ten days, the RA trend line shot up to 7, then dove to 2, while the NF trend line rose above 6.5,

then returned to the midpoint. Because of the variances between the two charts, Jane decided that the next time the trend lines exceeded 6.5 she would call her PI.

For the next four weeks, she anxiously watched the two charts. On the thirty-fifth day, the NF trend line rose to almost 7, while the RA trend line crawled below the midpoint. Now Jane had a dilemma over which chart to believe. If she believed the RA chart and took no action, she might miss the opportunity to catch Harry; if she believed the NF chart, she might send her PI on a wild goose chase. She concluded that further analysis during the next few days would help her understand the behavior of the two radically different methods. So she bided her time, each day meticulously comparing the charts. After four more days, on the thirty-ninth day, the NF trend line once again shot above 6.5, while the RA trend line crawled below the midline.

Jane was perplexed about what to do. Her suspicion of Harry's guilt was not being resolved. Her impatience grew during the passing days as both trend lines hovered around the midpoint, which gave Jane no provocation to call her PI. (Owing to her emotional thinking, she was trying to prove Harry's guilt, not his innocence.) The following days turned into weeks, until the sixty-fifth day, when the NF trend line shot up above 6.5. Jane quickly consulted the RA chart for a comparison. She wanted to make a decision, but the information was puzzling. When she saw that the RA trend line had only slightly penetrated the guilty zone, she threw up her hands and decided that the RA system was not going to take a strong direction. To her mind its path looked anemic, appearing to hold to a flat position. From her experience with regression analysis, she concluded that this was due to its tendency to find common ground—to average things out. Regression analysis uses a measure called the [mean error](#); that is, it seeks to discover the average (mean) degree by which a collection of data points deviates (error) from the midpoint. With this thought in mind, Jane decided to believe the stronger NF prediction, and she called her PI.

Meanwhile, unbeknownst to Jane, one of the CIA's special agents discovered her scheme. Soon word of her daily charts spread throughout the agency, and copies were circulated. This prompted a group of special agents, always looking for gambling opportunities, to start a betting pool. The rules were that each player would put \$100 into the pool and then draw a marker from a hat. There were NF and RA markers. Two spreadsheets (NF and RA) were set up to compute the betting based on the right and wrong predictions from each method. As Jane received her daily data, the agents intercepted it and fed it into the spreadsheets. At the end of one hundred days, the method that had gained the most value would be deemed the winner, and those with the winning markers would split the pool.

The following tables show the results:

### **Competitive Betting Tables**

Betting System: NF System				Betting System: RA System			
Event	Value of Bet	Right or Wrong	Balance	Event	Value of Bet	Right or Wrong	Balance
1	20	Right	120	1	20	Right	120
2	20	Right	140	2	20	Right	140
3	20	Right	160	3	20	Right	160
4	20	Right	180	4	20	Right	180
5	20	Right	200	5	20	Right	200
6	20	Right	220	6	20	Right	220
7	20	Right	240	7	20	Right	240
8	20	Right	260	8	20	Right	260
9	20	Right	280	9	20	Right	280
10	20	Right	300	10	20	Right	300
11	20	Right	320	11	20	Right	320
12	20	Right	340	12	20	Right	340
13	20	Right	360	13	20	Right	360
14	20	Right	380	14	20	Right	380
15	20	Right	400	15	20	Right	400
16	20	Right	420	16	20	Right	420
17	20	Right	440	17	20	Right	440
18	20	Right	460	18	20	Right	460
19	20	Right	480	19	20	Right	480
20	20	Right	500	20	20	Right	500
21	20	Right	520	21	20	Right	520
22	20	Right	540	22	20	Right	540
23	20	Right	560	23	20	Right	560
24	20	Right	580	24	20	Right	580
25	20	Right	600	25	20	Right	600
26	20	Right	620	26	20	Right	620
27	20	Right	640	27	20	Right	640
28	20	Right	660	28	20	Right	660
29	20	Right	680	29	20	Right	680
30	20	Right	700	30	20	Right	700
31	20	Right	720	31	20	Right	720
32	20	Right	740	32	20	Right	740
33	20	Right	760	33	20	Right	760
34	20	Right	780	34	20	Right	780
35	20	Right	800	35	20	Right	800
36	20	Right	820	36	20	Right	820
37	20	Right	840	37	20	Right	840
38	20	Right	860	38	20	Right	860
39	20	Right	880	39	20	Right	880
40	20	Right	900	40	20	Right	900
41	20	Right	920	41	20	Right	920
42	20	Right	940	42	20	Right	940
43	20	Right	960	43	20	Right	960
44	20	Right	980	44	20	Right	980
45	20	Right	1000	45	20	Right	1000
46	20	Right	1020	46	20	Right	1020
47	20	Right	1040	47	20	Right	1040
48	20	Right	1060	48	20	Right	1060
49	20	Right	1080	49	20	Right	1080
50	20	Right	1100	50	20	Right	1100
51	20	Right	1120	51	20	Right	1120
52	20	Right	1140	52	20	Right	1140
53	20	Right	1160	53	20	Right	1160
54	20	Right	1180	54	20	Right	1180
55	20	Right	1200	55	20	Right	1200
56	20	Right	1220	56	20	Right	1220
57	20	Right	1240	57	20	Right	1240
58	20	Right	1260	58	20	Right	1260
59	20	Right	1280	59	20	Right	1280
60	20	Right	1300	60	20	Right	1300
61	20	Right	1320	61	20	Right	1320
62	20	Right	1340	62	20	Right	1340
63	20	Right	1360	63	20	Right	1360
64	20	Right	1380	64	20	Right	1380
65	20	Right	1400	65	20	Right	1400
66	20	Right	1420	66	20	Right	1420
67	20	Right	1440	67	20	Right	1440
68	20	Right	1460	68	20	Right	1460
69	20	Right	1480	69	20	Right	1480
70	20	Right	1500	70	20	Right	1500
71	20	Right	1520	71	20	Right	1520
72	20	Right	1540	72	20	Right	1540
73	20	Right	1560	73	20	Right	1560
74	20	Right	1580	74	20	Right	1580
75	20	Right	1600	75	20	Right	1600
76	20	Right	1620	76	20	Right	1620
77	20	Right	1640	77	20	Right	1640
78	20	Right	1660	78	20	Right	1660
79	20	Right	1680	79	20	Right	1680
80	20	Right	1700	80	20	Right	1700
81	20	Right	1720	81	20	Right	1720
82	20	Right	1740	82	20	Right	1740
83	20	Right	1760	83	20	Right	1760
84	20	Right	1780	84	20	Right	1780
85	20	Right	1800	85	20	Right	1800
86	20	Right	1820	86	20	Right	1820
87	20	Right	1840	87	20	Right	1840
88	20	Right	1860	88	20	Right	1860
89	20	Right	1880	89	20	Right	1880
90	20	Right	1900	90	20	Right	1900
91	20	Right	1920	91	20	Right	1920
92	20	Right	1940	92	20	Right	1940
93	20	Right	1960	93	20	Right	1960
94	20	Right	1980	94	20	Right	1980
95	20	Right	2000	95	20	Right	2000
96	20	Right	2020	96	20	Right	2020
97	20	Right	2040	97	20	Right	2040
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99	20	Right	2080	99	20	Right	2080
100	20	Right	2100	100	20	Right	2100

