A Knowledge-Based Computer Purchasing Advisor

Jasper Vicenti

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Abstract

Choosing which computer to purchase can be a daunting task, especially for those new to computers and other technologies where the options are near limitless. This paper will present a tool to assist in the decision-making process, simplifying the task into plain English terms using knowledge about the typical tasks performed by users. This protects the user from being bogged down by technical specifications and jargon.

1 The Problem

The decision to purchase a new computer is usually an easy one. Most people will replace their machines every three to five years. Those familiar with the process are accustomed to what needs they have when they decide to make the purchase. The variety of current models available as well as the configuration options for each model can overwhelm even those in the industry. If asked to recommend a computer to a friend or neighbor, they would likely end up playing a game of twenty questions to find out what their individual needs are. Even then, those questions would probably not be applicable for the next person. Generally each person has their own set of circumstances and requirements for what they need the computer to do. Someone new to computers may not have much idea at all the variety of programs available. This can greatly affect which computer they would purchase in order to perform the tasks appropriate for their needs.

Computers have infiltrated into almost all aspects of our culture. As such, more and more people who are less technologically inclined are exposed to their usage. Many users do not want to worry about the operating system used, amount of RAM, size of hard drive, or speed of the processor. The most important questions they ask are: *1. Do the programs I need to use work?* and *2. Do the programs work sufficiently well to be productive?* The first question is targeted towards support and functionality of a program, and is beyond the scope of this paper. The second question is the focus of this paper.

Any person can purchase the most expensive desktop computer or notebook computer available and expect that it will adequately meet the needs of the user. At first glance, this seems like a reasonable statement. Putting more money towards the problem will usually result in an improvement over a less expensive model. However, this may not be the case at all. When considering a laptop computer, for example, the more expensive model might be more than fast enough for the present and future performance requirements, but it may be far too bulky for a user who will be lugging the machine to work and back on a daily basis. Similar tradeoffs can exist for desktop computers, where perhaps it will be used in an environment where too much noise can be a factor. The best performing computers tend to be the ones with the largest number of fans.

2 The Task

The goal of the tool is to take into account as many of the needs of the user in order to provide the user with a few good recommendations. As described before, the intention is to shelter the user from much of the jargon associated with the computer industry. Instead, the user will be asked questions about what their primary and secondary uses would be, what computers they currently use (if any) at home or at work. What their general price requirements are. If, for example they do not know what they are intending to use the program for, the advisor will inquire about their current job and area of work. From these few questions, a picture unfolds as to which computer systems would be more appropriate than others.

In general, the user's needs are guided by the type of programs that they use. Someone who wants to use the latest 3d games would need the highest performance machine available. On the other hand, a user that is only using email and writing documents could probably still use a computer that was cutting edge five or six years ago. The low end range of computers that are available today are easily

able to handle many of the more complex tasks such as digital photo archiving and editing.

3   Example

A simple example follows demonstrating the interaction between the advisor and the user. Commentary has been interspersed within the dialogue to explain the reasoning behind the questions being asked.

`What is BILL's expected spending amount:` *Medium*

This is generally a known value. When a person is shopping for a system, it is unusual to not have an idea of the amount you expect to spend.

`Is it the case that BILL does use a computer at work:` *Yes*

`What is BILL's work computer:` *Windows*

`Is it the case that BILL does have an existing computer at home:` *No*

Again, this is asked to determine the platforms used at work and home. If there is no pre-existing computer at home and no computer is used at work, then no bias is given towards either platform.

`Is it the case that BILL does want mobility in a computer:` *No*

This is used to determine whether a desktop or notebook computer would be more appropriate. Since Bill answered *No* , no further questions are asked regarding mobility.

`What is BILL's expected primary use of the computer:` *Dont-know*

This is usually the area where the requirements of the system are determined. A range of choices are available such as *email* ,*web*,*design*, etc. There is also a secondary usage option in order to more accurately gauge the user's needs.

