FEATURE

Is It Worth It? How Game Theory Should Guide Patent Prosecution Decisions

By Kate S. Gaudry and Sameer Vadera

A primary responsibility of prosecutors and patent counsel is to allocate fixed patent budgets and identify low-level strategies. Should a patent application be filed in an attempt to protect an innovation? Should an amendment or appeal be filed in response to a given rejection? For how long should prosecution be allowed to continue before an application is abandoned? Answering these questions effectively can allow an applicant to secure valuable patent protection efficiently, while prudently controlling costs.

Patent applicants frequently rely on specific criteria for assessing a potential value of a patent. For example: What type of market dominance might the patent provide? To what degree would it be foreseeable to prove infringement by a competitor and validity of the patent? How essential is the innovation to the applicant's business? As a potential acquirer in the context of mergers and acquisitions, which cost considerations should be taken into account when evaluating a target company's intellectual property assets? Meanwhile, other considerations can apply to potential costs: What is the probability of successfully securing a patent? How limited and/or costly might a patent be? What other protection opportunities may be lost due to pursuit of patenting the innovation?

These questions are absolutely relevant while making patent filing and prosecution decisions. A substantial problem arises, however, in that many of these questions are subjective and/or require very vague and speculative answers. Combining answers to the questions to produce final determinations only compounds the vagueness and uncertainty, and ultimately still fails to be instructive as to the economics surrounding the decision.

So one might ask: Is there a better, more objective technique for making patent-related decisions? Or, for providing a cost-benefit analysis of a particular decision? Yes.

The rise of big data has availed a vast array of statistics that pertain to patenting prospects. Specifically, each patent application is assigned to an art unit based on the technology of the application and to an examiner within the art unit. Assigning patent applications to art units depends, in large part, on classifying the contents of the patent applications into various technology sectors. Big data libraries include statistics for individual art units and examiners. Further, artificial intelligence techniques generate predictions as to which art units a patent application will be assigned.

We propose leveraging these big data statistics to assess potential patent prosecution strategies using a game theory model in the context of an applicant's interaction with an examiner or the Patent Trial and Appeal Board (PTAB). At a high level, game theory can be used to generate a mathematical model that describes a situation in which two or more entities (e.g., players) interact. For example, traditional game theory assesses potential decisions by predicting how one or more other entities will respond and probabilities of achieving a desired outcome. An optimal decision can then be identified. One game theory approach is to create a decision tree that identifies probabilities of various events (e.g., corresponding to another player's decisions) in many contexts. Based on identified values for various potential outcomes and costs associated with different potential decisions, optimal decisions can be identified at each decision node in the tree.

Our approach proposed herein includes a modification to the traditional decision tree, in that we refrain from assigning a value to each potential outcome, as valuing a patent is highly case-specific. Instead, we identify a threshold for each decision node, which indicates that the optimal prosecution strategy is to continue prosecution *if* an estimated value of the potential patent meets or exceeds the threshold. Otherwise, the optimal prosecution strategy is to abandon the application (and avoid subsequent prosecution costs). Thus, an applicant can make a binary value-based decision at each prosecution strategy, rather than attempting to assign a precise value along a continuum to the potential patent or to solely rely on instincts.

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Techniques

Game theory is a mathematically based technique used to analyze various strategies and identify a "best" decision, given interactions between two or more entities. More specifically, game theory is used in contexts for which an outcome depends on decisions made by each of multiple entities (or "players"). While game theory may be used in the contexts of traditional games, the vast majority of applications pertain to real-life circumstances or instances not traditionally thought of as a "game." For example, game theory and decision trees have been used to identify litigation-related strategies. The decision tree may include various decision nodes (e.g., whether to sue/countersue, whether to settle, etc.) and various chance nodes (e.g., representing a probability that a summary judgment will be granted, that a favorable verdict will be received, that various damages amounts will be awarded, etc.). Based on the probabilities associated with the chance nodes, optimal decisions can be identified.

For our approach of applying game theory to patent prosecution, the players can include the applicant, the examiner, and the PTAB. Thus, game theory can be used to shape an applicant's decisions based on expected decisions of one or more other players.

