‘Boxing’ Choices for Better Dispute Resolution

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ABSTRACT
Choosing among alternatives that vary in multiple ways you care about is one of the most fundamental mental activities, and one that is part of nearly all forms of cognition. Decisional processes often primarily involve balancing competing considerations. When multiple parties with conflicting interests are present, strategic interactions add to the complexity. This article explores opportunities for interactive visualizations in support of such processes, using as background a current software project that is developing systems for collaborative deliberation about choices.

1. INTRODUCTION
People face choices throughout their personal and business lives. Some are nearly invisible and instantaneous; others involve extended deliberation and debate. Some are made by one person alone; many involve consultation with others. By many accounts they are becoming more frequent and complex. We deal with choices all the time, although few of us are very good at them.

It is notable that most people don’t use technology creatively or aggressively to support decision making. That has something to do with how unreflective we tend to be about our deliberations. Most of us are woefully unsystematic and tech-challenged when it comes to decisions, despite their being among our most pervasive and consequential activities.

This article considers the software tools we use and might use to make better choices – alone, or in strategic interaction with others – and explores the principles that should guide the design of such tools. It is a wide ranging but admittedly preliminary foray into this vast subject.

The article is organized as follows. Section 2 summarizes general ways in which technology can support decision making. Section 3 lays out a particular methodology the author has been developing. Section 4 describes an effort to field online choice-support environments that leverage interactive visualization and collective intelligence. Section 5 considers their application to strategic bargaining and dispute resolution contexts. Section 6 covers related work. Section 7 poses questions and summarizes guiding principles. Section 8 concludes.

2. CHOICE SUPPORT TECHNOLOGIES
Decisions often involve careful judgment, delicate balances of considerations, and high quality communication. Professionals pride themselves on their ability to handle complex decisions, and to counsel clients effectively to appropriate resolutions. Technology has generally taken a back seat, mostly appearing in the form of email and word processors. Many people are reluctant to go beyond yellow pads and white boards for certain issues. But there are more modern decision-support technologies worth considering.

2.1 Gathering storm
We surely don’t lack means to gather information and opinions pertinent to a decision. Say you’re considering a new piece of technology. A few minutes with Google or Bing can yield hours of eerily relevant material. Posts on an email discussion list will often surface options, considerations, and viewpoints. If vendors or other interested parties are involved, they will happily shower you with literature and demonstrations.

What we *do* seem to lack are good tools for filtering through and sorting our options, and for managing the processes by which we rate and rank them. We can use word processors, spreadsheets, outliners, or “mind mappers” to collect and document relevant considerations, but they aren’t of much help in reaching conclusions.

Four kinds of tools help more directly with the ultimate act of *selecting*. These correspond to four kinds of decisions: (1) those that can be made by rules or formulas, (2) those that are reached in negotiations with opponents or counterparties, (3) those that involve assessments of probabilities, and (4) those that require trading off the pros and cons of options.

2.2 By the rules
Sometimes there’s a reasonably clear formula or algorithm for figuring out which of a set of options makes most sense (or is required.) For example, whether you should file the long or short financial statement form in a divorce proceeding. Or whether you need to pay the alternative minimum tax for US federal income tax purposes.

When formulas or rules are involved, decision makers can be assisted by applications that have been programmed to ask the right questions, accept inputs, and compute results. Expert systems can excel in rule crunching. Less exotic technologies often suffice. Scripting tools used for website development for instance can be used to model decisions that are rule-governed, and that take users down the appropriate path in a decision tree.

2.3 By agreement or mandate
When the rules or facts are in contention, and parties find themselves in an incipient or full-blown dispute, they may not think of themselves as involved in a common “choice,” but eventually they or some decision maker has to reach conclusions that will affect them all.

For an early exploration of computer-aided dispute resolution possibilities, see Lauritsen 1996 [10]. Section 5 below discusses how the technologies outlined in this paper can productively be applied to bargaining situations.

2.4 Playing the odds

Many decisions of course involve thinking through uncertainties and predictions. Risk analysis software can be of great value. We humans are notoriously bad at understanding cascades of probabilities.

Those who need or want to go beyond home-grown spreadsheets for understanding or presenting the likely outcomes, costs, and benefits of different litigation and settlement strategies, can use specialized risk analysis software. Two packages illustrate what's available.

TreeAge Pro from TreeAge Software (http://www.treeage.com) helps you build decision trees, influence diagrams, and other models to analyze problems that involve uncertainty.

PrecisionTree (http://www.palisade.com/PrecisionTree) is an add-in to Microsoft Excel that performs similar functions.

In these kinds of systems, decisions, chance events, and end results are represented by nodes and connected by branches. The resulting tree structure has a root, and various payoffs on the leaves. By specifying estimated probabilities of events and their associated costs or benefits, net payoffs of particular branches at any part of the tree can be computed.

2.5 Balancing act

Another form of decision support software is more focused on juggling pros and cons than on managing uncertainties. Such software helps to characterize the advantages and disadvantages of options being examined, and assists in balancing the inevitable tradeoffs. Once you get beyond two choices, or beyond a couple factors that 'cut' in different directions, it can be hard to do the balancing effectively with the unaided mind. When multiple decision makers are involved, or you need to document and justify your decision, software that helps you record and massage your evaluations and relative priorities can make the process much more satisfying and effective.

One illustrative player in decision support software of this kind is Expert Choice (http://www.expertchoice.com). It now offers a web-based solution called Comparion Suite, which helps people define goals, structure decisions, assign roles, and collaboratively deliberate.

My own work in this area has centered around a methodology I call "choiceboxing," which involves expressing the options, factors, and evaluative perspectives at play in a decision in an imagined three-dimensional box that you can manipulate and share online. This is described in section 3.