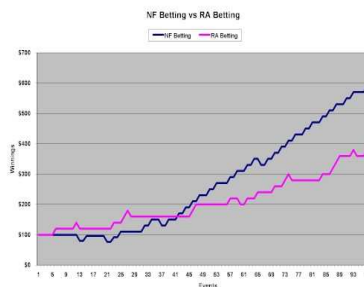
[\(click to enlarge\)](#)

Of course, when calculating money gained or lost, the bottom line is the bottom line, in this case \$611 for NF and \$360 for RA. It should be noted that the NF system requires some priming. In this example, it took forty-three events to reach its optimum performance level. Up to the forty-third event, RA's account value was ahead of NF's by a few dollars, but then the tables turned when NF was primed, and it proceeded to run away with the contest. Here are the stats after the one hundred days of betting:

Beginning Cash Accounts	\$100
Percent of Accounts Risked	20%
Leverages	1
NF Right Bets	30
RA Right Bets	19
NF Wrong Bets	4
RA Wrong Bets	6
NF Percent Right Bets	88%
RA Percent Right Bets	76%

Observe the competitive betting chart below:

### Competitive Betting Charts



[\(click to enlarge\)](#)

For those who have read this far and have a desire for closure (a cognitive bias that did not make the above list), Jane's illegal use of the CIA's equipment was discovered. A sympathetic judge sentenced her to only ten days jail time and six weeks community service. Meanwhile, Harry, who was innocently attending the Jaycee's monthly meeting at the Ritz Hotel when Jane's PI found him, met an

Italian cosmetologist, liquidated all assets, and escaped with her to Costa Rica. It bears repeating that nothing in life is certain but death and taxes.

## 6. Aging Events: salient events and the decay of historical information

(Previous sections may need to be read to understand references in this section)

We have discussed the fact that regression analysis gathers as much historical information as possible, because it is based on a theory of historical averages and the assumption that more information yields greater accuracy. In contrast, NF's method of intuitive rationality is based on the assumption that the most recent information is the most relevant to the future behavior of objects. When we remember the past, we do so by recalling events. As the weight of an object's cue data rises or falls, it becomes an event or nonevent in our minds. When cue values rise sharply, they denote salient events. Jane would have said that Harry's presence at his secretary's apartment was a salient event, because to her it would have been the most compelling evidence of his infidelity, throwing suspicion on all his future behavior. When the Mudville fans watched Casey strike out, they remembered the joyless event vividly and it was thereafter known as the day that Casey lost his touch.

Significant events become salient (prominent) in our memories, whereas nonevents, those that are called *noise* by scientists, are forgotten. The human cognitive mechanism for discarding information is perhaps more active than the mechanism for retaining events. We have discussed how cognitive biases contribute to parsing information. In a similar way, repetitive actions, like walking the dog, are quickly forgotten—except for the time the dog ran off with a white poodle and it took two days to find him. The deeper a salient event sinks into the past, however, the more it pales in memory; thus our cognitive mechanism for retaining the memory of salient events includes a mechanism for *aging* them.

NF uses a *function* that acts like the human aging mechanism: It discards noise and retains salient events and decays those events as they age. Unlike orthodox statistical systems, NF incorporates a real-world, humanlike sense that reduces the *significance* (weight) of older events.

