

An eCommerce Platform for Customized Page Design and Content Delivery

by

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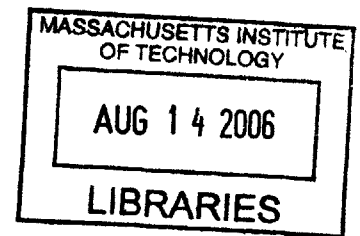
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BARKER

1 Abstract

As eCommerce becomes more prevalent, good site design that can cater to users with different backgrounds and experience becomes increasingly important. While many web based applications provide customized content, these systems do not adapt and provide a customized user experience as one navigates the site.

Our research investigates customizing web applications to fit individual decision styles by morphing user experience based on revealed clicks, search history, and the navigation path through the site. By using a Bayesian update algorithm to update our assessment of a user's preferred interface, our application creates a customized user experience that is best suited for their personality and learning style.

2 Introduction

We have created a customizable eCommerce system that can easily be used with existing web applications and architectures to provide customized page design, content and user interaction to help users easily navigate, find, and purchase the content they are looking for. Since web users have varying amounts of specific domain knowledge and different personality types, providing an infrastructure that can account for these differences and serve up a unique web experience for each individual will greatly enhance their user experience on any given website. In addition, the system is also able to track user behavior via click-stream and session specific data to measure the success of a real time morphing system.

3 Background to Customer Advocacy

Customers can compare many available options today and decide which is best via the internet. The internet provides an era of customer power where they have access to transparent information. Because of this new customer power, Dr. Glen Urban at MIT Sloan recommends using a style of marketing based on *trust* and *customer advocacy*. This style involves earning the customers trust rather than pushing products on them via false advertising or misleading promotions. From his book, Don't Just Relate—Advocate, Professor Glen Urban states that:

Customer advocacy means faithfully representing your customers' interests. It means giving them open, honest, and complete information because they'll discover the truth no matter what you do).

It means talking *with* them, not at them. And it requires a massive transformation in both your culture and your processes. (Urban, 2005).

In this thesis, I discuss a platform for customized page design that can aid customer advocacy by customizing a user's web experience to match their personality and learning style.

4 Customized User Interface Design for eCommerce Advocacy Sites

4.1 Background and thesis Objective

The goal behind of this work is to make the User Interface experience better by providing customized content and page design for different personality types. For eCommerce applications, Glen Urban's research is focused on the idea that open information presented via customer advocates and online advisors will help build trust between the seller and the buyer and help them make educated decisions about products or services they are looking for. By providing open information and breaking away from the traditional push advertising strategy, customers will realize he hypothesizes that the seller has their best interest in mind which in turn will lead to them trusting that brand more.

In creating customer advocacy online tools and open advisors, we found that it was difficult for users with different backgrounds and

knowledge to use the same set of tools to find products and services they were looking for. For example, when a user at BT.com is trying to purchase some new technology, it is difficult for BT to present information in such a way as to account for users with different technical backgrounds. While technically savvy users might want to get straight to the point and look for specific differences between available products, some users may not even be able to navigate the site and understand which product will meet their needs. To solve this problem, we have created a platform that can track and infer a user's personality type and background based on click-stream data, amount of time spent on each page, navigation patterns through a site, and optional feedback on their satisfaction with the available User Interface. Our tool allows website pages to be mapped as a graph where each page and path is tagged uniquely by our system. For each page within the site, the site owner is able to input either the raw content and pick an existing template or submit the html pages and then tag them based on which page it is and what kind of user it should be served up to. For example, the site owner may define 3 different versions of an advisor tool and tag them for users with different technical backgrounds and specify which page is served based on what our rules engines observes about their technical expertise. This system goes one step further and provide not only customized content for users, but customized page design and user experience based on pre-defined attributes for an ecommerce application.

An alternative to customized user experiences that highlights what different sets of users prefer would be to have a dense set of

navigation paths for any given page on the site thereby allowing users to choose which experience they prefer. Due to limited screen space and the limited attention span of most users, having too many choices often makes a sites user experience less effective.

4.2 Outline

In the next three sections, we demonstrate how the morphing system works for a BT.com test site. By considering 3 attributes used to morph the BT site, we can provide up to 8 different morphs for each page on the site using our system. After demonstrating what our system can do, we look at the application architecture. The system is not only able to create a morphing system with existing e-Commerce sites, but is able to create customized templates to deliver structured data from a database easily to create varying morphs for new sites. Finally, we look at future work going forward and how the system will be tested on a live test user base.

4.3 Scenarios and Examples

Past research studies have shown that while users would like personalized content and user experience that best helps them find what they are looking for, answering a set of questions about their cognitive style and the kind of pages they are looking for does not work. This is so because most users have difficulty in accurately categorizing what cognitive style they prefer and do not want to spend

the time and effort required online in filling out a survey. While one option would be to create a customized profile that can be read by the browser itself, we decided this was not a reasonable option at this time. Instead we provide a flexible tool that allows sites to not only describe what attributes they want to morph page design and user experience on, but also describe where each page and its different versions/morphs fit based on the different thresholds for each attribute. Site owners will be able to morph as much or as little of their entire site's graph of pages using either a basic averaging algorithm or a Bayesian update model described in the algorithm section.

In terms of specific scenarios, let us look at an existing site we are working on with British Telecom, the leading provider of broadband in England. British Telecom's Advocacy site is dedicated to helping users from all backgrounds find broadband internet access and related technologies to help with connectivity. The first step in this project was to incorporate Glen Urban's research in on-line advocacy to create Customized broadband advisors as rule-based decision systems that can help users with varying domain knowledge in this area find what they are looking for. We have worked closely with BT to test our prototype system since then to see how our platform can create a web application that can morph its page design and content from page to page for relevant pre-defined attributes. Three attributes we have currently used are a wholistic versus analytic users, deliberative versus impulsive users, and visual versus verbal users. By defining these attributes and the 2^3 (8) morph pages available for each click in the site, the rules describing which page version fits what personality, and how these variables values are updated to change our current

assessment of each user, we have created a morphing system that can help users more easily find what they are looking for. Not only is the content morphed based on user personality type, but so is the page design and website flow to accommodate the different cognitive styles. One caveat with this scenario is that the inference engine used to categorize users is currently based on a simplified algorithm instead of the Bayesian inference engine proposed in this document. We simply take the three attributes and check whether they are above or below a threshold value to determine whether they are on or off. Based on the 3 attributes then, we can serve up to 8 different pages and update each variable based on a table look-up that uses averaged updates across the click-stream associated with the current session ID.

Our system has the capability to morph existing websites based on any number of attributes using a factory of update models. Currently the site uses a simple averaging algorithm described in the algorithm section to update our assessment of a user's cognitive style, but is easily pluggable into a Bayesian update model developed by another member on our team. By making it easier for content owners to provide customized content for each personality and the rules engine that maps web pages to personality types, we hope that many site owners will use this feature in the future. By providing pre-defined templates we hope that new content owners will easily be able to create a morphing website by simply supplying the content.

4.4 Morphing with BT Broadband Advocate

Following are specific examples from BT.com to show the morphing system in action:

BT.com is a Broadband eCommerce site that sells high-speed Internet access and related technologies. BT.com like Urban's trust based advocacy model and asked us to create an online advisor that let people compare BT's products with its competitors on a number of key areas. After creating the online advocacy site, we decided to test our morphing system to see how it would work on BT's advocacy site by morphing the site on 3 attributes that we felt were important including Deliberative versus Impulsive users, Verbal versus Visual users, and Wholistic versus Analytic users.

Some users on the web are impatient and need to take the time to really learn about what they are buying while others are more comfortable making a quick decision based on basic metrics like cost and quality. We created an attribute for deliberative versus impulsive users and were given content for the two categories of users. The amount of information presented to deliberative users was more detailed and exhaustive whereas impulsive users had a quick summary of the key facts in this specific. To infer a user's style, we looked at the user's navigation history to see what links they had clicked and how much time they had spent on the site in terms of number of clicks.

Some of us are more visual and others prefer a more verbal approach. Urban felt this was an important attribute to morph the BT advocacy

system and we added this as our second attribute. The system is able to generate a visual graph based approach generated live data for visual users and present a traditional table breakdown of the data presented to the user. The system also has the capability to show video versus audio content and be able to take any dataset and create a pie chart, a bar graph, or a line plot for visual users. To determine whether a user is verbal or visual, we started with a few visual cues across the site and depending on how often they clicked a resource tagged visual, we categorized the user as either in that category or not.