2.6 Choice management

Document management, project management, knowledge management, and change management are familiar concepts in most organizations. We would do well also to pay attention to *choice* management. So many of our decisions involve ineffective, even painful, processes, and produce suboptimal results. The above technologies and more should be exploited for better processes and outcomes. They can assist in ensuring that all relevant options and factors have been considered, that all stakeholders have had an opportunity to be heard, and that there's a rationale that stands up to scrutiny.

But tools are just a start. Choosing well is hard work. It can be made easier by shared knowledge and social support.

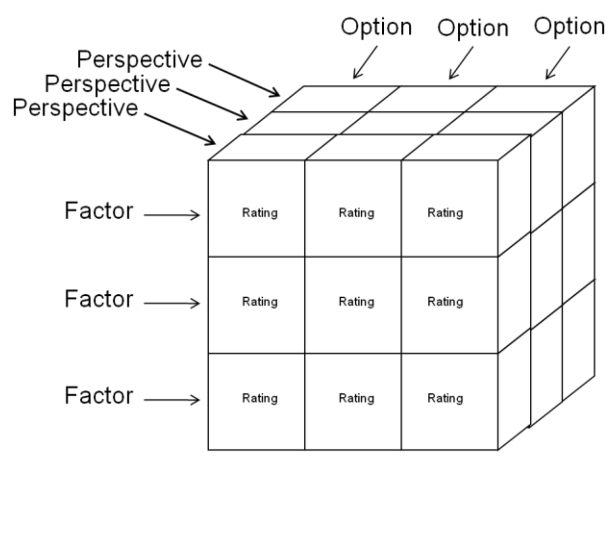
My emerging view of an ideal choice management system involves a rich online environment that leverages interactive visualization and social production ('crowd sourcing') within a Wikipedia-like repository of codified knowledge that learns as it is used. A public such system could draw sustenance from a vibrant ecosystem of sponsors and contributors. In most decision contexts there is a critical mass of 'providers' and 'guiders' who recognize their enlightened self interest in having 'deciders' make informed, autonomous choices. And there are often plenty of choosers who will happily leave a legacy of guidance for fellow choosers if fair, secure, and effective mechanisms for doing so are at hand. One effort in this direction is described in section 4.

3. CHOICEBOXING

3.1 Anatomy of a choice

A choice is a special kind of decision, where one selects from a group of discrete options.[1] To deliberate (from the Latin *libra*, a scale or balance) is to balance alternatives. While choices come in many shapes and sizes, and can present endlessly different kinds of things among which to select, it turns out that there *are* generic methods that work well to support the distinctive forms of deliberation involved in all of them. I've come to the conclusion that a 'universal grammar' underlies choice making, and that understanding it can both enhance the quality of our choices and drive the design of knowledge tools to support them.

Choices have a characteristic geometry that lends itself to a three-dimensional box metaphor. One dimension is that of *options* – the things among which one is choosing. A second dimension is that of *factors* – the qualities that distinguish options from one another. A third dimension is that of *perspectives* – the different evaluative takes that one or more people can have of how the options fare on the various factors. Each option can be rated on each factor from each perspective. Imagine something like this:



[1] This section is largely adopted from the *Choosing Smarter* chapter in Lauritsen [13].

While there are many different terms for these key dimensions (for instance, alternatives, considerations, and viewpoints; or possibilities, goals, and evaluators), all choices lend themselves quite well to being characterized in such a framework. This is hardly a surprise to anyone who has drawn a matrix of job candidates and hiring criteria on a whiteboard, or organized the pros and cons of alternative legal strategies on a yellow pad. What's interesting is the rich edifice of insights and tools one can build on this geometric foundation.

3.2 Multi-criteria decision making

Weighted factor analysis and related techniques for assessing options on criteria with differing degrees of relative importance have been around for a long time. The variation presented here seems to provide a substantially more powerful and easy way to deliberate about choices. By iteratively refining each of the dimensions mentioned earlier, "choiceboxing" helps deal with choice overload.

Here are some of the key concepts. (Most are simple and familiar. This abbreviated account doesn't get into all the interesting possibilities.)

3.3 Choices and options

Choice making involves selecting from groups of alternatives. Each possible selection is an **option**. ("What are my options?") I use "choice" to refer to the overall decision or one of the particular selections ultimately made, and "options" for the things *among* which one chooses.

Some choices involve picking a single best option from a group; others involve picking several, or even ordering an entire set from most preferred to least.

3.4 Categories

A given choice generally involves options that share certain kinds of characteristics, making it possible to compare them in terms of common factors. Those characteristics define the **category** or categories of things within which one is choosing. For example, the category might be "digital camcorders," "possible birthday presents for Jane," or "rental apartments in downtown Chicago."

By categorizing their choice in a standardized way, people can more easily access options, factors, and other information identified by others as worth considering in such a choice.

3.5 Factors

While a wide variety of techniques and approaches are used to make choices, they usually involve the consideration of multiple factors in terms of which the candidates differ. **Factors** are *kinds* of qualities or characteristics in terms of which options may be described and compared. They are answers to questions like "what makes a good ___?" and "what makes a bad ___?"

Factors often have differential weights in a particular choice – the relative degree of importance or significance attached to each by each perspective being considered in a decision.

Weighted factor analysis is one common method for systematically comparing options in a choice situation. Each option is rated with respect to each factor, each rating is turned into a normalized score, and the weighted total of scores across all factors is used to reflect its relative "goodness."

3.6 Ratings

A **rating** is the information entered with respect to a given factor for a given option.

This term is most apt for factors that can be evaluated in quantitative terms and that involve some judgment or opinion, but you can think of it more generally as "what there is to say about this option in terms of this factor."

3.7 Scores

In order to fairly compare and combine ratings across different factors, and across different perspectives – in order, in other words, for them to be commensurable – they should be normalized to a common scale. For example, the price of items may range from $300 to $3000, and their ease of use may be judged on a scale of 1 to 5. For the respective contribution of ratings on these factors to contribute to total scores only as much as those factors are explicitly weighted – and not be affected by the units in which they may happen to be measured – they both should be converted to a common scale, such as percentage of optimality or units of goodness. I use the word **score** to refer to the normalized value of a rating.