Some salient events, especially catastrophes, are so unusual and extreme that they dominate our perception of other events. They are sometimes called *black swans*, a term popularized by Nassim Nicholas Taleb in his book *The Black Swan*. These events have three basic characteristics: They are unforeseen, they have massive personal and societal impact, and they falsely appear in hindsight to have been predictable. Their great weight upsets our reasonable expectations of objects. The San Francisco earthquake of 1906, the great depression, the bombing of Pearl Harbor, 9/11, and hurricane Katrina are a few such American black swans. When black swans suddenly occur, because of their huge emotional impact, they alter the perception of predictable courses of objects. Only an unemotional observer can be unmoved by the weight such events have on the future. Normally, such events intrude on the emotional content of decision making. However, a virtual state of mind, such as NF, will not let its intuitive rationality suffer from *ambivalent* emotions.

## 7. Give Me the Best

(Previous sections may need to be read to understand references in this section)

NF includes a function that finds the best decision for competing objects. For example, the objects could be several price pairs in the foreign exchange market. As NF processes their data, it produces cue ratings for each price pair and arranges the ratings in NF's lexicographic order according to their real-world significance. Each price pair is analyzed and assigned a rating between plus one thousand (+1000) and minus one thousand (−1000). When the price pair ratings are arranged in lexicographic order, NF uses a stopping rule to search for the best trade probability. After the best trade is determined for each of the price pairs, the program executes its “Give me the best” function to find the best of the best of the competing price pairs. This function works with any application and for any number of objects.

## 8. Plausible Reasoning

(Previous sections may need to be read to understand references in this section)

Probability is the degree to which an object behaves predictably in a future complex system. Its measure is usually a value expressed as a number between zero and one (a percentage). Probability theory is traditionally divided into two categories, physical and evidential. For millennia, physical probability, also known as [frequentist theory](#), has been associated with games of chance. It deals with events like flips of a coin that tend to occur at a persistent rate, or relative [frequency](#), in a long series of trials. Frequentist theory predicts that the probability of a coin toss coming up heads is 50 percent, not because there are only two possible outcomes but because over a large number of trials repeated into infinity, the frequency of heads and the frequency of tails both tend to mathematically converge at 50 percent. In other words, physical probability is based on experiment—a large number of repetitive trials.

In the eighteenth century, probability theory was redefined by Thomas Bayes (1703–1761), but it was not until the 1950s that [Bayesian theory](#) was applied to a wide range of applications. Bayesian theory is based on a partial belief rather than on frequency. Bayes evidential probability theory is a subjective method of determining plausibility, or the degree to which an object's behavior is supported by available evidence. [Bayes' rule](#) is used to update the degree of a belief according to the validity of posterior information. For example, when Jane was on trial for pilfering CIA equipment, a judge was inclined to believe new evidence in light of the veracity of prior evidence. Thus evidential probability is based on the subjective assessment of the validity of information—we might also say the confidence in that information.

The difference between physical and evidential probability was clarified by David Hume (1711–1776), a historian, economist, and philosopher who wrote extensively on human rationality. Hume noted that there were two ways to validate information: relating ideas and referring to the real world of facts. He proposed that the relation of ideas can only validate other ideas and nothing more beyond their related contexts. The proposition that “an equilateral triangle has three sides of equal length,” which orthodox philosophers (notably Plato and Descartes) have deemed a logical statement, was, Hume thought, detached from reality, because its truth depends on the ideas of geometry, not on an actual triangle in

the real world with sides of equal length, which does not exist—at least not to an infinite degree of precision. Therefore Hume concluded that the relation of ideas cannot validate information. Moreover, he also thought that real-world facts can never be certain because of the fallibility of human interpretation. This proposition has become known as *Hume's fork*.

Thomas Bayes and David Hume seem in part to agree, but they also seem to disagree. Bayes's theory of evidential probability adheres to Hume's real world of facts, but it does so through human subjective interpretation, which Hume distrusts. Removing human fallibilities from the equation, however, may reconcile the differences between the two thinkers.

In our uncertain real world, the plausibility of a future event is a human common-sense measurement inhibited by our cognitive biases and by our limitations in gathering, selecting, and analyzing information. For example, just before the pitcher threw the third pitch, Casey figured it would probably be a fastball, but he was not 100 percent sure. As he pounded his bat on the plate, he thought about the several possibilities. During the game the pitcher had thrown 60 percent fastballs, 30 percent curveballs, and 10 percent changeups. With two strikes on a batter and fewer than three balls, he had thrown a curveball 80 percent of the time, however to the last two hitters, he had thrown third-strike fastballs. Of course, Casey did not mathematically compute this information. He could not recall exactly how many fastballs, curveballs, and changeups had been thrown for strikes during the game, but his prediction was more than 50 percent sure, based on a hunch of the most recent information. He expected the third pitch to be a fastball (actually he was about 130% sure due to his overconfidence); he swung at it and missed.

Although similar to the human cognitive process for predicting the future, NF conforms to formal rules of plausible reasoning and remains unswayed by the emotional ambivalence of human thinking. It adheres to nine fundamental principles:

1. Generic software that requires no modifications to use with any application.
2. Dedicated, focused, and uninhibited as it gathers and processes cue data.
3. [Qualitative](#) evaluation of information measures [magnitude](#)
4. [Quantitative](#) evaluation of information codifies and counts similar events.
5. Events are decayed with age, giving due weight to the greater relevance of recent events.
6. Fast and frugal heuristics find the best forecast and expedite decisions.
7. Subjective method of rating information is based on Bayesian probability theory.
8. Confidence from one-hundred to one-hundred-and-twenty percent is attributed to event ratings.
9. Represents the degree of objects' plausible behavior in real-world values.