A third attribute we chose for the BT site was wholistic versus analytic users. While some of us prefer high-level information on a topic, others prefer to delve into the details to really understand the space. The system is able to easily adapt for this attribute because the key difference here is the content itself that is presented. For wholistic users, the content for any domain is more general and tries to address the big picture issues relating to it. For analytic users, the content is much more detailed with many layers easily accessible via clicks to allow them to learn as much as they want to about any given domain. To distinguish between wholistic and analytic users, we looked at the search and navigation history for the user and the time spent across the site. Also, certain pages were tagged as generally more wholistic or analytic than other's based on the content available on that page.

Our system also considered other attributes such as qualitative versus quantitative users to see how we could morph the system and further customize user experience. While it very easy for this system to take

on new attributes and be able to manage a customized user experience for each attribute, the team decided that for the initial test, 3 attributes and 2^3 morphs for each page was sufficient.

Looking more closely, Figure 1 and Figure 2 attempt to show how one of the pages on the BT advocacy site was morphed for two segments of users. It is difficult to show some of the key differences as the content on further clicks is different based on how the user has been segmented, but some of the key differences are highlighted on this page. The first user in figure 1 in this case is categorized as verbal, deliberative and wholistic. An explanation of how this may be computed in our system, please look in the section titled algorithm. Since the user is considered verbal, we take the live data available to us in this case in a relational database and map out the attributes in a table. I will explain in the system architecture section how this is generalized for any dataset as the page interpreter is able to use an existing template to make sure the look and feel of the site is reasonable. For the deliberative attribute, our rules engines tells us to print all of the attributes available to us in the database which in this case is a set of factors to help users choose a broadband plan based on the many characteristics that set them apart. Since the user is considered wholistic, the data itself is analyzed by the rules engine and translated into laymen's terms. As a result, speeds and reliability are broken up into different segments like excellent, good, average, or poor instead of the actual data available in the database. In addition all of the information stored on-clicks such as an explanation of the different attributes is also morphed based on this attribute. All the user needs to provide for his/her site is these 3 attributes and the

content that needs to be served up for each category of user. The rules engine is then able to track and categorize the user and the page interpreter is able display the information in a browser with a reasonable look and feel.

BT Broadband

Broadband Plan Comparisons > Welcome!

Compare Broadband Packages

Provider	Price	Speeds	Reliability	Type	Support	Wireless	Contract	Spam Filter	Anti Virus
<input type="checkbox"/> BT	£ 15	Average	Great	DSL	Great	Yes	1 year	Yes	Yes
<input type="checkbox"/> Wanadoo	£ 15	Fast	Average	Satellite	Average	Yes	2 year	Yes	Yes
<input type="checkbox"/> Demon	£ 17	Average	Great	DSL	Great	No	3 year	Yes	Yes
<input type="checkbox"/> NetServices	£ 22	Average	Great	Cable	Good	No	1 year	Yes	Yes
<input type="checkbox"/> AOL G	£ 24	Average	Good	Cable	Good	No	2 year	Yes	Yes
<input type="checkbox"/> Elite UK	£ 24	Average	Average	DSL	Good	No	4 year	Yes	Yes
<input type="checkbox"/> Atlas	£ 25	Fast	Great	DSL	Great	No	2 year	Yes	Yes
<input type="checkbox"/> AOL P	£ 29	Fast	Good	Cable	Good	No	2 year	Yes	Yes
<input type="checkbox"/> Star 500	£ 69	Average	Average	Satellite	Average	No	4 year	Yes	Yes
<input type="checkbox"/> Star 1000	£ 83	Fast	Good	DSL	Average	No	3 year	Yes	Yes

Select and Compare

★ If the available plans are not in your price range try [bidding your Price](#)

Give us feedback on this comparison chart [here](#)

Broadband Tools [Minimize](#)

Advisor

[Listen](#)

As a leader of one of the largest consumer technology magazines in the world, I really have to be on top of whats going on in this space.

[Go](#)

Figure 1: A sample page from BT.com morphed for a verbal, deliberative, and wholistic user

In contrast to the page show in Figure 1, Figure 2 shows a page for another morph of the same resource or page. This page is morphed for

a visual, impulsive and analytic user. For the BT.com project, since there are 3 attributes, we created 8 different morphs to show the differences across each of the attributes. The rules engine could be changes however to set different thresholds within each attribute and have more than 2 variants per attribute. Looking back at this page, since the user is categorized as visual, the page interpreter uses the graphics package available to it to display the data in the database in one of the available graphical formats. Since the user is also considered analytic, the price and the bandwidth metrics are broken down using actual data available versus using the rules engine to translate that data into simpler terms. Since the user is considered impulsive, only the 4 most important attributes are sent to the page interpreter by the rules engine for display (2 shown in picture). If the user wants to get more data, we try to make that accessible to them via a click so that even if they are categorized as impulsive, they can revert back to a deliberative view and vice versa. This allows us to get more information about the user and update our assessment and lets them self select their profile.

Another example of the morphing system in action is in the Broadband Advisor section of the site. This is a resource typically used by wholistic, visual, and deliberative users that need help and want to learn about the different broadband packages available, the key trade-offs to consider, and peripheral products that are useful and important when purchasing Broadband. Our system has 3 different kinds of advisors available to cater to 3 general categories of users. The first one is a technical advisor that expects it's users to really have a good understanding of the broadband domain and get answers to specific

advanced questions. The second advisor is a middle of the road advisor for some who has some experience in this space and would like to make a good educated decision but not necessarily learn about advanced topics. The third advisor is for someone that doesn't know much about broadband and the internet in general and just wants his computer to be able to access the internet. These 3 advisors are provided by the user and categorized into one of the 8 morphs so that the rules engine knows what to send to the page interpreter. Within each advisor, there are other differences to account for each of the 3 attributes and present a unique morph for each segment.

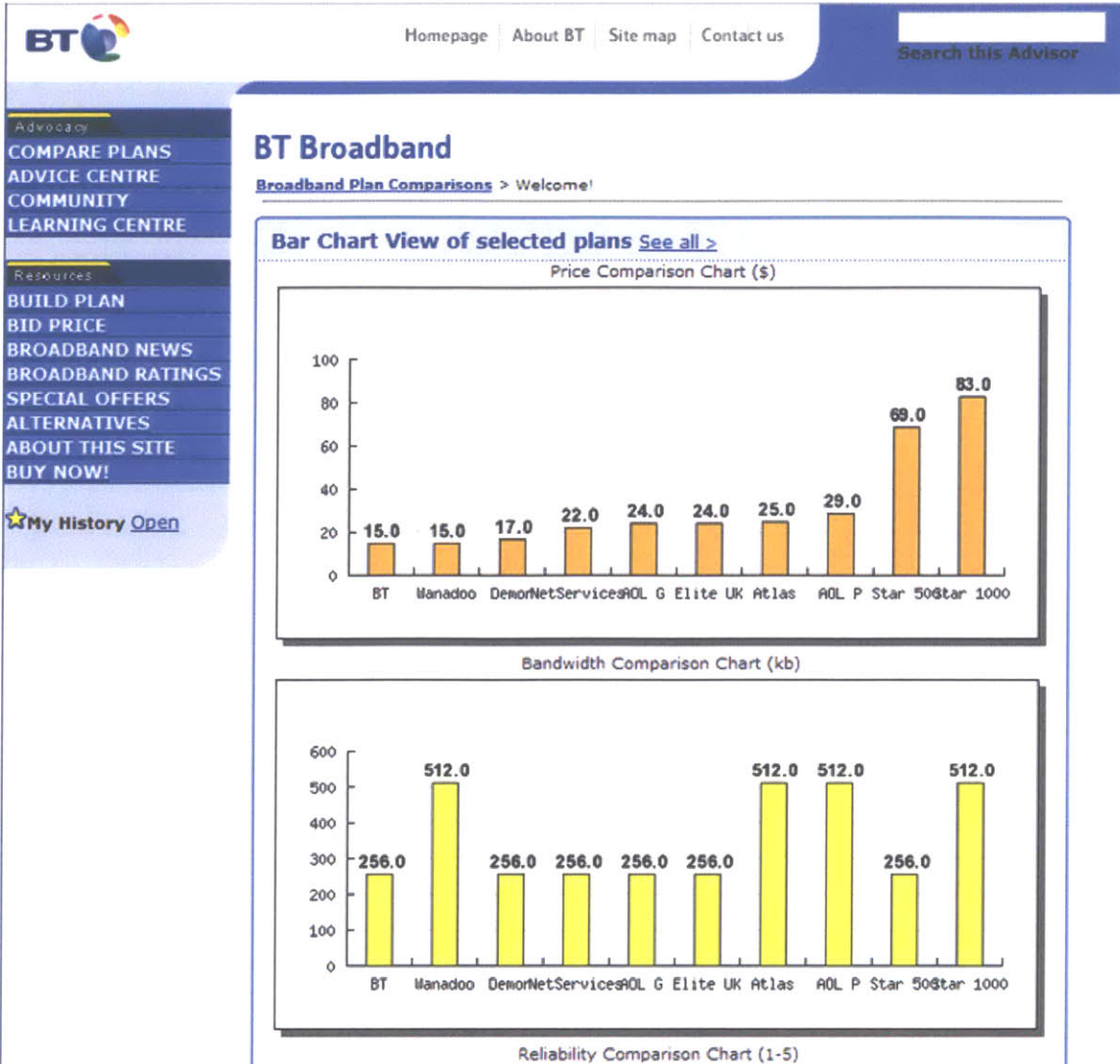


Figure 2: A sample page from BT.com morphed for a visual, analytic and impulsive user