3.8 Perspectives

There can be more than one **perspective** at play in a given choice context. A sole decision maker may have more than one way of looking at the options and factors, and each member of a deciding group will typically have at least one of his or her own. Helpers may have perspectives that vary in at least some respects from the decision maker(s). There can also be perspectives of candidates, suppliers, or other "choosees."

Perspectives are distinct informational or evaluative takes on a choice. They capture different voices and viewpoints, for instance from different people or time frames.

Each perspective can have its own view about the relative importance of the various factors, and its own weight(s) relative to other perspectives (potentially differing by factor.) In other words, each *factor* has a weight <u>in</u> each perspective, and each *perspective* has a weight <u>for</u> each factor. The latter ability (to weight a perspective differently by factor) can be used e.g., to reflect someone's expertise in a certain aspect of a decision, or a given user's entitlement to disproportionate impact on one or more aspects. (The managing partner might be given double weight in a hiring decision about an executive director.)

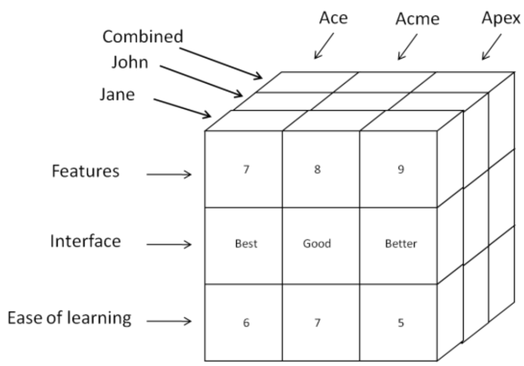
3.9 Choiceboxes

A **choicebox** involves mapping one or more options, one or more factors, and one or more perspectives to imagined x, y, and z axes respectively. The choice can be envisioned as a three-dimensional box. There is a column for each option, a row for each factor, and a layer for each perspective. Each cell at the intersection of such a column, row, and layer represents the characterization of some option in terms of some factor according to some perspective. There are also columns for factor and perspective weights.

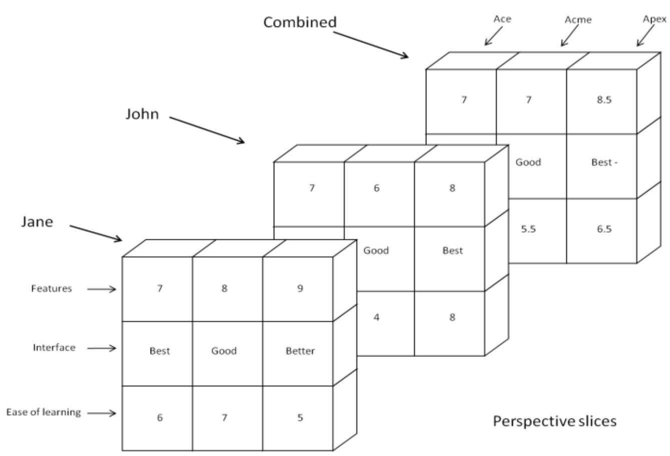
Each perspective layer can have a total score row showing the weighted average of scores for all options on the factors present. When there are multiple perspectives present in a box, a summary layer is available to show weighted averages of weights, ratings/scores, and totals from across the perspectives.

For example, imagine that Jane and John are partners in a law firm that is deciding which case management system to buy. They've narrowed it down to three products: Ace, Acme, and Apex. After lots of discussion, the choice seems to hinge on three factors: completeness of features, quality of interface, and ease of learning.

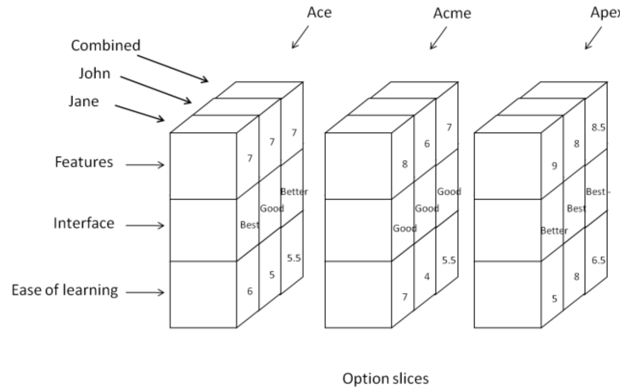
The following figure depicts how this matrix of options, factors, and perspectives might be represented in a choicebox. We're seeing Jane's perspective up front. The factors are matters of opinion, so her ratings and those of John may well differ. (In a real-world case, of course, other factors would be present, including some 'objective' ones like price.) Weights and scores are omitted in these figures.



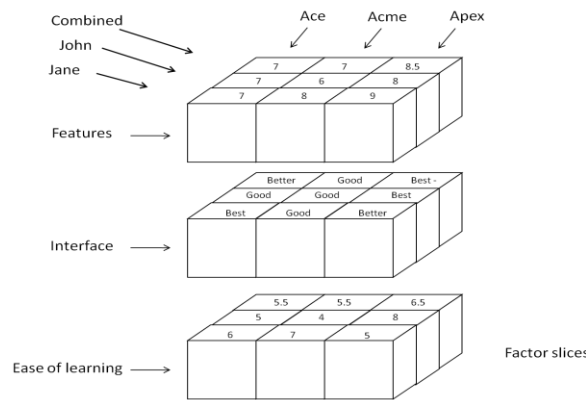
The next figure makes the separate perspective layers clearer. Now we can see some of John's different ratings, as well as average ratings on the combined layer.