## **9. Intuitive Rationality: emotion, valence, and relevance**

(Previous sections may need to be read to understand references in this section)

There have been ongoing efforts to define the role of human emotion in judgment and decision making. Much of the debate has been grounded on the thought that people use immediate, intuitive responses as a substitute for deliberate thinking. These intuitions, it is conjectured, are motivated by nonconscious emotional cues that have relevance to the object of decision. With rather speculative

observation, it is thought that emotional states are the result of appraisals between the self and the circumstance of objects. It is also generally agreed that the role of emotions is to monitor thinking and thereby motivate decision making. When considering that decision making requires: (1) an aspiration to promote wellbeing and success, (2) a time constraint, (3) attention directed to a subset of relevant aspects of an object's behavior in its environment, and (4) commitment to the decision; emotional states seem to fulfill the later requirement. Positive moods have been found to promote winning judgments and negative moods to promote losing judgments. It has been proposed that feelings of pleasure and displeasure inferred from the consequences of a decision provoke choices. The [valence](#) dimension (the attraction or aversion one feels toward an object) is presumed to be a core characteristic of emotional experience. Most researchers agree that from memory or imagination people infer emotional states, but they are not necessarily conscious of them.

When the third pitch was in the air, Casey relied on his hunch, his emotional state, to promote the way he swung the bat. He was so confident that it was going to be a fastball that he held nothing back. He swung for the bleachers. Plainly, his mood was inspired by the situation of the game (the perceived pleasure of winning), the roar of the crowd (the rewards of fame), and an expected high-five from the coach (assuring his rank on the team and its payoff). We can only imagine what his mood was in the aftermath of defeat, and how it would affect his future performance at the plate. Perhaps, he would shrug it off like a muddy uniform, forget the public humiliation, forget the swing and miss, clear his mind of the event, and replace it with a mood (we could call it an attitude) of confidence and conviction. A study into mood affecting wins and losses in the Iowa Gambling Task showed that a positive mood is the winning mood and that a negative mood promotes [ambivalence](#) and loss. Certainly, Jane's mood from her suspicion that Harry was having an affair can not easily be called positive. But neither can it be classed negative within the measure of her confidence that Harry was guilty. Her commitment to catch him during a tryst was certainly promoted by jealousy, social pain, and fear of loss—both materially and emotionally. It was an intuitive force from her emotional state that urged her to call her PI. She, like Casey, decided to act by following an intuition. The only difference was that she had time for rationality and Casey did not.

It seems that emotional states are stored in memory and tempered by habit. They gain perfection in practice and when activated, use intuition as their instrument. The more Jane imagined Harry with his lover, her jealousy gained steam and its force was expressed through her intuition. Emotions, like cues, seem to be prioritized: Jealousy may outweigh pain and pain may outweigh fear. Some emotions are creatures of imagination, taking form in the activities of fantasy, wishful thinking, and visions of good luck. It is most certain that a myriad of emotions are involved in decision making. Remarkably, it is now believed by some researchers that without emotional involvement, decision making may not be possible.

If emotional states are frames of past experiences with objects behaving in environments for a measured duration, faced with a decision relevant frames would come into play to motivate the decision-maker. The nonconscious, emotional framework of the decision-maker would then contain recipes for certain objects and situations, and when provoked, feed intuition on the fringe of consciousness. It is also rather poignant to the discussion of decision making that, as Freud (1920-1952) pointed out: "our entire psychical activity is bent upon procuring pleasure and avoiding pain." The perceived affects of making a decision is crucial in procuring relevant emotional frames. What the

decision-maker wants, expects, and hopes for—Casey wanting to hit a homer, expecting a fastball, and hoping to win the game—evoke relevant emotional frames.

At this point in time of our technology, it would certainly be presumptive to claim that a computer can simulate human emotion in all its biological process. But there seems to be agreement that emotional intuition is conceptualized as a motivational force. A decision-maker in emotional disarray and conflict is often characterized as unmotivated and incapable of making timely decisions, or none at all in extreme cases of emotional compromise. Certainly positive motivation is expressed by confidence and commitment. Perhaps with most decision making, the mere level of confidence is the core motivator and confidence alone is the measure of intuition. If intuition is believed to show direction as well as force, it may be that it attributes its force to relevant heuristics in an effort to promote a decision that satisfies its emotional framework. Undoubtedly, much more research is needed to define the fine and complex nature of human emotion in relationship to decision making.

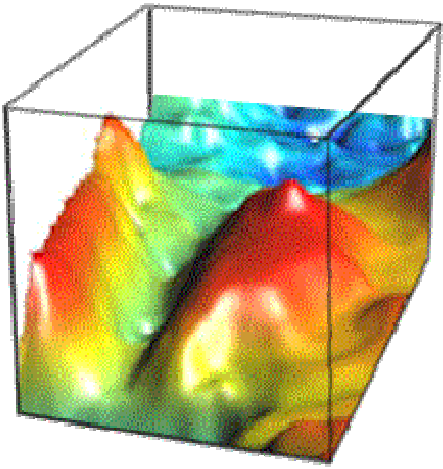
We have used intuitive rationality to describe NF's decision-making process. As a heuristics based system, simulating the human system, NF functionally ascribes confidence to heuristic cues in the process of making decisions. Thus, NF uses a degree of confidence to promote making a choice; we could say as well: NF uses a degree of intuition to promote making a choice. The function of intuition exerting confidence on decision making options is a two step process in humans and NF.