Figure 3 is a morph for a user that is wholistic, verbal, and impulsive. As a result, the middle of the road advisor mentioned second in the earlier paragraph is displayed. To further account for wholistic segment, the user is given questions that focus on high level general

information instead of technical specifics. In addition, any question can be explained by the system because we recognize that the wholistic user wants to look at the big picture and not necessarily dive into all of the details. Since the user is also considered verbal, we provide a verbal listen click based on an audio file the user provides about what the user should consider when purchasing broadband and an analysis of the information in a language the user can understand. Since the user is considered impulsive the number of questions asked of the user is limited and the system tries to move quickly to make a recommendation of what plans to consider and what peripheral products are available.

In contrast to Figure 3, Figure 4 shows the same resource, Broadband Advisor for an analytic, deliberative, and verbal user. Since the user is considered analytic by the segmenting algorithm, the advisor presented to the user is the analytic domain expert that provides detailed analysis and specific data to the broadband domain. The listen

BT Homepage | About BT | Site map | Contact us Search this Advisor

Advocacy

COMPARE PLANS

ADVICE CENTRE

COMMUNITY

LEARNING CENTRE

Resources

BUILD PLAN

BID PRICE

BROADBAND NEWS

BROADBAND RATINGS

SPECIAL OFFERS

ALTERNATIVES

ABOUT THIS SITE


BUY NOW!

★ My History [Open](#)

BT Broadband

[Broadband Advice Centre](#) > Lian

You have chosen student - Lian Taylor. Listen to her feedback on the best Broadband providers.



[Listen](#)

Please complete 3 steps in order for Lian to help

Step 1

Post Code:

Step 2

What are your broadband usage needs? [\(Explain this\)](#)

- 150K(1 hour of surfing a day)
- 150-250K (3 hours a day of email, some music and file downloads)
- 200-400K (24 hours a day, extensive file sharing, downloading and online gaming)

What type of broadband service are you looking for? [\(Explain this\)](#)

- DSL
- Cable
- Satellite

What price range are you looking at? [\(Explain this\)](#)

- \$15-\$20
- \$25-\$30
- \$45-\$50

To what contract length are you willing to commit? [\(Explain this\)](#)

- 1 year
- 2 years

Figure 3: A sample page of the Advisor from BT morphed for a verbal, impulsive, and wholistic user

icon also has a description from him about what is happening and changing in this space and what technical trade-offs to consider when purchasing a plan or other peripherals. Since the user is deliberative, the number of questions asked of the user is longer to try to get the most accurate recommendation from our system. For the verbal cue,

again there is a listen icon which would be replaced by a graphical view of some of the data since that was what the user provided to morph this page for verbal versus visual users.

The screenshot shows the BT Broadband website interface. At the top left is the BT logo. To its right are links for 'Homepage', 'About BT', 'Site map', and 'Contact us'. A search bar on the top right contains the text 'Search this Advisor'. On the left side, there is a vertical navigation menu with sections for 'Advocacy' (COMPARE PLANS, ADVICE CENTRE, COMMUNITY, LEARNING CENTRE) and 'Resources' (BUILD PLAN, BID PRICE, BROADBAND NEWS, BROADBAND RATINGS, SPECIAL OFFERS, ALTERNATIVES, ABOUT THIS SITE, BUY NOW!). Below the menu is a 'My History Open' link. The main content area is titled 'BT Broadband' and 'Broadband Advice Centre > James'. It features a message: 'You have chosen publisher - James Brown. Listen to his feedback on the best Broadband providers.' followed by a 'Listen' button and a small image of a man. Below this is a section titled 'Please complete 3 steps in order for James to help'. Step 1 includes input fields for 'Post Code', 'Download Speed (kb)', 'Preferred Price (\$)', and 'Lease Length (years)'. Step 2 is titled 'Please select from the list of available security features' and includes checkboxes for 'Anti-Virus', 'Firewall', 'Child Protection', 'Anti Spam Filter', and 'Public/Private Key Management'. Below this is the question 'What type of broadband service are you looking for?' with checkboxes for 'DSL', 'Cable', and 'Satellite'. The final section is 'Select from the following wireless options available' with checkboxes for 'Inlcuded Wireless Router' and 'Inlcuded Wireless Card'.

Figure 4: A sample page Advisor from BT morphed for a verbal, deliberative, and analytic user

The broadband advisor is similar to other online advisors in that tries to ask the right questions of the user to help them find or choose something. I will not go into much detail about how the questions for the advisor are determined, but instead discuss the component used to make a list of plans available to the user. Since our system is tailored for online advocacy in eCommerce systems, we have a component that looks at how closely the user's needs match what is available in the database of choices.

By using a traditional least squares approximation of how closely the plan matches the user's description for each feature he or she has described the system is able to rank order the list of choices recommended. If nothing exactly matches the user's request, the best fit is show regardless with an explanation of why this choice was best and what the user could consider changing to get more options.

Other sections of the BT site that were morphed included the Broadband Community forum section and the Online Learning Centre section. The page interpreter is able to create a simple discussion forum based on the topics a user specifies. Since many eCommerce sites have community discussion and news portals, we felt this was an important resource the page interpreter needed to handle. The online community is backed by a relational database where comments from different users on different topics are stored. Users can also rate other people's comments on whether they found them useful and reply to someone's comment and start a conversation thread. The comments appear in order of usefulness with the comments ranked highest by

everyone appearing first. One thing I will address soon is the site's capability to index the content of the site using a crawler so that the content is also searchable in the search feature. This allows all conversations to be indexed and searched using our template either via a search box or by making it available in other pages of the site where those terms are mentioned. For example, the Find Your Plan section of the BT site mentioned earlier has the ability to look at news and community discussions by provider as result of the search capability. A simple query could make all discussions about broadband security accessible to the user in another section where security features are described.

The online community also has the capability to morph based on user segmentation by the update algorithm in use. For deliberative, analytic, and visual users, the community shows a community that is geared to match their style. For example, all polls and ratings in the community are graphed to match their visual style. Similarly, there are a number of community discussion forums the users can choose from with all threads available for them to read. All topics can be tagged as either more analytic or wholistic and the user in this case would only get community discussion topics that are more analytic to match his cognitive style. Figure 5 shows a sample community page for a user considered analytic, visual and deliberative.

BT [Homepage](#) [About BT](#) [Site map](#) [Contact us](#)

Advocacy
[COMPARE PLANS](#)
[ADVICE CENTRE](#)
[COMMUNITY](#)
[LEARNING CENTRE](#)

Resources
[BUILD PLAN](#)
[BID PRICE](#)
[BROADBAND NEWS](#)
[BROADBAND RATINGS](#)
[SPECIAL OFFERS](#)
[ALTERNATIVES](#)
[ABOUT THIS SITE](#)
[BUY NOW!](#)

★ [My History](#) [Open](#)

BT Broadband

Are you ready to buy? > Start comparing broadband plans now >
 You should consult with other people to learn what they think about subjects of interest to you. Communities provide good sources of information, tips and advice. You can also direct and lead others through providing your own information and advice.

Discussion Board

Poll



Which plan did you choose?

- [AOL G](#)
- [BT](#)
- [Star 500](#)
- [Star 1000](#)
- [Atlas](#)
- [Elite UK](#)
- [NetServices](#)
- [Wanadoo](#)
- [Demon](#)
- [AOL P](#)

Live User selection distribution

Plan	Percentage
AOL G	14.3%
BT	7.1%
Star 500	7.1%
Star 1000	14.3%
Atlas	7.1%
Elite UK	7.1%
NetServices	14.3%
Wanadoo	7.1%
Demon	7.1%
AOL P	14.3%

DSL Subject

Figure 5: A sample community page from BT morphed for a visual, deliberative, and analytic user

In contrast to the page shown in Figure 5, a user considered verbal, impulsive and wholistic would be shown a page with verbal text printed out for all numerical data, a small subset of community discussion forums ranked highest and only those topics that are

tagged as wholistic. Figure shows the verbal versus visual difference for the online community page in the BT advocacy site.