Note that the box can be 'sliced' in other ways. For instance, to see how a single option is rated across the several perspectives:



Or you might want to see how all the options are rated on all the perspectives on a single factor:



You can get a sense of how the options rank on each of the factors from the ratings on the various layers. Some rank first on some factors from Jane's perspective; some rank first from John's perspective. But how do they rank overall?

To answer that, you need to add scores and weights.

A common scoring strategy is to use percentages. Since two of the factors are expressed in a simple 0 to 10 scale, with 10 being best, you can just multiply the rating by ten to get an appropriate percentage. For the interface factor, expressed in this case by words like 'good' and 'better,' you might associate scores with possible ratings as follows:

Best	100
Better	80
Good	70
Ok	50
Bad	30
Worse	20
Worst	0

Given this set up, and adding factor weights, you can compute scores for each perspective and for the overall box as follows:

	Jane	Ace		Acme		Apex	
weight		*rating*	*score*	*rating*	*score*	*rating*	*score*
5	**Features**	7	70	8	80	9	90
8	**Interface**	best	100	good	70	better	80
10	**Ease of learning**	6	60	7	70	5	50
	Total score for Jane		76.09		72.17		69.13

	John	Ace		Acme		Apex	
weight		*rating*	*score*	*rating*	*score*	*rating*	*score*
10	**Features**	7	70	6	60	8	80
5	**Interface**	good	70	good	70	best	100
2	**Ease of learning**	5	50	4	40	8	80
	Total score for John		67.65		60.59		85.88

	Combined	Ace		Acme		Apex	
weight		*rating*	*score*	*rating*	*score*	*rating*	*score*
7.5	**Features**	7	70	7	70	8.5	85
6.5	**Interface**	better	85	good	70	best minus	90
6	**Ease of learning**	5.5	55	5.5	55	6.5	65
	Overall score		71.87		66.38		77.51

(Blue-shaded cells above contain information entered by a box participant; green cells are computed. Total scores are calculated as weighted averages.)

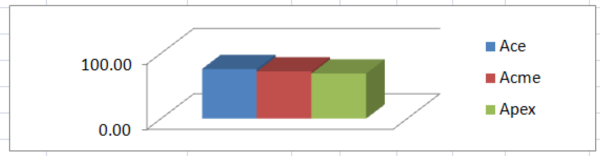
Note that Ace comes out on top for Jane, given her ratings and her emphasis on ease of learning over features. Apex comes out best for John. When the two perspectives are given equal weight, as here, Apex also comes out as best overall. Were Jane given disproportionate weight – e.g. because she is the senior partner with the largest financial stake in the decision – the result might be different. With an analysis like this in front of them, she and John can productively discuss why they feel differently about which factors are most important, or whether some of their ratings of the options should be adjusted.

3.10 Interactive visualization

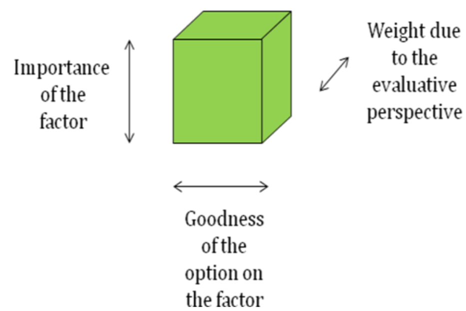
One key aspect of choiceboxing is the utilization of graphical methods to express and consume information. We believe that promotes the transparency of rationale, among other things.

One could of course express an overall assessment of the above options like Jane's with a simple Excel chart:

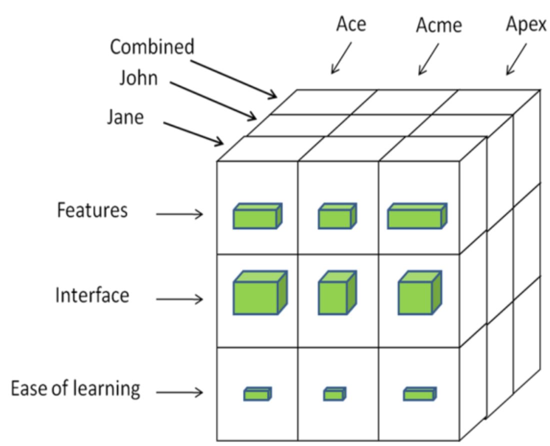
	Importance	Ace	Acme	Apex
Features	5	7	8	9
Interface	8	10	7	8
Ease of learning	10	6	7	5
	weighted total	76.09	72.17	69.13



Taking this a couple steps further, one can express each assessment of each option from each perspective in a separate block of 'goodness' like this:



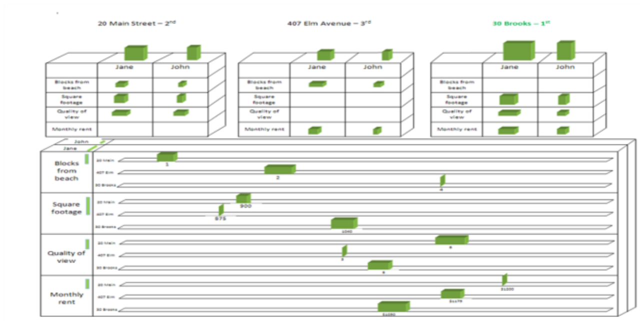
And then one can position each such block within the overall framework of a choicebox, as follows. (Shapes here are *not* meant to correspond to the numbers in the preceding figures.)



Through volumetric interfaces such as this (and associated concepts, like "cubic betterness"), one can enable direct manipulation of visual representations, automated totaling and comparison of blocks, and rich insights into decisions in progress, especially when teams are involved.

There does seem to be an inescapable *double* 3D-ness to collaborative choice-making in this conception -- the outer box being a matrix or array of cells allowing separate values (and comments) at the intersections of options, factors, and perspectives; the inner boxes being representations of goodness/badness, sized and shaped to reflect the dimensions of option score, factor importance, and perspective weight. Interfaces that make it easier to render such frameworks interactively intuitive will foster adoption.