`What is BILL's job-title:` *Admin-Assistant* `Whit is BILL's area of work:` *Government*

When information about the expected is not available, basic inferencing about the performance requirements of the computer can be made from a person's job title. In this situation, since Bill did not know what the primary use would be, he is then asked what his job title is. As an administrative assistant, it can be

```
[COMPUTERTYPE BILL WINDOWS-LAPTOP-LOWEND-SONY-B-SERIES] 0.36
[COMPUTERTYPE BILL WINDOWS-LAPTOP-MIDRANGE-SONY-FS-SERIES] 0.5
[COMPUTERTYPE BILL WINDOWS-DESKTOP-MIDRANGE-SONY-V-SERIES] 0.7
[COMPUTERTYPE BILL WINDOWS-DESKTOP-LOWEND-SONY-RB-SERIES] 0.504
```

Figure 1: Bill's Example Results

determined that his performance requirements for a new computer will be fairly minimal.

Is it the case that BILL does expect to bring work home: *Yes*

The advisor is also taking information about the type of computer used at work to determine an appropriate operating system. Familiarity with the computer system used at work (or home) is usually one of the largest factors in deciding what type of home computer will be purchased. This is despite the fact that interoperability is not necessarily difficult between platforms and often work is never even brought home.

Is it the case that BILL is willing to use virtual pc if necessary (to run windows software on a mac): *No*

The advisor is aware that it is possible to run windows software on a mac, and will ask questions about the user's willingness to do so if they use a windows machine at work or at home.

Is it the case that BILL does own an iPod: *No*

Is it the case that BILL is concerned about computer security and viruses: *No*

Is it the case that BILL can use the Mac platform: *No*

Questions asked about his ownership of an iPod or concern about computer security and viruses help may indicate an interest in the Mac platform, even though he may not have considered that possibility previously. Since no other rules fired to determine if Bill would be interested in a Mac, the base rule fires and asks Bill directly.

In the results (See Figure 1), the system did end up recommending a laptop machine even though he had stated he was not interested in a computer that was portable. This is the expected behavior as set up in the rule set. Essentially what the advisor is trying to say is that a laptop computer is still a decent choice even if Bill does not expect to use bring it anywhere. The converse is not necessarily

```
[COMPUTERTYPE BILL WINDOWS-DESKTOP-MIDRANGE-SONY-V-SERIES] is true
  It was derived from rule WINDOWS-DESKTOP-MIDRANGE-SONY-V-SERIES3
  [EXPECTEDSPENDINGAMOUNT BILL MEDIUM] is true
    It is an USER-INPUT
  [PORTABILITY BILL NONE] is true
    It was derived from rule ANY-PORTABILITY
    [WANTS-MOBILITY BILL NO] is true
      It is an USER-INPUT
  [CANUSEWINDOWSPLATFORM BILL YES] is true
    It was derived from rule WIN-OFFICE-USE
    [WORKCOMPUTERTYPE BILL WINDOWS] is true
      It is an USER-INPUT
    [USESCOMPUTERATWORK BILL YES] is true
      It is an USER-INPUT
```

Figure 2: Explanation of Results

true, though. If Bill had stated that he was interested in a mobile computer, then no desktops would have been recommended. When a user states that they want a mobile computer, they would not consider a desktop computer to be a decent recommendation. One notable exception to this would be the Mac Mini. Although it is technically a desktop computer, due to its size it might fit into a category where the user could bring it to work and attach a separate monitor, keyboard, and mouse at a different location.

The certainty values displayed show that the advisor is more confident that the desktop computer better matches Bill's particular needs than the notebook. In the explanation (See Figure 2), we can see that the primary rules used were based on the expected spending amount and operating system used at work. The performance requirement was also incorporated in the results since as an administrative assistant, his requirements were minimal. The reason why the certainty values are lower for the low end machines are due to the fact that the performance-requirement derivation was derived from his job title and area of profession. Since we are less certain about the types of work that are performed, the low end computers are not given as high values.