Various constraints may limit actions of the other player(s). These constraints may be difficult to objectively measure in terms of effects. For example, statutory eligibility requirements may act as a constraint by reducing the likelihood that an examiner in the business method art unit may allow a patent application relative to an examiner in a semiconductor art unit. Business method art units include art units 3621–29 and 3681–96. The technologies classified into these art units generally relate to or involve financial transactions. We previously reported that business method art units have notoriously low allowance rates.[1] However, even though an underlying phenomenon (e.g., differential eligibility assessments across technology areas) may be difficult to measure, big data can provide an indication as to the effect of the phenomenon—which may be even more useful for decision-making purposes than understanding the phenomenon itself.

Thus, we propose constructing a decision tree and various expected values to guide prosecution decisions. The decision tree can include a set of branching nodes. Each branching node can include either a decision node (at which a decision is to be made) or a chance node (at which probabilities of various decisions by another player are represented). Some decisions may be associated with a cost, such as attorney fees for drafting an amendment.

The decision tree can also include a set of edge nodes, at which various branches end. Each edge node can be associated with a value. The value can include a sum of a final value (e.g., a positive finite value of a patent or a zero value for an abandonment) and various costs accumulated throughout the trajectory beginning at an initial node to reach the edge node.[2]

Values of edge nodes can be used to generate, at each decision node, an expected value for each potential decision. Specifically, for each decision node, a set of potential decisions (that include one or more nodes) can be considered. For example, after a final office action is issued, the applicant may be faced with a decision: respond with a request for continued examination (RCE) or file an appeal. An office action is a rejection of one or more pending claims in a patent application. With regard to any decision node in the potential trajectory, it can be assumed that a "best" decision (i.e., the decision that yields the highest expected payoff or reward) will be made at each subsequent decision node. With regard to each chance node in the trajectory, an expected probability can be assigned to the chance node that equals a dot product of the subsequent node's expected payoff and the probability of transitioning to the subsequent node. The expected payoff of the potential decision can then be set to equal the sum of the values of any "best" decisions, chance nodes, and/or immediate end nodes (e.g., if there are not intervening chance and/or decision nodes). A best decision can then be selected as the one that corresponds to the highest expected payoff.

We define an estimated cost for filing an application to be a sum of $12,000 in attorney fees for drafting and filing the application and $1,720 in government fees. We define a cost for responding to an office action to be $3,000. Further, we assume that large-entity RCE fees (of $1,300 for the first RCE and $1,900 for any subsequent RCE) would be paid for a response to any even-numbered office action (which we assume to be final). We define a cost for filing an appeal to be a sum of $5,000 in attorney fees for preparing an appeal brief and filing appeal documents and $3,040 for large-entity government fees for filing a notice of appeal and paying the forwarding fees.

In this particular instance, expected payoffs and probabilities associated with chance nodes can be generated based on the now-available big data for examiners and art units. Specifically, for our approach, we equate the probability of receiving an office action versus an allowance in response to an amendment as being the same as a big data recent probability of the same for a specific art unit (assigned for a specific application). Further, for our approach, we similarly define the probabilities of receiving various appeal results based on big data that corresponds to a specific art unit (assigned for the specific application). We speculate that it may be advantageous to use examiner-specific data for the probability of receiving an office action versus an allowance, but for the purposes of this article, we kept it at a level of generality corresponding to art units.

We recognize that the probability of receiving an allowance in response to, for example, an amendment filed after a fourth office action is different than the probability in response to an amendment filed after a first office action. Thus, the probabilities are identified specifically in view of a number of previously received office actions.

It is unusual to appeal rejections more than one time during prosecution of a given patent application. Thus, the statistical chance probabilities likely mirrored first-appeal instances. Accordingly, we constrained our decision tree to only include trajectories that included zero or one appeal decision.

Statistics presented in this article were collected using LexisNexis® PatentAdvisor℠. Specifically, for each art unit identified below and for each chance node (corresponding to an event that branches to multiple outcomes), we identified each instance where the specified type of "event" occurred within 2015–2017 and where an outcome has occurred as of May 9, 2018. Probability distributions were then generated based on the likelihood of the outcomes.

We extended the decision tree to cover potential trajectories that include decision nodes following seven office actions. Thus, after a seventh office action chance node, a decision node identifies options to respond, appeal, or abandon. Each option connects to a corresponding chance node, which then connects to two edge nodes representing either an allowance or otherwise, which we equated to an incremental cost of zero and expected payoff of zero. We recognize that prosecution may well extend to further rounds, but sample sizes consistent with our timing constraints and corresponding to further rounds became smaller.