An alternative interface is a ‘slide box’:



In this interface, each of the options has a conceptual 'lane' for each factor on which a sliding box signifies both ratings and scores, where its horizontal position reflects the rating of an option on a factor, its width is proportionate to the normalized score corresponding to that rating, its height is proportionate to the weight assigned to the factor on the perspective, and its depth is proportionate to the weight assigned to the perspective on the factor. The boxes can be moved along the lane to change a rating, and are automatically resized and repositioned as a user changes ratings and weights. (The above example is a variant in which relative betterness is used for box widths, rather than absolute scores.)

3.11 Acknowledged limits

Before moving on, let’s acknowledge some common reactions to this kind of approach. It may seem both too simplistic and too complex. Too mathematical. Too rational. Misleadingly precise. Where’s the emotion? Isn’t reality much fuzzier? Do you expect *me* to decide like that?!

Behavioral economists delight in exposing how irrational most decisions are, how seemingly independent factors can influence each other, and how supposedly irrelevant considerations can make a difference. Game theorists remind us of the endless complexity that can emerge as parties to a decision or dispute interact strategically. Choiceboxing does not purport to address all those challenges. It adopts an admittedly ‘naïve utilitarian’ model for the sake of usefulness and usability. Its results are approximate and only as good as the inputs. They are fodder for deliberation and conversation, not definitive pronouncements.

Emotional considerations, by the way, are hardly foreclosed. You can explicitly include ‘soft’ factors like overall impression or gut reaction. And weight them as you see fit.

3.12 The value-add of choicemaking tools

Choiceboxing can be done in principle with little more technology than a pencil and paper. (Non-trivial choices worth ‘boxing’ present too many options, factors, and tradeoffs to keep reliably in your head.) But choiceboxing is not practical without better tools. Scoring functions and related bookkeeping cry out for software.

You can perform basic weighted factor analysis using Word tables and functions. Choiceboxes can be implemented as three-dimensional spreadsheets in applications like Microsoft Excel (using multiple sheets and lots of tricky formulas.)

Specialized software is required to realize the full potential of choiceboxing. Such software can make it easy to reconfigure options and factors, perform useful analytics, and document your decisions. There are sophisticated (and expensive) applications that are best suited for experts, and also modestly priced desktop tools that you can find by Googling “decision support software.” The following section describes an effort to build a system for collaborative choiceboxing on the Web using interactive visualization and crowd-sourcing techniques.

4. ALL ABOUT CHOICE

All About Choice (‘AAC’) is a startup company that is building online systems to help people make better personal and business choices. Its focus is on open and collaborative environments, radically simplified for non-specialists, backed by knowledge bases that learn as they are used. The goal is to make effective choice making widely available through intuitive technologies that leverage collective wisdom. Our company seeks to deliver a suite of choice support services that can be used by anyone anywhere at any time. We want to provide the very best solutions for choice making, and to serve as steward for robust communities of collaborating decision makers.

AAC has chosen to tackle hard problems in both user interface and back-end knowledge processing. Its initial research objectives are to validate assumptions and confirm the feasibility of several key components. These include a Web-based application that makes weighted factor analysis compellingly easy, a dynamic ontology that captures evolving correlations of decision contexts and considerations, and tools that help manage semantic heterogeneity within and across domains. AAC has basic working systems underway and has drawn up a roadmap for development.

Intelligent online decision support environments have significant potential. Vendors and consumers alike are greatly benefited when goods, services, and plans of action are effectively matched to authentic preferences. Heavy costs flow from inadequately informed or examined decisions. A powerful infrastructure for structured collaboration among the deciders, providers, and advisers active in most choices will require both cutting edge technology and business innovation, but yield high payoffs when achieved. Academic and research institutions will be among the beneficiaries of that infrastructure.

AAC plans to operate at the intersection of artificial intelligence and intelligence augmentation. By seeking to field systems that do justice to the deep structure of everyday decision making, AAC hopes to enhance scientific and technological understanding. Applying folksonomy and machine learning techniques to the choice context will yield new practical insights that should be broadly useful elsewhere as well.

All About Choice also promises meaningful societal impacts. Systems that enable collaborative deliberation about important decisions strengthen both individual and collective effectiveness. Transparent systems promote accountability. By making such systems easily and inexpensively available, AAC hopes to raise the overall quality of decisions made.

A web-based system will enable distributed teams to review alternatives and fine-tune their decision-making processes.

Individual users will draw upon extensive stores of objective and subjective information that leverage the collective learning of those who have been similarly situated.

Current research objectives are to test the following assumptions:

- A Web-based application can be delivered that makes weighted factor decision analysis compellingly easy, relying largely on interactive visualizations.
- A dynamic knowledge base can be constructed and administered in ways that capture evolving correlations of decision contexts and considerations – efficiently and scalably.
- Effective tools for managing semantic heterogeneity (e.g. in how people frame their choices and considerations in different contexts) can be deployed both on a server for knowledge base optimization, and in user sessions.

Our ultimate success will also depend on the validity of more fundamental assumptions, namely (1) that a substantial number of people are sufficiently deliberative to use a well designed tool for a meaningful subset of their choices and (2) that weighted factor analysis, supplemented with qualitative and ordinal modes, and delivered via compelling graphical interfaces, is an effective foundation for such a tool. *Those* assumptions are best validated by fielding choice-support systems and seeing how they are received.

Our platform has three components:

- ChoiceSorter is a browser-based **tool**. It supports weighted factors, multiple perspectives, and many strategies for comparing options. Based on an intuitive 3D model, it helps people make choices more easily and confidently. ChoiceSorter will also give advisers and providers a useful medium for quality communication with decision makers.
- Integrated with ChoiceSorter is an evolving fabric of server-side **content** – resources about choices and choice making, including context-specific suggestions of factors and options. This shared repository unobtrusively learns from its users, as considerations and preferences are expressed, while vigilantly respecting privacy and neutrality.
- Collaborative deliberation features are integral to ChoiceSorter, as are mechanism that let people easily find others with common concerns. These **social networking** facilities enable users to involve friends and advisers in their choices, and to participate in communities of related interest – locally and globally.