4   Advisor Scope

The advisor system can handle suggesting and ranking a few of up to a dozen computers. In the example, it suggested a couple windows computers primarily based on *operating system*, *price criteria*, and *portability*, with some additional recommendations based on *performance requirements*. The advisor system can

also handle specific cases where the user has a Windows machine at work or home, but might want to use a Mac as their new computer and taking advantage of Virtual PC to emulate Windows. This option is only given if their performance requirements are not high because the assumption is that the computer will not be able to handle the software adequately when run in emulation due to the performance hit.

There are other minor rules which may influence the weight of choosing the Mac, specifically if the user replies that they own an iPod or are concerned about security and viruses. The former is because the user is exposed to the aesthetics of iPod and iTunes for Windows and may increase their propensity towards choosing a Mac in the future. This has been a theory by some analysts which is driving increased traffic to Apple retail stores. The latter due to the increased media coverage of the extensive number of security holes in Windows exacerbated by email worms spread by and affecting Windows machines.

One of the limitations in the current system is the reliance on general areas of tasks to identify performance requirements. Rather than stating simply *email* use or *design* work, one could imagine expanding the system to focus on specific programs run by the user. Knowing these specific attributes would allow for much more detailed knowledge of the performance requirements. An added side benefit would be that knowledge of specific programs could also contain information about which ones are cross-platform. This would further improve the ability to recommend an alternate operating system from their current work or home use rather than relying solely on the recommendation of Virtual PC. It would also improve recommendations of a Windows machine in the midst of Mac use in the home or at work.

5   Knowledge

The computer type is the final goal of the rule based system. Each computer type has two or three rules associated with it, using certainty values to combine the correlation of each area (performance, portability) to correctly weight the best computer system. As can be seen (See Figure 3), this makes the overall ruleset look excessively complicated. In reality, since there are multiple rules associated with each computer type. This is one of the limitations seen in having a strictly rule-based knowledge representation. By looking one level up the hierarchy, we can see that the graphs are much more readable and make sense logically. For example, the operating system attributes show in good detail the propagation of
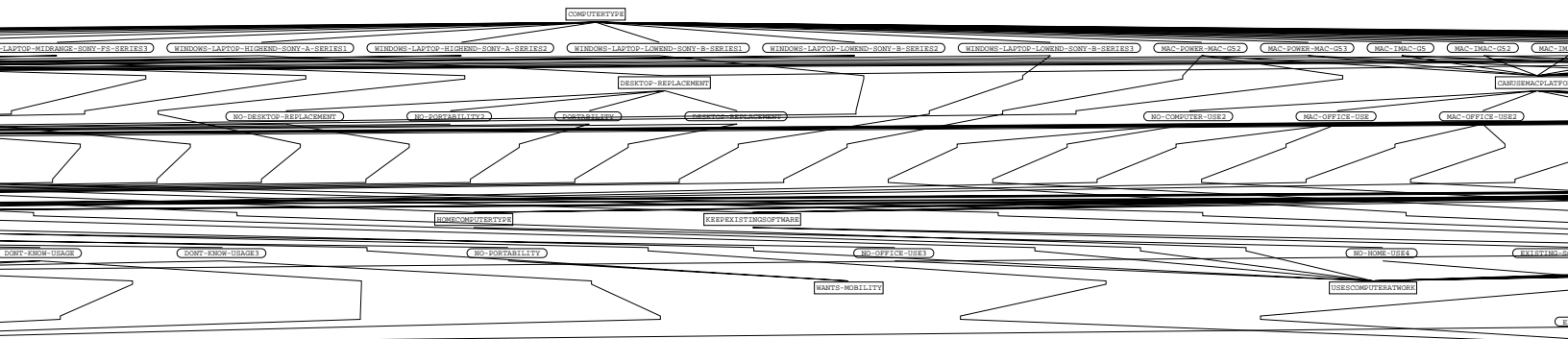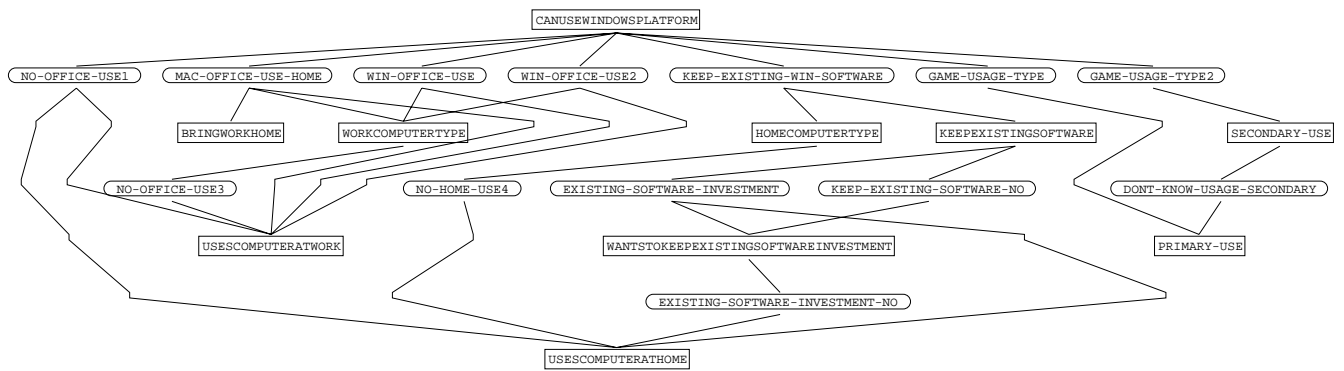
Figure 3: Graph of All Rules