Traditional decision trees include defined values at each edge node. Thus, for each potential event sequence (or specific outcome), a specific value is assigned. Expected values for particular decisions can then be generated based on chance probabilities and the specific expected payoffs. However, this type of analysis requires identifying a precise value for a potential patent. This is difficult even when specific factors pertaining to a particular patent application are known. Many objective methods for calculating a value for a potential patent generally involve guesswork, leaving much to be desired. Thus, we devised a modified decision tree analysis that avoided the reliance on this evaluation. Specifically, at each decision node, we identify a condition instead of a decision: We define a threshold such that *if* a value of a patent for a given application is estimated to be at least equal to the threshold, the "best" decision would be to continue prosecution (by filing a response or appeal).[3] Conversely, if the value of the patent for the application is estimated to be less than the threshold, the "best" decision would be to abandon the application. Thus, a user need not precisely identify a value of a potential patent but may nonetheless strategically guide prosecution based on much more general valuation estimates.

Results

Through our approach, we identified thresholds for continuing prosecution at each decision node in the decision tree.[4] We constructed decision trees for four art units: (1) art unit 2431, which relates to cryptography innovations; (2) art unit 2831, which relates to electrical circuitry innovations; (3) art unit 3685, which relates to cryptography in financial transactions; and (4) art unit 3689, which relates to incentive programs and electronic shopping. Art units 2431 and 3685 were selected because these art units share similar technologies (i.e., cryptography); however, art unit 3685 is considered a business method art unit. Even though their technologies are similar, art unit 2431 has an allowance rate of 82.3 percent, whereas art unit 3685 has an allowance rate of 24.8 percent.[5] Further, art units 2831 and 3689 were selected to illustrate a stark contrast in allowance rates—art unit 2831 has an overall allowance rate of 85 percent, whereas art unit 3689 has an overall allowance rate of 7.8 percent.

A visual representation of the decision tree is shown in figure 1. Decision nodes are represented as squares. Chance nodes are represented as circles. Edge nodes are represented as triangles. Some nodes may never be encountered in a particular trajectory through the decision tree. For example, it is possible that a first-action allowance is issued, in which case no decision nodes will be reached. Nonetheless, the more complete representation allows for calculations of expected values associated with various decisions to identify strategic decisions.

However, as previously mentioned, we have modified the traditional decision tree framework: we do not identify specific and general decisions to be made at various decision points; rather, we identify a condition for making a particular decision. Particularly, at each decision node, we identify a particular threshold that can be used as a guiding principle for making a prosecution decision: *If a potential patent is worth at least the threshold to an applicant, we suggest that the applicant should proceed with prosecution.*

Table 1 and figure 2 identify these thresholds for various points in prosecution and for each of the four art units considered in our analysis.

As an illustration: If a patent application is classified into art unit 3689 (which has been reported as having the lowest art unit allowance rate[6]) and if a patent for the application's technology has a potential value of $40,000, our proposed game theory prosecution approach would be to abandon the application after the first office action because the patent valuation is below the threshold value. The expected applicant payoff of this decision would be to save or not expend the costs of responding to the first office action, given the statistical expectation that the examiner will not allow the application.

In our approach, thresholds will be higher in instances where probabilities of securing a patent are lower. Figure 3 shows the probability of receiving a next-action allowance upon filing an amendment in response to various office actions in prosecution. As indicated (by comparing figures 2 and 3), the art units having the highest thresholds for continuing prosecution are associated with the lowest probabilities of receiving allowances. For example, the business method art units 3685 and 3689 are associated with lower allowance prospects and higher thresholds as compared to the other art units 2431 and 2831.

Interestingly, the thresholds for the non-business-method art units do not exceed the estimated filing costs (which we estimate as being $13,360 for attorney and government fees) across all rounds of prosecution. Thus, if a rational decision maker determined that the filing costs were justifiable for the potential patent, the decision maker would also determine that it would make sense to proceed with prosecution. These strategies may be advantageous due to the relatively high allowance rates of the art units. For example, the probabilities of receiving an allowance after responding to a fourth office action in art units 2431 and 2831 were 47.5 percent and 50.4 percent, respectively, while the cost of responding to a fourth office action added a mere $4,900. Thus, a game theory analysis would indicate that responding would be advantageous (over abandoning the application) if a potential patent value was worth more than approximately $9,800 (which is less than the estimated filing costs).