We believe that a universal resource that substantially improves both choice-making processes and results – while ensuring autonomy, neutrality, privacy, and transparency for participants – is within reach and highly worth achieving.

5. Boxing and Bargaining

A geometrical choicebox model is a useful framework for conceptualizing many kinds of choices.

Negotiation and other dispute resolution processes involve consideration and balances of multiple attributes and perspectives quite similar to those involved when an individual or a collaborative group is seeking an optimal solution to a decision problem. Interactive visualizations of the competing value assessments, and collectively evolved inventories of relevant considerations, can be leveraged creatively in support of such processes.

There are good uses for structured approaches to choices beyond choice itself. Once you have a solid framework for approaching the assessments and tradeoffs involved in a choice situation, you can use it as an instrument for understanding yourself and others better. Boxing can surface unarticulated expectations, and educate your instincts.

You can engage in “shadowboxing” by anticipating the preferences of counterparties or decision makers. Put yourself in their shoes and draft a set of ratings and weights that likely represents their perspective. What do they care most and least about? Where are their views most different from your own? If they seem to assess an option inadequately or disproportionately on certain factors, how might you influence them to change?

When it comes to negotiation, understanding the different preference profiles of the parties will sometimes yield win-win solutions you might otherwise miss. One party can frame its positions and arguments in terms that address the likely motivating concerns of the other.

5.1 An example

Brams and Taylor[2] provide an example that can be used to illustrate an application of choiceboxing to dispute resolution. Two companies are contemplating a merger. Open issues include the surviving company’s name, the location of corporate headquarters, who will play the chairman and chief executive roles, and how necessary layoffs will be allocated.

Each side is given 100 points to distribute across the issues in proportion to the degree to which it cares about them. They do so as follows.

	Name	Headquarters	Chairman	CEO	Layoffs
C1	6	<u>35</u>	19	<u>14</u>	<u>26</u>
C2	<u>21</u>	15	<u>28</u>	12	24

A hypothetical ‘initial wins’ resolution assigns each party its choice on the issues it rates of highest importance (underlined above.) That produces an inequitable result, however, with C1 getting 75 of its points and C2 only 49. The Adjusted Winner method is then used to allocate an issue on which the parties’ interests are closest in such a way as to equalize their overall respective points. That issue is layoffs, which is conveniently divisible (each company loses some employees.) By giving each side just enough of that issue to offset the imbalance produced by having won on the other issues on which they have shown most interest, an equitable and envy-free result can be produced. A 48/52 allocation between C1 and C2 accomplished that result, assuming the companies are entitled to share everything equally. (Brams and Taylor also show how this method can be used when the parties have <u>un</u>equal entitlements, such as where one the merging companies has agreed to less than 50% of the new entity.)

[2] Brams, S. and Taylor, A., *The Win-Win Solution* (1999), pp. 124-131

Here's how company C1's options look in a choicebox under four possible scenarios -- 'C1 take all,' 'C2 take all,' 'Initial Wins,' and 'Adjusted Winner.' Preferences among the various 'goods' are expressed by the weights at left. (Weights are expressed on a scale of 0 to 10, proportionate to the 100 points in the Brams and Taylor example.) The numbers in the cells represent the percentage of 'goodness' a party gets under the scenario. So e.g., for the 'C1 takes all' option, C1 gets 100% for everything, and obviously would find that most attractive.

Company 1 | Company 2 | Summary | Factor Weight Summary

Scores:	Rank: 1 100.00	Rank: 4 0.00	Rank: 2 75.00	Rank: 3 61.48
	C1 takes all	C2 takes all	Initial Wins	Adjusted Winner
Name (Weight .6)	100	0	0	0
Headquarters (Weight 3.5)	100	0	100	100
Chairman (Weight 1.9)	100	0	0	0
CEO (Weight 1.4)	100	0	100	100
Layoffs (Weight 2.6)	100	0	100	48

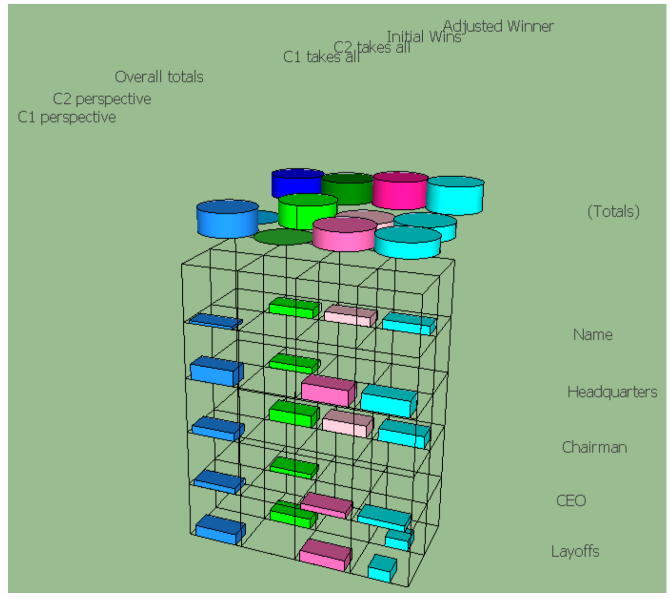
The corresponding sheet for Company 2 looks like this:

Company 1 | Company 2 | Summary | Factor Weight Summary

Scores:	Rank: 4 0.00	Rank: 1 100.00	Rank: 3 49.00	Rank: 2 61.48
	C1 takes all	C2 takes all	Initial Wins	Adjusted Winner
Name (Weight 2.1)	0	100	100	100
Headquarters (Weight 1.5)	0	100	0	0
Chairman (Weight 2.8)	0	100	100	100
CEO (Weight 1.2)	0	100	0	0
Layoffs (Weight 2.4)	0	100	0	52

The Adjusted Winner scenario (fourth column) is second only in preference of both parties to their respective winner-take-all scenarios, and of equal utility to both.