Figure 4: Graph of Windows Rules

attributes from the home and office use computer use. Similarly the performance rules are based on primary and secondary usage as well as job title and profession. The mac . See Figures 4, 5, 6, 7, 8.

5.1 Sample rules

The following rules can be seen as defining one of the computer models. This rule group is for the PowerBook 15". Essentially each contains the required attribute *canUseMacPlatform* which is to ensure that it will only be true if the Mac is allowed. The other rules *performance-requirement* , *portability* , and *expectedspendingamount* contained within are self explanatory and determine the appropriateness of this selection. When all three of the rules fire, the certainty values combine to increase this model's particular importance in the list of rec-
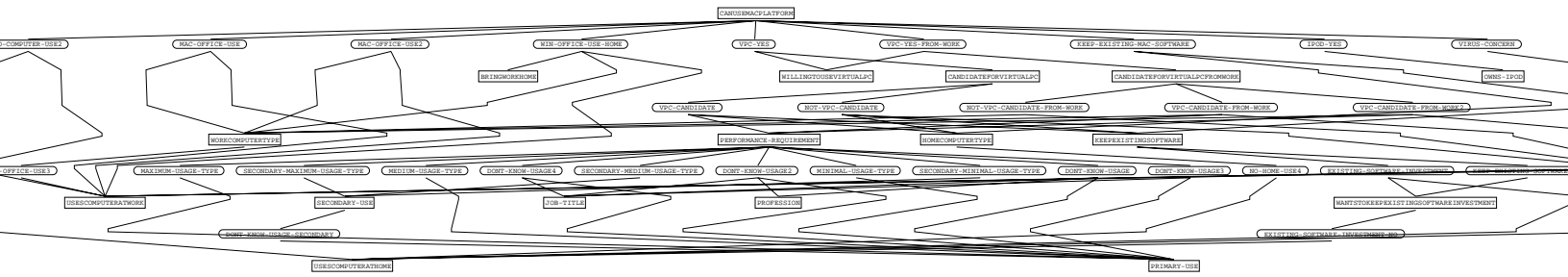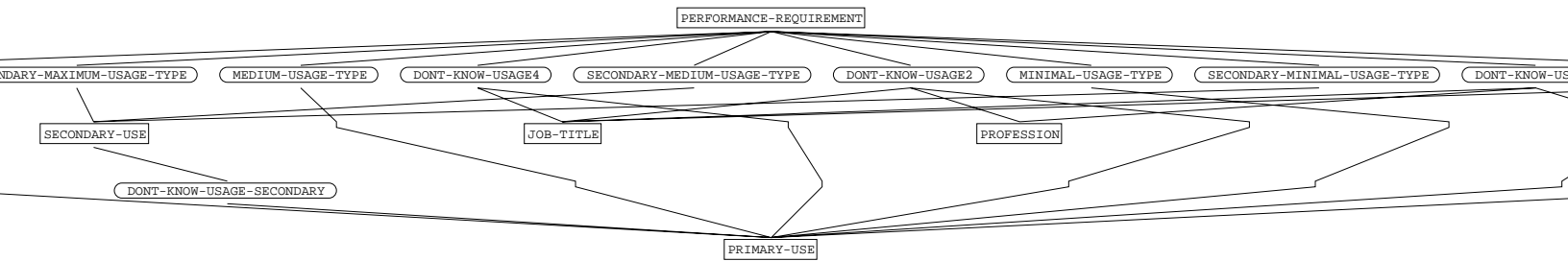
Figure 5: Graph of Mac Rules