Emotion is a human attribute that is felt but not consciously recognized in decision making. It lives and acts beneath a shroud of conscious thinking. Passionate attraction (the valence of social intercourse) is responsible for most common habituated emotional states. Many decisions that fall under the guise of social and ethical choices may draw from a myriad of emotional cues. However, some decisions of specificity—such as those concerned with profit—may be more singular in their emotional cues. Certainly the desire to profit from an investment is a strong emotional cue, and at the same time, it is often the singular motivator for the investor. A dedicated decision-maker like NF, with focus on a single application, can be unambivalent in its decision making because it is not compromised by competing emotional and intuitive motivations. NF is an intuitive decision-maker because it uses confidence to promote, to add value to, its heuristic options; it is a rational decision-maker because it selects the best option to make a right decision.

## **10. The Virtual State of Mind**

(Previous sections may need to be read to understand references in this section)

As computer technology allows us to see, feel, and learn more about complex environments and how objects behave within them, our future reliance on a virtual state of mind is imperative. Some predict that the singularity—the point at which machines surpass human intellect—will occur in the foreseeable future. NF is a step in that direction. NF's state of mind is not inhibited by biases, emotional ambivalence, wandering attention, or the slowness of human thought. NF is dedicated to monitoring and making predictions about objects in complex systems, and it can also be used to control such objects. (For more on control, see the next section: The Cube.) Some of the vital complex systems are in the stock, commodities, and foreign currency exchange markets, in weather forecasting (storm tracking, for example), in gaming operations (including sports betting and game development),



in design and manufacturing (monitor and controlling machines), in economic systems, in biotech, and in robotics.

Why simulate human thinking with all its apparent fallibilities? The answer may be found in the fundamental [utility](#) of human decision-making—that is, if the results are satisfactory and beneficial then we can confidently say that the decision-making method is right. We can further this by saying: if NF works better than regression analysis and other statistical methods of forecasting, then

we can be confident that its method is right.

Grant Renier, founder and CEO of NeuroFission, puts it this way: “Evolution has caused the human brain to be the best tool for decision making in the real world, so far. As a result, our environment is basically a product of human decision making—good, bad, or ugly. Humanity is perforce concerned with understanding the complex environments we live with, because they ultimately determine our future. Thus, a faster, more efficient simulation of human decision making guides us to what we will ultimately know. To approach complex system problems with non-human logic will produce results that are incompatible with our world of rationality, and may even threaten our survival. Therefore, the goal of rational technology must be to simulate and improve human decision making.”

## 11. The CUBE (Previous sections may need to be read to understand references in this section)

The NF Cube is a palpable, graphic interface to observe, and in some applications a way to control, the real world changes of objects in complex systems. In a world where complex environments frequently change the directions of objects, the Cube displays the dynamics of those changes. The Cube simulates the four dimensions of an object—the three dimensions of space and the fourth dimension of time. With systems that can be controlled (machines and robotics for example), the Cube is a sensitive, touch-screen display that can be used to correct and control the behavior of objects.

It should be noted that the Cube is an *optional* NF user device. The NF system can operate in-the-blind for any application. However, for uncontrollable application systems (such as financial markets, weather, and gaming), the Cube can be used as a monitoring tool, and for application systems that are controllable (such as robotics and mechanics) it can be used not only a monitoring tool but a control mechanism.

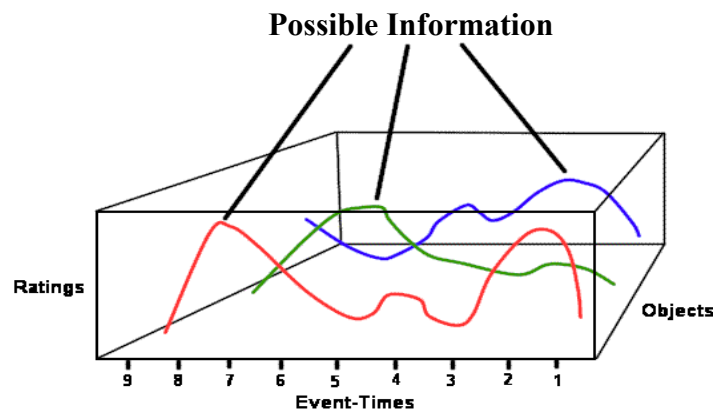
The Cube can be compared to a measuring instrument, such as a car’s speedometer, an airplane’s altimeter, or a weatherman’s barometer. Several objects can be tracked concurrently. As a control device, it can be compared to a car’s accelerator or an airplane’s joystick.

The Cube displays a multi-colored terrain as it animates the disposition of objects moving through time. As new event-times evolve and object ratings are fed into the Cube, they are represented as waves moving from right to left. For example, a company’s stock could be monitored in the Cube. A terrain is created by the stock’s wave and changes as time moves the wave across the Cube’s horizontal axis. There could be several stocks in a portfolio that move across in multiple waves. Thus, the Cube is a microcosm, or the epitome, of the stocks performance in the real world. It is like a glass

aquarium in which the activities within are transparent. Moreover, once the user becomes familiar with reading the Cube's waves, viewing waves from different applications becomes a familiar process.