Table 1 also identifies what type of prosecution strategy is recommended in instances where prosecution is to be continued in response to various prosecution events. In the two non-business-method art units, the recommended approach is consistently to continue engaging with the examiner instead of appealing rejections to the PTAB. This is a result of the relatively high cost of appealing and the decent prospects of continuing normal prosecution. For example, when an applicant responds to any of the first through fourth office actions with an amendment, the likelihood that the examiner's next action is to issue an allowance is above 50 percent for art unit 2831. Meanwhile, the likelihood of an appeal resulting in an immediate allowance is slightly lower at 46 percent.

Meanwhile, the recommended approach for the business method art units is to appeal rejections at the earliest opportunity (when prosecution is to be continued). This is a result of the relatively low allowance prospects associated with amendment approaches relative to appeals for these art units. For example, when an applicant responds to any of the first through fourth office actions with an amendment, the likelihood that the examiner's next action is to issue an allowance is less than 5 percent for art unit 3689. Meanwhile, the likelihood of an appeal resulting in an immediate allowance is 12 percent.

Analysis

As described above, game theory analytics can be leveraged to drive optimal decision-making in the multiplayer context of patent prosecution. The applicant, as a player, files a patent application and makes subsequent filing decisions in response to rejection decisions by the examiner, as another player, or in response to appeal decisions by the PTAB, as yet another player. Understanding the statistical payoffs or rewards involved from an applicant's perspective throughout patent prosecution can facilitate optimal decision-making.

Once a patent application is assigned to an art unit, the probabilities of the chance occurrences can be defined by the big data statistics of the art unit or of the examiner assigned to the application. Further, throughout the trajectory of the prosecution cycle, we propose that the traditional decision tree analysis can be modified by transforming the decision nodes into condition nodes—where a particular decision (continuing prosecution) is the statistically advisable decision *if* a potential value of a patent meets or exceeds a calculated threshold value. If the estimated value of a potential patent is worth at least the defined threshold, then it is estimated that the applicant will gain the best payoff by continuing to engage the examiner. However, if the estimated value of the potential patent is below the defined threshold, then it is estimated that the applicant's best payoff will be achieved by abandoning the application (and saving subsequent prosecution costs).

For the business method art units (particularly art unit 3689), unless patent protection of the corresponding technology would be highly valuable, the data indicates that a sound strategy may be quickly abandoning the application after receiving a first office action. Payoff, in this instance, may be potential costs saved by not responding to the outstanding office action, which may be substantial. For example, in art unit 3689, across all of the applications that were abandoned within this art unit across the last two years, roughly one-third of these applications (resulting in no patent value) had more than one final office action. This means that roughly a quarter of the patent applications assigned to art unit 3689 reached at least the fourth office action in the decision tree. Presuming that the applicants in those cases filed a response to each office action, the applicants paid out $15,200, using our estimated filing costs above. However, in cases where the value of the patent application was less than the threshold value of the relevant decision node, applicants using the game theory approach may have optimized their payoff by abandoning the application and saving the filing costs associated with each response. The optimal payoff gained by abandoning an application is especially true for the extreme example of art unit 3689, which notoriously has the lowest allowance rate.

In contrast, for non-business-method art units (e.g., art unit 2831), the data indicates that, of the various options available at a decision node, applicants gain the best payoff by continuing to engage with the examiner with response filings (and potentially examiner interviews). This result is consistent with the big data probabilities we evaluated: in art unit 2831, for example, filing responses to office actions has a greater than 50 percent chance of reaching an allowance, whereas appealing the examiner's rejections has a slightly lower chance of reaching an allowance at 46 percent. Additionally, at least for applications assigned to art unit 2831, the payoff gained by continuing to prosecute the patent application is optimal, given that the original filing costs (which we estimated at $13,360) are greater than the threshold value at each of the seven decision nodes in the above hypothetical prosecution trajectory of table 1. In these cases, the innovation underlying a potential patent was sufficiently valuable to pay $13,360 to file a patent application to protect the innovation.

Even if the exact value of the potential patent is difficult to calculate, applicants can still make prosecution decisions that yield the best payoffs by considering the potential patent to be at least as valuable as the initial filing costs throughout prosecution. To illustrate, after the fourth office action is issued in art unit 2831, the chance of receiving an allowance after filing a response is roughly 50 percent, and the threshold value for responding to the fourth office action (in art unit 2831) is $9,546. The optimal course of action, presuming the potential patent is at least as valuable as the initial filing costs, is to continue filing responses to office actions and engaging with the examiner because the presumed value of the potential patent is greater than the fourth-office-action threshold value. Further, pursuing a patent through the prosecution route for applications in art unit 2831 is also a sound strategy, given the overall favorable allowance prospects.