When rendered in a three-dimensional format, this configuration of weights and allocations looks like this:



Here the rectangular blocks represent the value of goods as allocated to the two parties under the various scenarios, and the cylindrical shapes at top the total goodness in each vertical column. (You can think of them as containers into which the 'ingots' of value below have been melted and poured.) Thus, C1 and C2 get everything respectively in the first two scenarios, and the total utility for both (back row of cylinders) is the same. Initial Wins produces a higher joint utility, but it is unevenly distributed between them. Adjusted Winner delivers just slightly less joint utility, but it is evenly divided.

5.2 Benefits of boxing

A choicebox-like visualization does not add anything fundamental to Adjusted Winner or related methods. But such a representation, once understood, provides an convenient way to grasp the dynamics of bargaining games, especially for those more visually than numerically inclined. Parties can directly interact with such models to express preferences and explore solutions, perhaps in mutually invisible ways that a neutral (human or machine) accesses to suggest collectively optimizing moves.

Visual depiction can help, for instance, in anticipating ways in which one party might try to 'game' the other, such as by exaggerating the degree to which they care about an issue, so as to wring a greater concession in exchange for forgoing it.

Visual depiction can also remind people that other value considerations are almost always in play than those associated with the terms about which one may be bargaining. For example, in the merger example there are costs of negotiation or litigation that might be incurred or avoided under various scenarios, and benefits in terms of public relations and 'industrial peace' that may accrue. Also, even if the participants' decisional frameworks are necessarily entangled, there are often considerations that are peculiar to one side or the other, providing asymmetries that can be exploited for mutually optimizing results.

6. RELATED WORK

The ideas and plans sketched here of course touch on subjects that have been active fields of research for decades. They likely seem like rediscovery of very basic concepts. For instance, online analytical processing[3] (OLAP), Pugh matrices,[4] and three-mode analysis[5] use quite similar constructs.

Although enriched by hundreds of books, articles, and other materials, most of the work sketched here has been driven by an inventor's drive to build something new and useful, rather than by a scholarly agenda. Any grand effort such as this is certain to treat many ideas superficially and neglect to credit borrowings from elsewhere.

One significant source is the work of Stuart Nagel, such as [18]. He was an early and energetic enthusiast for the power of personal computers to improve decision making in legal and policy settings.

6.1 Psychology and game theory

Human decision making has long been a focus of behavioral psychologists and game theorists, and there is an enormously rich literature. Books by Baron [1], Gilbert [6], Hammond et al. [7], Iyengar [8], Lehrer [14], Luce and Raiffa [16], and Schwartz [20] are excellent starting points.

Psychologists have identified dozens of decisional fallacies that beguile us. For example, there is the 'diagnostic bias': once we label something, we resist contradicting evidence. We give disproportionate weight to aspects of a situation that spring easily to mind ('availability'). We latch onto mentioned quantities, even if irrelevant ('anchoring'). We react differently when the exact same choice is presented in terms of avoiding a loss rather than realizing a gain ('framing'). See Brest and Krieger. [4]

6.2 Dispute resolution systems

MEDIATOR, a negotiation support system described by Jarke, Jelassi, and Shakun in a classic 1987 paper [9], was designed to support groups of players and a human mediator in decision situations involving multiple criteria as to which participants had differing (and potentially nonlinear) utility functions. By mapping utility spaces and providing opportunities for players to adjust their functions, consensus solutions may be found.

The work by John Zeleznikow, Emilia Bellucci and their colleagues, e.g. [22], has carried ideas like this further. They offer useful insights into trade-off analysis and related disciplines such as the Analytical Hierarchy Process.[6]

6.3 Computer science

A large body of work has accumulated on preference handling techniques. See e.g. Brafman and Domshlak 2009 [2] and Conitzer [5].

Branting [3] describes an algorithm for learning customer preferences (in terms of feature weights) from online shopping selections and how it performed in a simulated empirical evaluation. In a 'choice space' environment, such a technique could be a powerful tool for predicting metapreferences (which option-differentiating attributes in a given category are likely to be most salient to a decision maker), where, as in e-commerce contexts, there are tradeoffs between presenting sufficiently large return sets to maximize the likelihood of optimal selections being present, and the cognitive load presented by large sets of alternatives.

Liiv [15] has published a fascinating review of seriation and matrix reordering methods across disciplines as disparate as archaeology and bioinformatics, including the possibility of automating pattern discoveries that are now largely only accomplished through visual inspection of brute force rearrangements.

7. QUESTIONS AND PRINCIPLES

Choice making is one of those intellectual activities, like argumentation and document drafting (as discussed by the author in [11] and [12]), in which the underlying issues and opportunities largely transcend the particular context. They seem quite basic and domain-independent.

Choices of the sort discussed in this paper are critical to many of life's processes. Balancing 'tests' are ubiquitous. They are often used as parts of broader decisional frameworks. Many judgments involve more balancing than rule-following. Even when composed of many sub-decisions, at bottom there are often discrete options that respond to goal-accomplishment differentia or other desiderata. Sometimes the rules "run out," or you need to make a choice to determine what rules to apply. Often the competing factors are fuzzily quantitative, not Boolean.

Choice making is a characteristic kind of reasoning that does not so much involve chains of implications as compositions of value assertions. It is often subconscious and metaphorical, sometimes sloppy. Choosers can hide behind approximate and misleading metaphors. Because words are inadequate to express our thinking, it is hard to hold people to account.

We may relegate these kinds of decisions to subjectivity, deontology, open texture, or vagueness. We may think of true choice as un-automateable, as not responsibly machine-assisted, as ineffably human, as off limits. But there are constraints on what can and can't legitimately be taken into account in given situations, and neutral notions of coherence that can be applied.