An understanding of the simple composition of the Cube will prepare the user for monitoring any object in any application. It does not require a high level of technical training to become adept at reading the Cube's waves. Recognizing their peaks and valleys, their dynamics, can be grasped by the user after just a few minutes of watching the Cube. Relating the Cube's waves to an application with which the user is experienced (such as a broker with stocks or an engineer with machines), is quickly realized, because the waves reflect their real world performance exactly. Additionally, since the NF software is generic for all applications, users who become familiar with the Cube, but are not familiar with a particular application, will quickly understand the dynamics of that application by following the terrain of its waves.

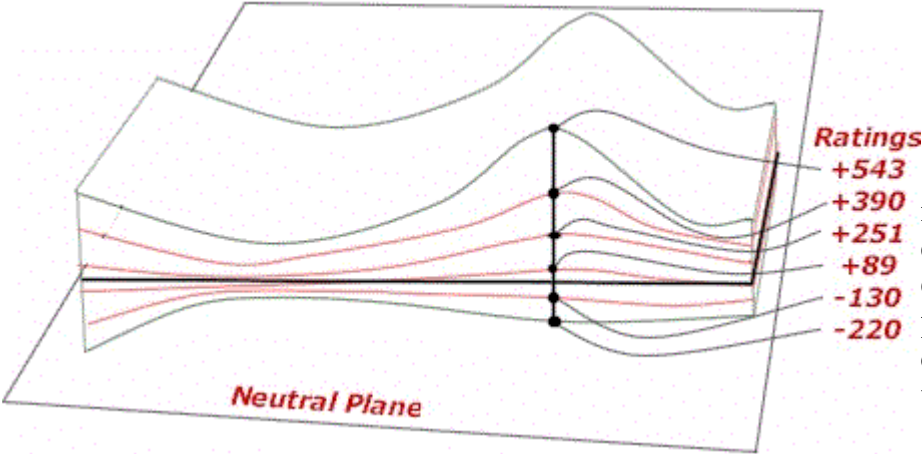
The Cube is a three-dimensional box with width, height, and depth. The graphic below shows a skeletal view of three objects (such as three FOREX price pairs) creating waves that undulate through the Cube—as they do, they transcend event-time segments. Starting at the right side is the most recent event-time and moving toward the left side the event-times encompass larger bites of the past. The wave's high and low points are indicated by the respective rating for each event-times. The waves of several objects stack up from front to rear. Their peaks and valleys represent significant and insignificant events. The objects shown in the graphic below could be three price-pairs in the Forex market, stocks in a portfolio, or a mix of any number of objects in any number of applications.



### Event-times

We have discussed above how the NF technology gathers data in segments over time, which we call event-times. The event-times play a central role in making decisions about immersing behavior. Since NF applies the real world process of aging to object ratings, the event-times age as they move from right to left in the Cube, which, like human memory, reduces the significance of older events.

The event-times are of fifteen (15) minute duration. Thus, the event-times increase by fifteen (15) minute increments from right to left: 15, 30, 45, 60, 75 minutes and so forth, until they reach the final event-time (the 200th event-time segment) of three-thousand (3,000) minutes duration, or fifty (50) hours, which is slightly more than two (2) days. The NF system processes new data every fifteen (15) minutes and applies it to the Cube, which shifts the event-time series one (1) increment to the left as a new fifteen (15) minute rating is added. The processing of a new event-time is extremely quick, which



reduces the delay in seeing real world changes reflected in the Cube. For example, quick responses to the changing prices to FOREX price-pairs can mean the difference between successful and unsuccessful trading decisions.

### Ratings

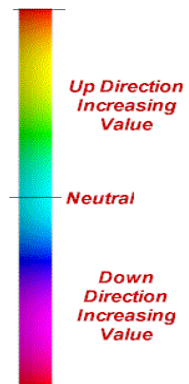
We have discussed above in technology that the ratings are derived from real world heuristic rules and assigned to application objects. The ratings are set on a scale of +1000 to -1000 with zero (0) as the neutral plane. To the right, the cross-section view of the CUBE shows waves as they flow above and below the neutral plane, or the zero (0) point on the ratings scale. The waves can be compared to mountain peaks and valleys which run above and below sea level, with sea level being the neutral plane, or ground zero. Thus, the Cube's terrain is created by the relative ratings along the event-time segments.

### Objects

As we have stated above, the Cube can contain numerous objects concurrently. They stack up from front to rear along the Cube's depth. When several objects cohabit the Cube, they form a stratified depth to the terrain: peaks behind peaks, valleys between valleys. The significant advantage of combining objects in the Cube, even those from different applications, is in the comparative aspects of their behavior. The user can monitor and control (more on control below) one or more objects in the Cube's visual microcosm. For instance, a broker could watch the effects of several economic indicators as transcending waves beside the waves of stocks in a portfolio, or watch the waves of international economic indications beside FOREX price-pair waves. As a composite device, the Cube has infinite capacity to view and manage several complex applications because of NF's generic technology. Any object in any complex application for which real world data is available can be included in the Cube without modification to the NF software. The Cube's composite feature is a new world window for information analysis that heretofore has not been known.