The screenshot shows the BT Broadband website interface. At the top, there is a navigation bar with links for 'Homepage', 'About BT', 'Site map', and 'Contact us', along with a search box labeled 'Search this Advisor'. The left sidebar contains a menu with 'Advocacy' and 'Resources' sections, listing various services like 'COMPARE PLANS', 'ADVICE CENTRE', 'COMMUNITY', 'LEARNING CENTRE', 'BUILD PLAN', 'BID PRICE', 'BROADBAND NEWS', 'BROADBAND RATINGS', 'SPECIAL OFFERS', 'ALTERNATIVES', 'ABOUT THIS SITE', and 'BUY NOW!'. A 'My History Open' link is also present.

The main content area is titled 'BT Broadband' and features a section 'Are you ready to buy?' with a link to start comparing broadband plans. Below this is a 'Discussion Board' section containing a poll titled 'Which plan did you choose?'. The poll options are: AOL G, BT, Star 500, Star 1000, Atlas, Elite UK, NetServices, Wanadoo, Demon, and AOL P. A 'Submit' button is located below the options. The results of the poll are listed below the options, showing the number of users who have purchased each plan so far.

The discussion board entry is titled 'Broadband Security' and has a subject line: 'AOL has firewall, antivirus software > RT has zanelahs' firewall >'. A small profile picture of a user is visible next to the subject line.

Figure 6: A sample community page from BT morphed for a verbal, impulsive, and wholistic user

The last resource that we morphed in our BT test system was the online learning center. The purpose of having a learning center is to provide people a place to look at the most relevant and popular questions about broadband and related technologies and learn from the experience of others about Broadband. To morph based on the attributes described, essentially the page interpreter was able to choose from a flat file of content and send it to the browser for display.

Figure 7 shows a morph for someone considered deliberative, analytic and verbal. For the first attribute, the content itself is morphed with a lot more detail about each topic discussed. Similarly, the content is written to cater to an analytic user. There are no differences between verbal and visual users because the data to create that difference has not been added to the system by the user.

In contrast to Figure 7, Figure 8 shows the same Learning center resource for an impulsive, wholistic and verbal user. The content provided to the page interpreter in this case is wholistic and abbreviated.

Another key component of this system is its ability to create an index or a hash-map of all the content that is entered into the system. All user added content is tagged based on which segment it falls into for

each attribute defined and the system creates an index so the can easily search it. This is particularly useful for an online advocacy tool

BT 

Homepage | About BT | Site map | Contact us


Search this Advisor

Advocacy

- COMPARE PLANS
- ADVICE CENTRE
- COMMUNITY
- LEARNING CENTRE

Resources

- BUILD PLAN
- BID PRICE
- BROADBAND NEWS
- BROADBAND RATINGS
- SPECIAL OFFERS
- ALTERNATIVES
- ABOUT THIS SITE
- BUY NOW!

 My History [Open](#)

BT Broadband

[Are you ready to buy?](#) > Start comparing broadband plans now >

Want to learn more about Broadband? Here you will find everything you need, including descriptions of Broadband technologies, the latest ratings, and links to other sites for more resources:

How DSL Works



Traditional phone service connects your home or small business to a telephone company office over copper wires that are wound around each other and called twisted pair. Traditional phone service was created to let you exchange voice information with other phone users and the type of signal used for this kind of transmission is called an analog signal. An input device such as a phone set takes an acoustic signal (which is a natural analog signal) and converts it into an electrical equivalent in terms of volume (signal amplitude) and pitch (frequency of wave change). Since the telephone company's signalling is already set up for this analog wave transmission, it's easier for it to use that as the way to get information back and forth between your telephone and the telephone company. That's why your computer has to have a modem - so that it can demodulate the analog signal and turn its values into the string of 0 and 1 values that is called digital information.

Because analog transmission only uses a small portion of the available amount of information that could be transmitted over copper wires, the maximum amount of data that you can receive using ordinary modems is about 56 Kbps (thousands of bits per second). (With ISDN, which one might think of as a limited precursor to DSL, you can receive up to 128 Kbps.) The ability of your computer to receive information is constrained by the fact that the telephone company filters information that arrives as digital data, puts it into analog form for your telephone line, and requires your modem to change it back into digital. In other words, the analog transmission between your home or business and the phone company is a bandwidth bottleneck.

Digital Subscriber Line is a technology that assumes digital data does not require change into analog form and back. Digital data is transmitted to your computer directly as digital data and this allows the phone company to use a much wider bandwidth for transmitting it to you. Meanwhile, if you choose, the signal can be separated so that some of the bandwidth is used to transmit an analog signal so that you can use your telephone and computer on the same line and at the same time.

What is Bandwidth? Bandwidth is used as a synonym for data transfer rate - the amount of data that can be carried from one point to another in a given time period (usually a second). This kind of bandwidth is usually expressed in bits (of

Figure 7: A sample Learning Center page from BT morphed for a verbal, deliberative, and analytic user

BT Homepage | About BT | Site map | Contact us Search this Advisor

Advocacy

[COMPARE PLANS](#)

[ADVICE CENTRE](#)

[COMMUNITY](#)

[LEARNING CENTRE](#)

Resources

[BUILD PLAN](#)

[BID PRICE](#)

[BROADBAND NEWS](#)

[BROADBAND RATINGS](#)

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[BUY NOW!](#)


[My History](#) [Open](#)

BT Broadband

[Are you ready to buy?](#) > Start comparing broadband plans now >


Want to learn more about Broadband? Here you will find everything you need, including descriptions of Broadband technologies, the latest ratings, and links to other sites for more resources:

Children and Broadband DSL



While adults find broadband DSL to be a useful tool, children are a different story. Young people take very quickly to new technology, and soon may be spending more time online than you want to be the case. If you have small children in your home, broadband DSL will allow them more access to the internet than you want. It may also provide them access to materials you do not want them to see, or the opportunity to illegally download copyrighted materials. If you do get broadband DSL in a household with children, monitor their usage closely, and never assume they won't be able to do something online because they don't know how.


Finding Broadband DSL



Broadband DSL is provided by a DSL provider. This provider is also known as a DSL ISP, or DSL internet service provider. You can find listing of these your local phonebook. There may not be any providing service to your home if you live in a rural area. If the phonebook yields no responses, be sure to try an internet search. Also, because many phone companies also offer DSL, your local phone provider should be able to give you information on finding broadband DSL.

[Is my PC compatible?](#)

Broadband Advantages



Broadband has obvious benefit for business, home users and students, giving **fast connections** to the Internet, the opportunity to utilise broadband telephony (Voice over Internet Protocol - VoIP) and download video on demand.

Broadband can be **connected 24 hours a day**. There is no delay while you wait for a dial up connection.

Broadband **does not tie up your phone line**. You can make and receive calls while using the Internet.

Figure 8: A sample Learning Center page from BT morphed for a verbal, impulsive, and wholistic user

because all of the content is easily and openly accessible from a search box for the user. In addition, a simple sql based query can generate all results related to an attribute as is the case with the Find Your Plan Section of this site where the user is able to look at all community discussion and news about a specific broadband provider. Figure 9

shows how the search capability allows you to generate relevant results.

The screenshot shows the BT Broadband website's search results for the term 'bt'. The page features a blue header with the BT logo, navigation links (Homepage, About BT, Site map, Contact us), and a search bar. A left sidebar contains navigation menus for 'Advocacy' (COMPARE PLANS, ADVICE CENTRE, COMMUNITY, LEARNING CENTRE) and 'Resources' (BUILD PLAN, BID PRICE, BROADBAND NEWS, BROADBAND RATINGS, SPECIAL OFFERS, ALTERNATIVES, ABOUT THIS SITE, BUY NOW!). A 'My History Open' link is also present. The main content area is titled 'BT Broadband' and includes a breadcrumb trail: 'Search Results > Start comparing broadband plans now >'. Below this, it lists 'Broadband providers available:' with a table of results. The table has columns for Provider, Price, Speeds, Reliability, and Type. One result is shown for 'BT' with a price of £15, speeds of 256 kb, and a reliability of 'Great'. Below the table, there is a 'Community Forum Discussion comments:' section with a list of links such as 'BT has zonelabs' firewall >', 'BT is choppy >', 'Re: BT has zonelabs >', 'bt has great help >', 'bt is fast >', 'bt >', 'BT >', 'dsl cxi >', 'dns >', and 'uquig >'. A 'News Articles:' section follows, listing articles with titles like 'BT has zonelabs' firewall', 'BT is choppy', 'Re: BT has zonelabs', 'bt has great help', 'bt is fast', 'bt', 'BT', 'dsl cxi', 'dns', and 'uquig'.