Here are some of the interesting questions: What kinds of visualizations are possible and desirable in this context? How do we best support choice *processes*? What kinds of knowledge and intelligence characterize excellent human decision making, as rare as they may be? How can we best model the options, circumstances, goals, and preferences at play?

Choiceboxing so far is a complex of ideas, not a realized implementation, let alone one that has been carefully evaluated, like ValueCharts. [2] These are some of the principles behind its development:

- It emphasizes rich visualizations of choices in progress, beginning with three dimensional metaphors that seem to capture the fundamental dynamics of most situations, but

[3] http://en.wikipedia.org/wiki/Online_analytical_processing

[4] http://lssacademy.com/2007/06/19/the-pugh-matrix/

[5] http://three-mode.leidenuniv.nl/ provides an excellent gateway to the literature on this topic and related software.

[6] http://en.wikipedia.org/wiki/Analytic_Hierarchy_Process.

with a commitment to ongoing interface improvement driven by actual participant experience.

- Such representations must deliver high transparency of rationale and support collaborative deliberation.
- It builds on social production of choice-support content, Wikipedia-like, yet goes well beyond textual forms of meaning communication, and is turbocharged by intelligent content refinement.
- It celebrates and empowers chooser autonomy through portability and relentless neutrality and privacy.
- It supports rich conversations among choosers and those with stakes in particular choices, rather than just being an apparatus to help one party make a decision.
- It builds on an deep and comprehensive model of choice making.
- It encompasses a full system of tools, content, communities, and social/economic players, rather than just being an "application."

8. CONCLUSION

The current president of the United States likes to note that people are entitled to their own opinions, but not to their own facts. We might similarly say that decision makers are entitled to their own values, but not to their surreptitious or inconsistent application. Tradeoffs should not be exempt from analysis and critique.

Having choices is the essence of freedom. Choosing well is a hallmark of responsibility. Intelligent tools with rich visual interfaces can help people choose both more freely *and* more responsibly. We need more such tools.

REFERENCES

[1] Baron, J. *Thinking and Deciding* (2nd ed., 1994)

[2] Bautista, J., & Carenini, G. An empirical evaluation of interactive visualizations for preferential choice. Proceedings of the working conference on Advanced visual interfaces (pp. 207-214) (2008)

[3] Brafman, R. and Domshlak, C. Preference Handling – An Introductory Tutorial. AI Magazine, Spring 2009, pp. 58-86.

[4] Branting, K. Learning Feature Weights from Customer Return-Set Selections, *Knowledge and Information Systems* 6(2):188-202 March (2004)

[5] Brest, P. and Krieger, L. *Problem Solving, Decision Making, and Professional Judgment: A Guide for Lawyers and Policymakers* (2010)

[6] Conitzer, V. Making Decisions Based on the Preferences of Multiple Agents. *Communications of the ACM* Vol. 53 No. 3, Pages 84-94 (2010) [available at http://cacm.acm.org/magazines/2010/3/7629

[7] Gilbert, D. *Stumbling on Happiness* (2006)

[8] Hammond, J., Keeney, R., and Raiffa, H, *Smart Choices* (1999)

[9] Iyengar, S. *The Art of Choosing* (2010)

[10] Jarke, M., Jelassi, M, and Shakun, M. MEDIATOR: Towards a negotiation support system. European Journal of Operational Research 31 (1987) 314-334.

[11] Lauritsen, M. Settling Differences Through Interactive Multimedia Networks. In *Materials for NCAIR Conference on Electronic Dispute Resolution*. Washington, D.C., May 1996

[12] Lauritsen, M. Knowing Documents. In *Proceedings of the Fourth International Conference on Artificial Intelligence and Law*. Amsterdam, June 1993.

[13] Lauritsen, M. Intelligent Tools for Managing Factual Arguments. In *Proceedings of the Tenth International Conference on Artificial Intelligence and Law*. Bologna, June 2005

[14] Lauritsen, M. *Lawyer's Guide to Working Smarter with Knowledge Tools* (American Bar Association, 2010) [http://www.abanet.org/abastore/productpage/5110706]

[15] Re-envisioning Law Practice with Computers: Visualization and Collaboration. With David R. Johnson. In *Materials for Sixth Annual Technology in the Law Practice conference*. American Bar Association. Chicago, March 1992 [http://w2.eff.org/Misc/Publications/David_Johnson/lauritsen_johnson_legal_comp.article]

[16] Lehrer, J. *How We Decide* (2009)

[17] Liiv, I. Seriation and Matrix Reordering Methods: An Historical Overview. *Statistical Analysis and Data Mining* 3: 70-91 (2010) [http://innar.com/Liiv_Seriation.pdf]

[18] Luce, R. and Raiffa, H. *Games and Decisions* (1967)

[19] Morge, M. Collective decision-making process to compose divergent interests and perspectives. *Artificial Intelligence and Law* 13: 79-92 (2006)

[20] Nagel, S. *Using Personal Computers for Decision-Making in Law Practice* (1985)

[21] Philipps, L. Just Decisions Using Multiple Criteria, or: Who Gets the Porsche? An Application of Ronald R. Yager's Fuzzy Logic Method. *Proceedings of the Fifth International Conference on Artificial Intelligence and Law*. College Park, May 1995

[22] Schwartz, B. *The Paradox of Choice* (2004)

[23] Sieckmann, J. Why non-monotonic logic is inadequate to represent balancing arguments. *Artificial Intelligence and Law* 11: 211-219 (2003)

[24] Zeleznikow, J., Bellucci, E., Schild, U., and Mackensie, G. Bargaining in the shadow of the law – using utility functions to support legal negotiation. *Proceedings of the Eleventh International Conference on Artificial Intelligence and Law*, pp. 237-246. Stanford, June 2007