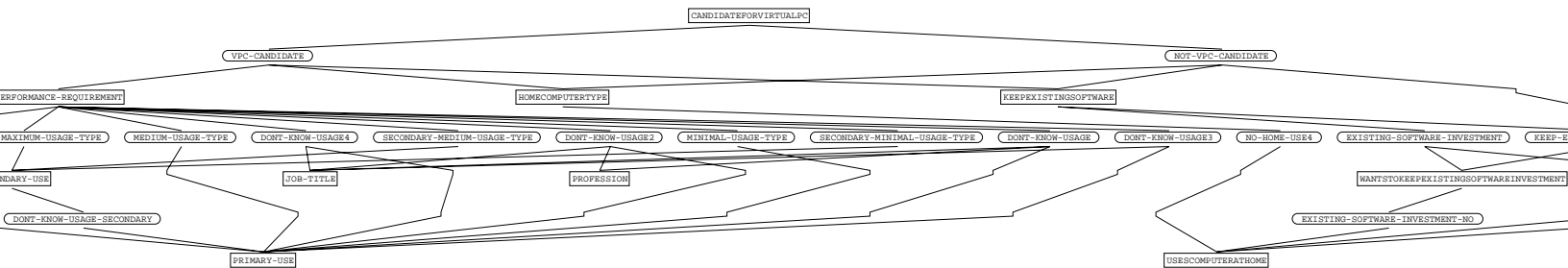Figure 6: Graph of Performance Rules
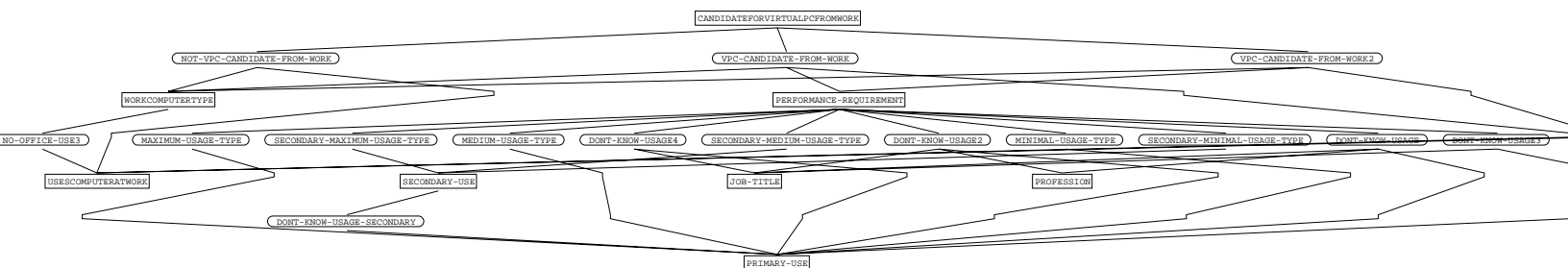
Figure 7: Graph of Virtual PC Rules