Figure 9: A sample Search Results page from BT for the word bt
As the user navigates the site, our system allows the user the ability to track his navigation history. Not only is this a useful tool to navigate the site and go back to a page you recently visited, it lets the user see how the different morph pages were chosen and in a different session

what the profile and pages might be like. If a user was happier in a previous morph, he can go back and re-navigate another path to stay in that morph as he uses the site. The search history is essentially a list of non-repeated links as show in Figure 10.

The screenshot shows the BT Broadband Advice Centre website. At the top, there is a navigation bar with links for 'Homepage', 'About BT', 'Site map', and 'Contact us', along with a search box labeled 'Search this Advisor'. On the left side, there are two main menu sections: 'Advocacy' with links for 'COMPARE PLANS', 'ADVICE CENTRE', 'COMMUNITY', and 'LEARNING CENTRE'; and 'Resources' with links for 'BUILD PLAN', 'BID PRICE', 'BROADBAND NEWS', 'BROADBAND RATINGS', 'SPECIAL OFFERS', 'ALTERNATIVES', 'ABOUT THIS SITE', and 'BUY NOW!'. Below the 'Resources' section is a 'My History' section with a 'Close' button and a list of navigation history items, each with a 'Go' button: 'Broadband Home >', 'Compare Plans >', 'Complete Feature List >', 'Compare Plans >', 'Graphical View >', 'Lian's Favorites >', 'Lian's Recommendation >', 'Compare Plans >', 'Graphical View >', 'Compare Plans >', 'Lian's Favorites >', 'Compare Plans >', 'James' Favorites >', 'James' Recommendation >', 'Learning Centre >', 'Broadband Home >', 'Learning Centre >', 'Community >', and 'Compare Plans >'. The main content area is titled 'Welcome to the Broadband Advice Centre' and includes a sub-header 'Broadband Home >' with a description and a 'here' link. Below this are four main sections: 'Compare Plans' (a table of providers), 'Personal Advisor' (featuring James Brown, Publisher), 'Broadband Community' (with an image of people), and 'Learning Centre' (with an image of a woman at a computer). Each section has a 'Go' button at the bottom.

BT Homepage | About BT | Site map | Contact us Search this Advisor

Advocacy
 COMPARE PLANS
 ADVICE CENTRE
 COMMUNITY
 LEARNING CENTRE

Resources
 BUILD PLAN
 BID PRICE
 BROADBAND NEWS
 BROADBAND RATINGS
 SPECIAL OFFERS
 ALTERNATIVES
 ABOUT THIS SITE
 BUY NOW!

★ My History [Close](#)
[Broadband Home >](#)
[Compare Plans >](#)
[Complete Feature List >](#)
[Compare Plans >](#)
[Graphical View >](#)
[Lian's Favorites >](#)
[Lian's Recommendation >](#)
[Compare Plans >](#)
[Graphical View >](#)
[Compare Plans >](#)
[Lian's Favorites >](#)
[Compare Plans >](#)
[James' Favorites >](#)
[James' Recommendation >](#)
[Learning Centre >](#)
[Broadband Home >](#)
[Learning Centre >](#)
[Community >](#)
[Compare Plans >](#)

Welcome to the Broadband Advice Centre
Broadband Home > We provide you with open information about all plans and providers available in your area and customize the user experience to fit your needs. To learn more, click [here](#)

Compare Plans

Provider	Price	Speeds	Reliability	Type
BT	£ 15	256 kb	Great	DSL
Wanadoo	£ 15	512 kb	Average	Satellite
Demon	£ 17	256 kb	Great	DSL
NetServices	£ 22	256 kb	Great	Cable
AOL G	£ 24	256 kb	Good	Cable
Elite UK	£ 24	256 kb	Average	DSL
Atlas	£ 25	512 kb	Great	DSL
AOL P	£ 29	512 kb	Good	Cable

[More >](#) Choose a range of providers [Go ▶](#)

Personal Advisor
James Brown, Publisher 
 As a leader of one of the largest consumer technology magazines in the world, I really have to be on top of whats going on in the Broadband space. Choose an advisor and get a customized assistant to meet your needs [More >](#)
[Listen](#) WATCH

[Next Advisor >](#) Get Advice on Broadband [Go ▶](#)

Broadband Community

 Right Now.
 Share and Consult views [Go ▶](#)

Learning Centre

 Learn about Broadband [Go ▶](#)

Figure 10: Navigation history allows user to look at pages from a previous morph

Advocacy
COMPARE PLANS
ADVICE CENTRE
COMMUNITY
LEARNING CENTRE

Resources
BUILD PLAN
BID PRICE
BROADBAND NEWS
BROADBAND RATINGS
SPECIAL OFFERS
ALTERNATIVES
ABOUT THIS SITE
BUY NOW!

★My History
[Broadband Home >](#)
[Compare Plans >](#)
[Complete Feature List >](#)
[Compare Plans >](#)
[Graphical View >](#)
[Lian's Favorites >](#)
[Lian's Recommendation >](#)
[Compare Plans >](#)
[Graphical View >](#)
[Compare Plans >](#)
[Lian's Favorites >](#)
[Compare Plans >](#)
[James' Favorites >](#)
[James' Recommendation >](#)
[Learning Centre >](#)
[Broadband Home >](#)
[Learning Centre >](#)
[Community >](#)
[Compare Plans >](#)
[Community >](#)
[Broadband Home >](#)
[Community >](#)
[Broadband Home >](#)

BT Broadband

Broadband Video Lecture Series > Check out a great repository of expert testimony. Find out why certain providers stand out and which attributes are critical when choosing broadband access.

Get expert testimony on various topics

Broadband Basics <small>WATCH</small>		A basic guide to broadband and what different features mean. This also explains what the key components are when setting up a broadband connection. *Note: Needs Windows Media player or Real player
Setting up a wireless router <small>WATCH</small>		*Note: Needs Windows Media player or Real player
Advanced Windows Networking <small>WATCH</small>		Share or access your music, files and email using an Internet Browser by making it accessible on your home PC. *Note: Needs Windows Media player or Real player
Setting up home intranet <small>WATCH</small>		*Note: Needs Windows Media player or Real player
Windows vs. Linux <small>WATCH</small>		Pros and Cons of both. *Note: Needs Windows Media player or Real player

Broadband Tools

Advisor <small>Listen</small>		As a leader of one of the largest consumer technology magazines in the world, I really have to be on top of whats going on in this space.	Go ▶
Bid your price		Inspired by the priceline model, tell us what you want and how much you are willing to pay. When providers compete, you win!	Go ▶

Figure 11: A sample video repository created using our system for broadband related topics by BT

The system allows users to easily create a template and store audio or video content. This particularly useful for an online advocacy tool because you want to empower the consumer and give him as much information as possible. For morphing, have a template to create a

morph for users that like multimedia content is important as well. A sample page with videos about broadband and networking is shown in Figure 11. The content of course is provided by the user to populate the template.

Another component that the system is able to handle is a price bidding tool with a similar model as say price-line that lets users provide a maximum price they are willing to pay for broadband service or a related product. The tool is built along the same framework as an advisor tool and lets users configure a plan on the front-end and then has the capability to store on the backend so providers can bid for people's business. The system also has the capability for providers to set thresholds as to the best offer they are willing to provide and automate the process of accepting bids online. Figure 12 shows a sample view of the Bid your Price tool.

- Advocacy
- [COMPARE PLANS](#)
 - [ADVICE CENTRE](#)
 - [COMMUNITY](#)
 - [LEARNING CENTRE](#)

- Resources
- [BUILD PLAN](#)
 - [BID PRICE](#)
 - [BROADBAND NEWS](#)
 - [BROADBAND RATINGS](#)
 - [SPECIAL OFFERS](#)
 - [ALTERNATIVES](#)
 - [ABOUT THIS SITE](#)
 - [BUY NOW!](#)

- ★ My History
- [Broadband Home >](#)
 - [Compare Plans >](#)
 - [Complete Feature List >](#)
 - [Compare Plans >](#)
 - [Graphical View >](#)
 - [Lian's Favorites >](#)
 - [Lian's Recommendation >](#)
 - [Compare Plans >](#)
 - [Graphical View >](#)
 - [Compare Plans >](#)
 - [Lian's Favorites >](#)
 - [Compare Plans >](#)
 - [James' Favorites >](#)
 - [James' Recommendation >](#)
 - [Learning Centre >](#)
 - [Broadband Home >](#)
 - [Learning Centre >](#)
 - [Community >](#)
 - [Compare Plans >](#)
 - [Community >](#)

BT Broadband

[Broadband Plan Comparisons](#) > Welcome!