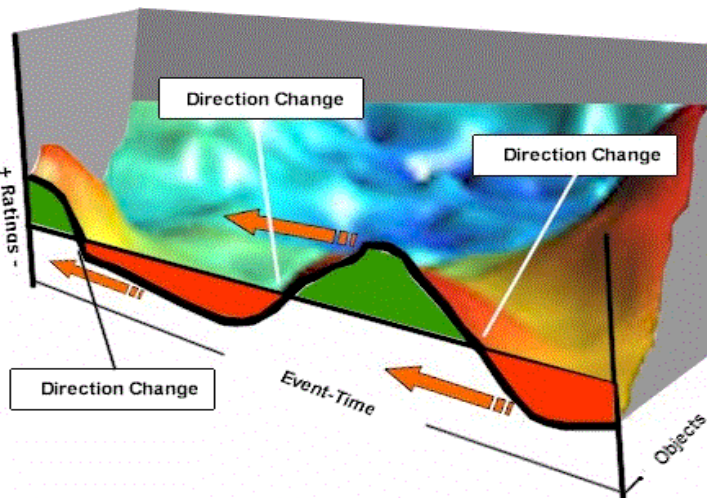
### Color Spectrum

The terrain of an object's wave in the Cube is displayed with a gradient spectrum of colors. At the height of the wave, the color intensifies and brightens to yellow and red and at the bottom, the color fades and dims to blue and magenta. Thus, as the user observes the waves in the Cube, those with higher ratings become prominent (salient events), not only by their height, but by their radiance of color—like the distinct white peaks of the Rocky Mountains and the dark gorges of the Grand Canyon. Indeed, by color alone, the sensitive eye can follow salient events as they flow within the Cube's microcosm.



### Graphic Slicing

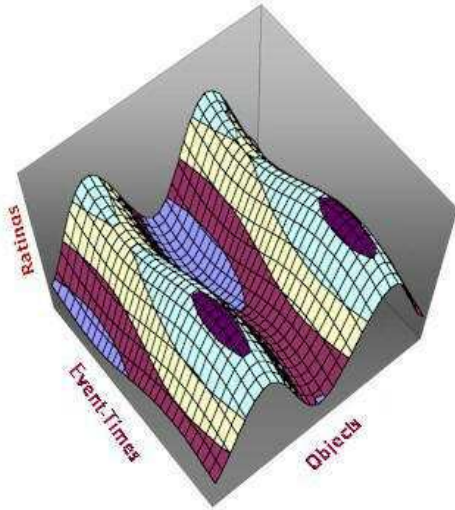
For the purpose of viewing a single object's wave among other objects in the Cube, for example a FOREX price-pair, the user can click on the price-pair tag along the depth axis which will display a



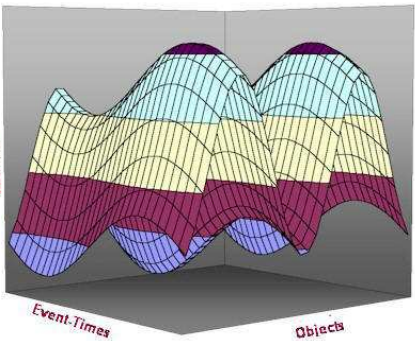
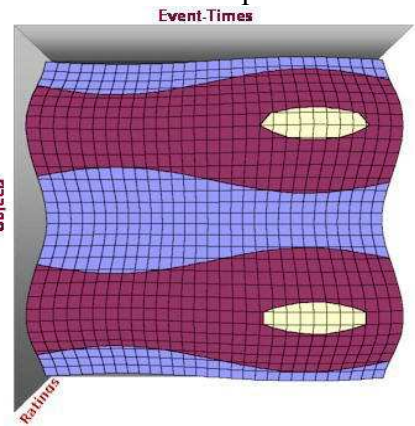
cut-away view of its wave. Then the user can analyze the path the price-pair is taking along the neutral plane over the complete range of event-times and determine where the most advantages trade opportunities occur. The visual provides an elemental view of a price-pair in the context of the market as a whole. Optionally, a graphic slice along the ratings axis will display a bird's eye view of the price-pair's wave, displaying the prominent peaks of the terrain which can be identified by their gradient colors.

**Cube Rotation**

For visually observing the interrelationships of objects, the Cube can be rotated. This utility provides the user with a look and feel for the component environment. The waves can be viewed from any angle. For example, a comparison of the twin waves in the graphics to the right and below could be the two front wheels of an automobile that create ratings derived from sensors monitoring tire pressure, temperature, wheel vibration, and rates of rotation. Any anomaly in the performance of the wheels will be revealed in a variation between the two waves. Moreover, acceleration in speed would change the height of the waves as new event-time ratings are fed into the Cube. Or, the twin waves could be two stocks in the stock market. A bull market move would similarly raise the heights of the incoming waves. With multiple waves undulating through the Cube, the rotation device allows for diverse observation of performance which, after some hands-on experience, will help the user learn to intuitively recognize the condition of the waves and their comparative dispositions. Rotating the Cube to a birds-eye view provides another perspective of the critical condition of the two front tires or the peak prices of



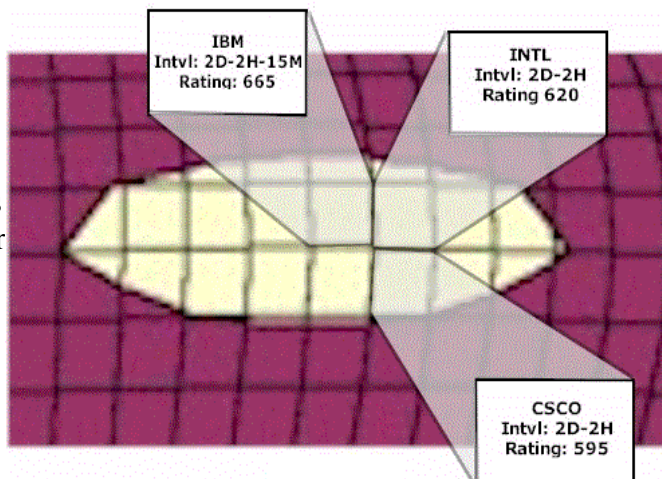
two stocks.



two stocks.