Figure 8: Graph of Virtual PC from Work Rules

ommended machines.

```
(defrule mac-powerbook-fifteen (:backward :certainty 0.5 :importance
88) if [and [canUseMacPlatform ?who yes] [performance-requirement ?who
medium]] then [computerType ?who mac-powerbook-fifteen])

(defrule mac-powerbook-fifteen2 (:backward :certainty 0.5 :importance
88) if [and [portability ?who medium] [canUseMacPlatform ?who yes]] then
[computerType ?who mac-powerbook-fifteen])

(defrule mac-powerbook-fifteen3 (:backward :certainty 0.5 :importance
88) if [and [canUseMacPlatform ?who yes] [expectedspendingamount ?who
medium]] then [computerType ?who mac-powerbook-fifteen])
```

The following rules help determine the performance requirements of the system.
The first rule is based on the user-entered primary usage, which states that if the
primary use is *email*, *web*, or *office*, then it is minimum performance requirement.
Certainty level is less than 1 to allow for the secondary usage. The second rule
here uses the job title to determine the performance requirement if the primary
usage is not unknown by the user. Here the requirement is medium if the user is
a designer or engineer.

```
(defrule minimal-usage-type (:backward :certainty 0.8 :importance 99)
if [or [primary-use ?who email] [primary-use ?who web] [primary-use ?who
office]] then [performance-requirement ?who minimum])

(defrule dont-know-usage4 (:backward :certainty 0.6 :importance 99)
if [and [primary-use ?who dont-know] [or [job-title ?who designer] [job-title
?who engineer]]] then [performance-requirement ?who medium])
```

6   Problem Solving Approach

By using a backward chaining rule-based system, we are able to adequately de-
fine the end goal based on the propagation of attribute values up the hierarchy.
The idea was to identify each of the distinguishing attributes of the computer
systems. In this case, the primary attributes were operating system, performance
requirement, price point, and portability. I was able to deconstruct each of these
attributes in order to further separate the goal from the questions to be asked.
Overlaps occurred in areas such as determining the usage of Virtual PC, which
had impact from both the operating system selected and the user's performance

requirement.

7 Observations

7.1 Advantages of the rule-based system

The task of providing recommendations for a computer system worked fairly well under the rule-based system. Besides the issues with defining the top-level computer models, the underlying attributes and subgoals were straightforward to design and extend with further rules as needed. Adding of new rules was fairly easy, with only minimal effort required to ensure that certain questions were asked before others. Using the certainty values as a weighting system turned out to be useful in combining the necessary subgoals.

7.2 Disadvantages of the rule-based system

As was stated earlier, the overall graph of the knowledge base becomes exceedingly complex as we traverse closer to the goal of determining the computer type. Since multiple rules are required for each system in order to capture the trade-offs between different computer models, the final level of knowledge propagation was somewhat coerced into the correct behavior. While the certainty values were effective, they also did not provide the best fit. The "winner-take-all" ranking system may have excluded other recommendations that may have been useful.

Combining the rule-based system with another system might provide a more robust, extensible system. A frames-based system would probably provide the best match for representing each of the different computer models. Rules could be used to perform the analysis of the machine specifications and translate that into attributes. These attributes would then be stored in the frames themselves. Frames that are similar (such as all Dell machines or all laptops weighing less than 5 pounds) would have universally similar attributes that could be matched on the other side from the predicates determined by the user's needs.

8   Conclusions

The goal was to separate the user from the technical details usually required when purchasing a new computer. This was achieved by reducing into plain English the specific requirements of the user based on the needs they have for the new machine. The knowledge captured in the system is easily extendable to expand the number of requirements or the breadth of knowledge within the currently defined requirements. While limitations were apparent early in the process, they were generally manageable for the current scope of the task.

9   Appendix

See attached document.