Compare Broadband Packages

Provider	Price	Speeds	Reliability	Type		
<input type="checkbox"/> BT	£ 15	256 kb	Great	DSL	Buy now	Discuss Info
<input type="checkbox"/> Wanadoo	£ 15	512 kb	Average	Satellite	Buy now	Discuss Info
<input type="checkbox"/> Demon	£ 17	256 kb	Great	DSL	Buy now	Discuss Info
<input type="checkbox"/> NetServices	£ 22	256 kb	Great	Cable	Buy now	Discuss Info
<input type="checkbox"/> AOL G	£ 24	256 kb	Good	Cable	Buy now	Discuss Info
<input type="checkbox"/> Elite UK	£ 24	256 kb	Average	DSL	Buy now	Discuss Info
<input type="checkbox"/> Atlas	£ 25	512 kb	Great	DSL	Buy now	Discuss Info

*The postcode we searched was 02139

*The maximum amount you were willing to pay was \$25

[Click here to print this page](#)

Was this tool helpful? If not, also try [Lian](#) or [Robert](#)

Give us feedback on this tool [here](#)

Also try Video Tutorial

Video

[WATCH](#)



Check out a great repository of expert testimony. Find out why certain providers stand out and which attributes are critical when choosing broadband access.

[Go ▶](#)

Broadband Tools

Bid your price



Inspired by the priceline model, tell us what you want and how much you are willing to pay. When providers compete, you win!

[Go ▶](#)

Figure 12: The answer to a Bid Price query where the maximum amount the user was willing to pay was \$25.

4.5 eCommerce Platform Architecture

The architecture for the eCommerce Platform has 4 key components that can be used to interact with an existing web application or create a new one. The page interpreter accepts all of the pages that can be

tagged based on where they fit into the site's graph of pages, the attribute descriptions and the granularity used to describe each attribute variable, the rules based engine used to describe how attribute values map to existing site pages and their morphs, and finally the update algorithm engine used to update attribute values based on click-stream data, time-spent on each page, choice based user input, and other variables not formalized yet.

4.5.1 Page Interpreter

Used to interact with an existing website and created morphed versions of pages for eCommerce Sites

4.5.2 Attribute Description

The set of attributes used to describe what the page morphing is based on; defined by the site owner

4.5.3 Rule based Engine

Used to describe what page design, flow and user interaction is used based on changing attribute values

4.5.4 Update Algorithm

Bayesian algorithm used to update attribute values based on variance metrics. The attribute values are then used to serve up a morphed page

In the following section, I will try to delve in further into the 4 major components that comprise the platform.

4.5.5 Page Interpreter Description

The page interpreter is the component used first by site and content owners to integrate their existing website and create a morphed version to accommodate variable cognitive style. The page interpreter first requires the graph of the existing eCommerce application as a set of nodes and connections where web pages are nodes and hyperlinks are connections. Each node is essentially tagged with a unique identifier and each set of links from that node are stored in a list. Next, the user creates a set of morphs for each page and describes them using version numbers or any other tags they later use to identify pages in the rules engine. Finally the user is asked to fill in holes in case certain pages from morphed versions are unreachable. What this means is that there should not be any island pages regardless of what version of the set of pages is currently being used and a user must be able to navigate the entire graph. The page interpreter also has a template used for eCommerce applications so that users without existing infrastructure can use our system to quickly create a morphing website to enhance UI experience. When creating a site from scratch the page interpreter simply uses the default tags used to add resources of a unique type and the rules based system is able to tell it based on the update algorithm which morph to serve up next.

The key value of the page interpreter beyond simply tagging existing pages is the capability to take data from a live feed like a relational database and use it to create a useful user experience for different kinds of pages. Following are some examples of the page interpreters' capability of handling structured data and printing it either in a table

format or in a graphical view for users to compare the different options available as was the case with BT's Find Your Plan section

```
/* Utility functions for printing out a traditional table format */
/**
 * Renders a variable dimension matrix as an HTML table using an SQL query.
 */

function renderTable($query) {
include_once("mysql-connect.php");
print "<table>";
$result = mysql_query($query);
    // Display attribute names
    print "<tr>";
    for ($i = 0; $i < mysql_num_fields($result)-7; $i++) {
        $columnMeta = mysql_fetch_field($result, $i);
        if ($columnMeta->primary_key == 1) {
            continue;
        }
        if ($columnMeta->name == "Provider") {
            if ($_SESSION['ia'] >= 0.5) {
                echo "<td> </td>"; }
            print "<td align='center'><input type=hidden value=on name="
.$columnMeta->name . "><b> " . $columnMeta->name . "</b></td>";
            continue;
        }
    }
print "</tr>";

// Print plan attributes
for ($i = 0; $i < mysql_num_rows($result); $i++) {
    print "<tr>";
    $row = mysql_fetch_row($result);
```

```

$numAttributes = count($row);
for ($j = 1; $j < $numAttributes; $j++) {
    print "<td align='center'>". $row[$j] . "</td>";
}
print "</tr>";
}
print "</table>";
}

// Process form input and create dynamic portion of final SQL query

function determineQuery() {

    $planIDQuery = "SELECT providerid FROM plans";
    $providerIDs = mysql_query($planIDQuery);
    $isFirstAddition = true;
    for ($i = 0; $i < mysql_num_rows($providerIDs); $i++) {
        $currentRow = mysql_fetch_row($providerIDs);
        if ($_GET[$currentRow[0]] == "on") {
            if ($isFirstAddition) { $whereConditions .= " WHERE providerid = " .
            $currentRow[0] . " "; }
            else { $whereConditions .= " OR providerid = " . $currentRow[0] . " "; }
        }

        $isFirstAddition = false;
    }
}
return "SELECT * FROM plans $whereConditions order by Price";
}

```

The above example takes a dataset in a sql database and prints out the results in a traditional table format which can easily be customized to provide tables of different size, different content, and additional features or links by adding special cases as necessary.

Following is another example of the page interpreters' capability of handling a graphical view for the same data and print out the graph as bargraphs. Different versions of graphs may be created by simply changing the type of graph desired.

```
include ("jpgraph/jpgraph-1.20.3/src/jpgraph.php");
include ("jpgraph/jpgraph-1.20.3/src/jpgraph_bar.php");

$query = determineQuery();
$result = mysql_query($query);

while($row = mysql_fetch_array($result))
{
    $data[] = $row[2];
    $leg[] = $row[1];
}

$graph = new Graph(540,250,"auto",0,false);
$graph->SetScale("textint");
$graph->img->SetMargin(50,30,50,50);
$graph->AdjBackgroundImage(0.4,0.7,-1); //setting BG type
$graph->SetBackgroundImage("images/blue.jpg",BGIMG_FILLFRAME); //adding
image
$graph->SetShadow();

$graph->xaxis->SetTickLabels($leg);

$bplot = new BarPlot($data);
$bplot->SetFillColor("orange"); // Fill color
$bplot->value->Show();
$bplot->value->SetFont(FF_ARIAL,FS_BOLD);
```

```

$bplot->value->SetColor("black","navy");

$graph->Add($bplot);
$graph->Stroke($_SESSION['temp']);
$_SESSION['temp']++;

$result = mysql_query($query);

while($row = mysql_fetch_array($result))
{
$data2[] = $row[3];
$leg[] = $row[1];
}

$graph = new Graph(540,250,"auto",0,false);
$graph->SetScale("textint");
$graph->img->SetMargin(50,30,50,50);
$graph->AdjBackgroundImage(0.4,0.7,-1); //setting BG type
$graph->SetBackgroundImage("images/blue.jpg",BGIMG_FILLFRAME); //adding
image
$graph->SetShadow();

$graph->xaxis->SetTickLabels($leg);

$bplot = new BarPlot($data2);
$bplot->SetFillColor("yellow"); // Fill color
$bplot->value->Show();
$bplot->value->SetFont(FF_ARIAL,FS_BOLD);

$bplot->value->SetColor("black","navy");

$graph->Add($bplot);
$graph->Stroke($_SESSION['temp']);
$_SESSION['temp']++;

```

```

$result = mysql_query($query);
$i=0;
while($row = mysql_fetch_array($result))
{

$data3[] = $row[4];

if ($data3[$i] == "Bad") {
$data3[$i] =1;
}
else if ($data3[$i] == "Average") {
$data3[$i] =3;
}
else if ($data3[$i] == "Good") {
$data3[$i] =4;
}
else if ($data3[$i] == "Great") {
$data3[$i] =5;
}
$i++;
$leg[] = $row[1];
}

$graph = new Graph(540,250,"auto",0,false);
$graph->SetScale("textint");
$graph->img->SetMargin(50,30,50,50);
$graph->AdjBackgroundImage(0.4,0.7,-1); //setting BG type
$graph->SetBackgroundImage("images/blue.jpg",BGIMG_FILLFRAME); //adding
image
$graph->SetShadow();

$graph->xaxis->SetTickLabels($leg);