Caveats

While the game theory approach to making patent decisions can be broadly applied to patent applications across various art units, we note several caveats. First, we made several simplifying assumptions, such as allowing only one appeal during prosecution and assuming that prosecution would not be extended past seven office actions. A more complex decision tree may be built to remove these assumptions, though care would need to be taken to ensure that probabilities accurately pertain to given trajectory positions (e.g., second-appeal data may be different than first-appeal data) and not built on too small of a sample size.

Second, the big data statistics we used to calculate the probabilities of various events at chance nodes were obtained at the art unit level (which enabled us to obtain sizable data sets pertaining to a recent time period and specific prosecution stages). However, a more precise probability distribution of chance events at chance nodes may involve examiner-specific statistics and substantive rejection analysis. For example, even though the overall allowance prospects in art unit 2831 are relatively high at 85 percent, one examiner in the art unit has an allowance rate of half that (43 percent), which may affect which decisions are optimal.

Third, we assumed that the value of the potential patent remained constant at each decision node over the trajectory of the seven office actions. For instance, we assumed that the value of the potential patent after the first office action is the same after the fourth office action. In practice, however, the valuation of a potential patent often decreases after each applicant response to an office action. Amendments are submitted narrowing claim scope, additional arguments are presented potentially increasing prosecution history estoppel, and other applicant actions may cause this decrease in valuation. Depending on the priorities that a decision maker places on data recency (as probabilities may be collected for additional prosecution stages and/or at the examiner level if time constraints are relaxed) and/or potential nuanced patent value devaluation throughout prosecution, our decision tree approach may be adjusted accordingly.

Conclusion

Strategic decision-making using game theory analytics can facilitate effective and efficient decision-making at the application level, which can (on average) improve the probability of securing a patent (e.g., by determining whether to appeal or respond to an office action) and/or can offer monetary savings (e.g., based on appeal/response decisions and/or deciding to abandon an application relatively early in prosecution). These savings can be reallocated to pursue protection of other technologies, thus strengthening an overall patent portfolio. Our approach allows applicants to make these strategic numbers-based decisions without needing to identify a precise value of a potential patent (which would be an imprecise and tiring exercise). Rather, by tying quantitative thresholds to decision points, we have avoided the need for applicants to provide a speculative continuum-based specific valuation and instead rely on much more digestible binary valuation-based decisions.

And with each yes/no decision, our modified decision tree approach provides a recommended prosecution action.

Endnotes

1. Kate Gaudry, *Is There a Tide-Change in the Prospects of Patenting Business Method Innovations?*, IPWatchdog (May 25, 2017), http://www.ipwatchdog.com/2017/05/25/prospects-patenting-business-method-innovations/id=83693/.

2. In theory, various intermediate values would also be summed, though for the sake of simplicity, we assume that there are no pre-patenting values in our approach.

3. We determined the threshold value based on an analysis of several data points, including big data prosecution statistics and average amounts paid for patents.

4. We assume that a rationale decision maker would make the "best" subsequent decisions in terms of identifying the decision corresponding to the highest expected value. Further, we assume that the valuation of a potential patent remains constant across rounds of prosecution. We speculate that a subsequent implantation of our technique may introduce a devaluation function such that a potential value of a patent decreases across rounds of prosecution due to the potential of introduction of narrowing amendments and/or limiting prosecution history.

5. We define an allowance rate as being equal to the number of patents issued within the last two years divided by the number of final disposals (including patent issuances and abandonments) occurring within the same time period.

6. *See* Gene Quinn, *What the Patent Office Refuses to Understand*, IPWatchdog (July 12, 2016), http://www.ipwatchdog.com/2016/07/12/patent-office-refuses-understand/id=70809/.

Authors

Kate S. Gaudry

Kate S. Gaudry is a senior patent attorney at the Washington, D.C., office of Kilpatrick Townsend & Stockton LLP. She focuses her analysis on patent prosecution and counseling, with an emphasis on quantitative analysis of patent portfolios and strategic options and on prosecution for the software, computer systems, and quantitative biology industries.

Sameer Vadera

Sameer Vadera is a patent attorney at the Washington, D.C., office of Kilpatrick Townsend & Stockton LLP. He focuses his practice on preparing and prosecuting patent applications in a variety of technical fields, including wireless technologies, software, and electronic devices.

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