**Drilldown**

The graphic to the right shows a zoomed-in, bird's eye view of an enlarged peak of two closely correlated objects, such as tire pressure and tire temperature, with pop-up boxes activated. To view the details at a point in an object's activated by object and its an name (such as pair, or tire air and the value a stock). The



wave, the drilldown feature is clicking on a cell defined by the event-time segment. This pops up information box with the object's a stock symbol, FOREX price-pressure), interval number, rating of the object (such as the price of value can be adjusted to send

feedback control to adjust the an object's performance (more on feedback control below).

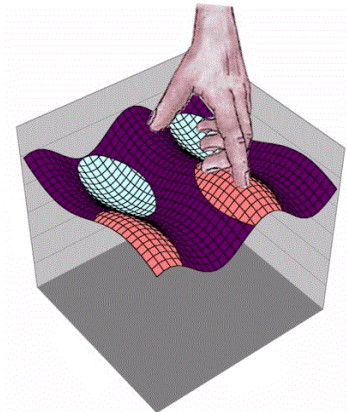
### **Templates**

The Cube has a feature to save a wave, or take a snap-shot, and store it in a template file. The template can then be recalled and used as a model for emerging waves. This is a powerful tool that can be used as a guide for managing those objects that can be controlled. For example, saving a template of the optimum, stable operation of an automobile tire could later be recalled to create a variance graphic for tires in actual operation. The result is a graphic that would reveal performance that deviates from the desired operation. The peaks and valleys would be compared exactly. When an anomaly occurs, the operator would be alerted to make adjustments. A tire in actual operation may have lost air pressure or incur a defect. Thus, the operator would be alerted to correct the anomaly. The variance graphic might look like the one above.

### **Feedback Control**

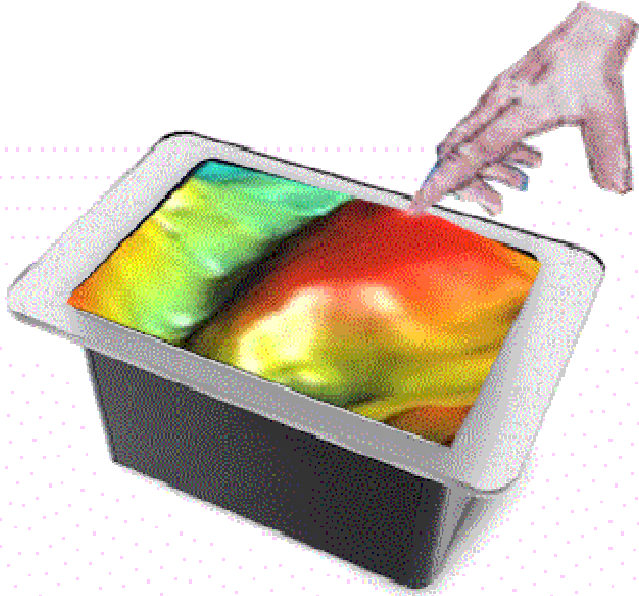
Some applications, such as machines and robotics, can be managed and adjusted by feedback control. To accomplish this, an interface from the Cube to a control device on a machine or robotic would be used to fine tune or correct performance. Controlling a mechanical device can be managed by an operator or by the NF Cube set in automatic mode. The drilldown feature is always available to provide performance details and to inform the operator that control is needed to bring it back in line with optimum performance. The operator can make adjustments using the cursor or by touch-screen manipulation.

Adjustments can also be made with the value field in the drilldown window. But by manipulating the waves on the touch screen, pushing down and pulling up areas of a wave to bring it in line with the optimum template wave, may be the most intuitive way to manage objects. Thus, adjustments are transmitted to the control device which executes the corrective instructions.



Automatic feedback control can be used for applications to obviate an operator's resource. Imagine saving a template for the optimum behavior of a power plant and having NF manage it by automatic feedback control.

A remote manager could monitor its operation in the Cube. Boundary values could be predefined to issue alerts when performance does not appropriately respond to automatic control or deviates too far from optimum performance. The operator would not have to monitor the power plant's gauges and various instruments since their values would be explicit in the Cube's waves. Relief from pressing buttons, turning knobs, and flipping switches to the Cube's graphic control does not only provide an operator with an intuitive sense of performance, but also a wider scope for observing several systems in a single graphic. Therefore, the operator's resource for managing several applications concurrently is greatly expanded.



### **Interface Devices**

As our technology continues to produce new and better I/O devices to interface computers with mechanical and other electronic devices, the NF Cube plays a groundbreaking role in transforming mechanical input and control to graphic touch-screen devices. The advent of such new products like Microsoft's Surface is changing the fundamental way we interact with digital content. Surface is a 30-inch tabletop display that allows several people to work concurrently and independently without using a mouse or keyboard.

With such devices as Surface, a new age of monitoring and controlling objects in complex systems is on the horizon. The NF Cube's application software was created for such devices which reduces intuitive object management to pointing a finger.