```

```

$bplot = new BarPlot($data3);
$bplot->SetFillColor("lightgreen"); // Fill color
$bplot->value->Show();
$bplot->value->SetFont(FF_ARIAL,FS_BOLD);

$bplot->value->SetColor("black","navy");

$graph->Add($bplot);
$graph->Stroke($_SESSION['temp']);
$_SESSION['temp']++;

// include ("jpgraph/jpgraph-1.20.3/src/jpgraph_canvas.php");
include ("jpgraph/jpgraph-1.20.3/src/jpgraph_pie.php");
include ("jpgraph/jpgraph-1.20.3/src/jpgraph_pie3d.php");
$result = mysql_query($query);

while($row = mysql_fetch_array($result))
{

$data4[] = $row[3];
$prov[] = $row[1];
}

$graph = new PieGraph(540, 250);
$graph->SetShadow();
$graph->title-> Set("User selection distribution");
$p1 = new PiePlot3D($data4);
$p1->SetLegends($prov);
$graph->Add( $p1);
$graph->Stroke($_SESSION['temp']);
$_SESSION['temp']++;

header('Location: graph.php');

```

The page interpreter is able to create community discussion boards, basic indexes to make the content searchable and an advisor based tool to allow users to use an online advocacy tool to compare choices. For a complete description of the code used to generate an online advisor or a community discussion forum, and the other features available, please look in the appendix section.

4.5.6 Attribute Description Explanation

This piece of the platform is essential to the morphing infrastructure. At a simplistic level, the attribute description component is a piece that allows users to define attribute values that the website morphs on. For example, a variable definition Xa that defines say impulsive versus patient users may be defined followed by the range of values that variable may take on. Next, based on the thresholds defined, these attributes are used by the rule based engine to map attributes to pages in our system. While it is clear that a user may define any number of attributes used to describe his system, it is not clear what the best method is to store these values. In our first iteration, these variables simply had a range between 0 and 1 with 0.5 being the default value. Based on how the rule based engine updated these values, if the variable was over the 0.5 threshold it was considered on and if was lower than 0.5 it was considered off. As a result, for a set of n attributes we used 2^n morph pages in our system. In the future, there may be thresholds used to have a higher number of ranges per attribute or a whole new scale used to store and infer based on these values. The attribute description is essentially a list of session variables or lists that track everything about the user including data used to morph the site, search and navigation history, and data click-

stream data that is finally stored in the database. Following is an example of click-stream history collected and added to a session list, a format that is followed throughout the system to store session data. For a list of all session variable types available and the user interface component used to create a session variable, please look in the appendix.

```

if (!isset($_SESSION['navcount'])) {
    $_SESSION['navcount'] = 0;
    $_SESSION['arr'][$_SESSION['navcount']] = "<a href=index.php
class='Breadcrumb'><strong> Broadband Home ></a>";
}
else if ($_SESSION['arr'][$_SESSION['navcount']] != "<a href=index.php
class='Breadcrumb'><strong> Broadband Home ></a>"){
    $_SESSION['navcount']++;
    $_SESSION['arr'][$_SESSION['navcount']] = "<a href=index.php
class='Breadcrumb'><strong> Broadband Home ></a>";
}

<?php
for($_SESSION['i']=0;$_SESSION['i']<=$_SESSION['navcount']; $_SESSION['i']++)
{
    echo"<tr>";
    echo"<td bgColor=#D7DEF1><img alt="" height=16 src='images/s.gif'
width='1'></td>";
    echo"<td colSpan='3' bgColor=#D7DEF1><font class='Breadcrumb'>".
$_SESSION['arr'][$_SESSION['i']] ." </font></a></td>";
    echo"</tr>";
} }?>

```


4.5.7 Rule Based Engine Details

Based on the attributes described above, the rule based engine is an open enough system to translate attribute descriptions to page versions or a navigation path through a site. At a basic level, the rule based engine simply translates a set of attribute values to a specific version of a page based on the rules defined. Each page version however has only a specific set of links of connections thereby morphing the navigation path through a site. In addition, different page versions have different page content, page design, and user interface experience in general thereby providing a completely unique and customized experience for each user. What is interesting is the ease with which a site or content owner can use the existing infrastructure of the rule based system and create a morphed site. The rule based engine takes advantage of the pre defined tags from the page interpreter to determine what page to serve up based on the attribute values. When creating the attributes, the user is asked to define thresholds for each attribute and the rule based engine then combines the two to select a page based on a set of attribute values and which page tags they correspond to. After the set up of the page interpreter and the attribute descriptor, the user is required to map attribute thresholds to page tags for the rule based engine to use. Following is a simple example with sample code that might be generated by the rules engine to morph based on a set of attribute threshold for a specific link in a site.

```

    if ($_SESSION['ia'] >= 0.5 && $_SESSION['ip'] >= 0.5 && $_SESSION['iq'] >=
0.5 && $_SESSION['is'] >= 0.5) {
        include("compare/compare1.php");
    } else if ($_SESSION['ia'] >= 0.5 && $_SESSION['ip'] >= 0.5 &&
$_SESSION['iq'] >= 0.5 && $_SESSION['is'] < 0.5) {
        include("compare/compare2.php");
    } else if ($_SESSION['ia'] >= 0.5 && $_SESSION['ip'] >= 0.5 &&
$_SESSION['iq'] < 0.5 && $_SESSION['is'] >= 0.5) {
        include("compare/compare3.php");
    } else if ($_SESSION['ia'] >= 0.5 && $_SESSION['ip'] >= 0.5 &&
$_SESSION['iq'] < 0.5 && $_SESSION['is'] < 0.5) {
        include("compare/compare4.php");

        } else if ($_SESSION['ia'] >= 0.5 && $_SESSION['ip'] < 0.5 &&
$_SESSION['iq'] >= 0.5 && $_SESSION['is'] >= 0.5) {
            include("compare/compare5.php");
        } else if ($_SESSION['ia'] >= 0.5 && $_SESSION['ip'] < 0.5 &&
$_SESSION['iq'] >= 0.5 && $_SESSION['is'] < 0.5) {
            include("compare/compare6.php");
        } else if ($_SESSION['ia'] >= 0.5 && $_SESSION['ip'] < 0.5 &&
$_SESSION['iq'] < 0.5 && $_SESSION['is'] >= 0.5) {
            include("compare/compare7.php");
        } else if ($_SESSION['ia'] >= 0.5 && $_SESSION['ip'] < 0.5 &&
$_SESSION['iq'] < 0.5 && $_SESSION['is'] < 0.5) {
            include("compare/compare8.php");

            } else if ($_SESSION['ia'] < 0.5 && $_SESSION['ip'] >= 0.5 &&
$_SESSION['iq'] >= 0.5 && $_SESSION['is'] >= 0.5) {
                include("compare/compare9.php");
            } else if ($_SESSION['ia'] < 0.5 && $_SESSION['ip'] >= 0.5 &&
$_SESSION['iq'] >= 0.5 && $_SESSION['is'] < 0.5) {
                include("compare/compare10.php");
            } else if ($_SESSION['ia'] < 0.5 && $_SESSION['ip'] >= 0.5 &&
$_SESSION['iq'] < 0.5 && $_SESSION['is'] >= 0.5) {

```

```

        include("compare/compare11.php");
    } else if ($_SESSION['ia'] < 0.5 && $_SESSION['ip'] >= 0.5 &&
$_SESSION['iq'] < 0.5 && $_SESSION['is'] < 0.5) {
        include("compare/compare12.php");

        } else if ($_SESSION['ia'] < 0.5 && $_SESSION['ip'] < 0.5 &&
$_SESSION['iq'] >= 0.5 && $_SESSION['is'] >= 0.5) {
            include("compare/compare13.php");
        } else if ($_SESSION['ia'] < 0.5 && $_SESSION['ip'] < 0.5 &&
$_SESSION['iq'] >= 0.5 && $_SESSION['is'] < 0.5) {
            include("compare/compare14.php");
        } else if ($_SESSION['ia'] < 0.5 && $_SESSION['ip'] < 0.5 &&
$_SESSION['iq'] < 0.5 && $_SESSION['is'] >= 0.5) {
            include("compare/compare15.php");
        } else if ($_SESSION['ia'] < 0.5 && $_SESSION['ip'] < 0.5 &&
$_SESSION['iq'] < 0.5 && $_SESSION['is'] < 0.5) {
            include("compare/compare16.php");
        }

        else {
            include("compare/compare-default.php");
        }
    }
}

```

4.5.8 Update Algorithm Details

Currently we are using a simplistic update algorithm in the backend used to update attribute values based on metrics used including user click-stream data, timestamps on pages, and self select user input. Each page has a unique update value ranging between 0 and 1 used to update each attribute and we will incorporate the amount of time spent on each page to update the attribute value. Each link has an equal weight and the current value of any defined attribute is simply the average of all of the updates applied to the default value of 0.5. In

addition, users may manually update their preference that then maps to a set of values based on thresholds defined to customize their user experience. This simplistic model where each webpage simply fits into a specific cell or version of a page and asymptotically brings you closer to that version based on how often that page is visited in a session, will eventually be replaced with a Bayesian update algorithm that better models which cognitive style best describes the user and what user experience best matches them.

The details of the Bayesian update algorithm are still being worked on will be available in the final system to categorize users and customize a site.

Following is an example of sample code that essentially tracks for a session how the attributes value may vary for a given page as the user navigates the site:

```
// basic averaging
if (!isset($_SESSION['numclicks'])) {
    $_SESSION['numclicks'] = 0;
} else {
    $_SESSION['numclicks']++;
}

$_SESSION['ia'] = (($_SESSION['ia'] * ($_SESSION['numclicks']-1)) + value) /
$_SESSION['numclicks'];
$_SESSION['ip'] = (($_SESSION['ip'] * ($_SESSION['numclicks']-1)) + value2) /
$_SESSION['numclicks'];
$_SESSION['iq'] = (($_SESSION['iq'] * ($_SESSION['numclicks']-1)) + value3) /
$_SESSION['numclicks'];
$_SESSION['is'] = (($_SESSION['is'] * ($_SESSION['numclicks']-1)) + value4) /
$_SESSION['numclicks'];
```

5 Bayesian Algorithm

The Bayesian algorithm not only considers how each page helps us update our assessment of a user's preferred style, it accounts for how the population on the whole is using the site to see which attributes are more telling when updating our assessment of a user to morph the user experience.

Notation

Let $\vec{\beta}$ = vector of cognitive-style constructs linked to the click-stream data

\vec{y}_k = vector indicating the click chosen at the k^{th} opportunity. We code \vec{y}_k as a vector with a "1" if an option is clicked and a "0" if it is not clicked.

\vec{e}_k = vector of measurement errors for the k^{th} set of clicks.

\vec{X}_{kj} = vector of characteristics (defined below) for the j^{th} option within the k^{th} option set

w_{kj} = "utility" of the j^{th} option within the k^{th} option set

\bar{v}_o = population mean for \bar{v}

p = number of choice alternatives

We observe k opportunities of clicks on the vector y with j choice alternatives. For each k^{th} choice occasion the latent utility u_{kj} is present.

Probit Model

$$w_{kj} = \vec{\beta}' \vec{X}_{kj} + e_{kj} \quad \text{where } e_{kj} \sim N(0, \Sigma) \quad (1)$$

$$y_k = j \text{ if } w_{kj} > w_{k-j}$$

Each regression equation in (1) presents the utility of option j at a specific occasion. A given area j of the site will be clicked if its utility is higher than other area's utility i.e., if it has a better "fit" to user's cognitive style.

Parameters to be estimated: $\vec{\beta}$, A, Σ

Priors

$$\vec{\beta} \sim N(\vec{\beta}_0, A) \quad A \sim IW(a_0 + n, (A_0 + \sum (\beta_i - \vec{\beta})(\beta_i - \vec{\beta})))$$

$$\Sigma \sim IW(nu, V)$$

Values

$A_0 = \begin{bmatrix} 0.01 & 0 & 0 & 0 \\ 0 & 0.01 & 0 & 0 \\ 0 & 0 & 0.01 & 0 \\ 0 & 0 & 0 & 0.01 \end{bmatrix}$	$\Sigma_0 = \begin{bmatrix} 1 & 0.05 \\ 0.05 & 1 \end{bmatrix}$
$a_0 = p+2$	$p = 3$ (three alternatives of click areas)
$\beta_0 = (0, 0, 0, 0)$	$\vec{\beta}_0 = (0, 0, 0, 0)$
$\beta^{true} = (-1, 1, 1, 2)$	$nu = p+2$

$V = \nu + \text{diag}(p-1)$	Keep = 1 (i.e., keep every 1 draw)
------------------------------	------------------------------------

The Bayesian algorithm used in our development was created by Phd student Gui Liberali. The key goal behind the algorithm is to recognize that given a set of morphs and a site's layout, some features are more likely to be clicked. By accounting for how the whole population behaves on average, the system is able to continuously update the utility of each click in terms of how much weight it should have towards changing the morph value and moving the user to a different cell than the one he or she is currently in.

6 Data Collection and Compression for analysis

One key issue is to be able to look back and analyze existing data based on apache logs or session data to really understand user behavior and whether putting a user in a specific cell really helped their user experience. For an older project under Glen Urban from GM, I compressed some apache logs so that a user may be able to look at it and look at it and notice trends or patterns by writing a simple perl script on a manageable amount of data. A similar approach will be needed when BT's data is analyzed. Sample code of how the data compression was done is attached.

```
import java.io.*;
import java.*;
import java.lang.*;
import java.util.HashSet;
import java.util.StringTokenizer;
```

```

public class converter_tester {

    public static void main(String[] args) throws IOException {

        // the input and output files used
        // name the files appropriately or coverter_tester will throw an IO
Exception
        File inputFile = new File("read_test.txt");
        File outputFile = new File("outagain2.txt");

        // read in the input file
        FileReader inputReader = new FileReader(inputFile);
        BufferedReader myReader = new BufferedReader(inputReader);

        // used to write to the output
        FileWriter out = new FileWriter(outputFile);

        // line is used to temporarily store each line read from the input file
        String line;

        // the hashset is used to check whether a url is new or part of a run
        HashSet set = new HashSet();

        // read in all commented lines from inputfile
        myReader.readLine();
        myReader.readLine();
        myReader.readLine();
        myReader.readLine();

        // while lines exist
        while ((line = myReader.readLine()) != null) {

            // create a string tokenizer from the input line

```



```

StringTokenizer tokens = new StringTokenizer(line);

// extract date and time
String date = tokens.nextToken();
String time = tokens.nextToken();

// extract url
String url = tokens.nextToken();

// is the first line of the file?
if (set.isEmpty()) {
    out.write(date);
    out.write(" , ");
    out.write(time);
    out.write(" , ");
    set.add(url);
    out.write(url);
    out.write(" , \r\n");
}

// is the url unique or it part of a run?
else if (!set.contains(url)) {
    if (!url.equals("-")) {
        out.write(date);
        out.write(" , ");
        out.write(time);
        out.write(" , ");
        set.clear();
        set.add(url);
        out.write(url);
        out.write("\r\n");
    }
}
}

```

```
    }  
  
    // close everything  
    myReader.close();  
    inputReader.close();  
    out.close();  
}  
  
}
```

7 Performance metrics going forward

The key measure of performance for this system is a market research study with British Telecom in the spring to see if our system can markedly improve user experience and help people find what product or service they are looking for. Our system should be easily usable and self explaining in terms of putting the different components together to create a morphing system. The next big question we will answer is whether morphing adaptive systems actually improve user experience for a web application or if the current model one size fits all is still the better approach. All of our objectives will be measured in a set of surveys to a test audience on the pros and cons of a morphing system versus the basic original website.

8 Future Research

Going forward, one key step is to try out the morphing system on more web applications to see how it works and how providing a customized user experience for different sets of users adds value. We are testing our system on a Broadband health advocate site that will

help users find a medical coverage plan that best suits their needs from the myriad choices available. Also, we will morph sites on many other attributes to see what kinds of differences are important in providing customized journeys. Suruga bank of Japan for example, is signed up for a project that will provide cultural morphing across different geographies to see whether people in different parts of the globe prefer different ways to interact with their site online.

9 Conclusions

We have created a customizable eCommerce system that can easily be used with existing web applications and architectures to provide customized page design, content and user interaction to help users easily navigate, find, and purchase the content they are looking for. Since web users have varying amounts of specific domain knowledge and different personality types, providing an infrastructure that can account for these differences and serve up a unique web experience for each individual will greatly enhance their user experience on any given website. In addition, the ability to easily track user behavior via click-stream and session specific data as they navigate to measure whether a particular morph was successful has also been created.

10 My Experience

I really enjoyed working with Professor Glen Urban on this BT project. He is a joy to work with and is one of the nicest people I have ever met. He provided great leadership for our team and was always energetic and encouraging. I would also like to thank Tilli Kalisky, Min Zhang, Gui Liberali, and everyone at British Telecom for their contributions and support. Working with a sponsor in BT.com was very

exciting because our team got the chance to interact with seasoned executives to deliver a cutting edge research that can have strong impact on their brand. BT was always understanding and supportive and gave us a lot of freedom to come up with unique and creative solutions.

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