1-1-2007

Implementation of meta search engine with different rank aggregation algorithms

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Implementation of Meta Search Engine With Different Rank Aggregation Algorithms

By

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A Project

Presented to Ryerson University

In partial fulfillment of the

requirements for the degree

Master of Engineering

In the Program of

Electrical and Computer Engineering

Toronto, Ontario, Canada, 2007

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Acknowledgement

I am deeply indebted to my supervisors Dr. Farah Mohammadi and Dr. Cherie Ding to have helped me complete this thesis and guided me through various stages of complexities and my tough time table.

I would also like to express my gratitude to all those who gave me the opportunity to complete this thesis even morally and not exactly technically.

And lastly all my thanks go to Ryerson University in providing a superb means to my educational goals.

Abstract

The development of a Meta Search engine has been described and the ranking of the queries has been accomplished by implementing four rank aggregation algorithms.

Meta Search Engine is used to combine different lists for the same query by different search engines into a single list so as to return the most relevant results with a wider coverage in the quickest possible time.

The performance improvement is achieved by testing four rank aggregation algorithms namely:

1) Linear
2) Exponential
3) Borda Fuse
4) Condorcet Fuse

The efficiency of each algorithm in terms of accuracy and time has been compared.

Table of Contents

List of Figures

1. Introduction

1.1 Background

Meta Search Engine is a conglomeration of several engines for efficient and relevant searches. In its simplest form, a meta search engine takes as input the *n* ranked lists output by each of *n* search engines in response to a given query. It then computes a single ranked list as output, which is usually an improvement over any of the input lists, post-processing and value-adding stage. Meta search offers a systematic way of incorporating all of the various types of evidence available to a search engine. Fusion techniques have the potential of combining effectively the information contained in disparate components. For example, for the problem of webpage retrieval, there are many sources of information: each page has text, in-links, out-links, images, tags, keywords, and structure tags. For each of these elements, numerous indexing and searching algorithms may exist [10, 11, 12, 13]. Meta search can elegantly incorporate all of this information by merging the results of specialized sub-engines. In the case of internal meta search, relevance scores are likely available, but in external meta search often only ranks are available. But perhaps the biggest distinction between internal and external meta search is the amount of overlap among the document sets of the input systems. Meta search offers several advantages over traditional monolithic approaches to retrieval. First, meta search improves upon the performance of

individual search engines because different retrieval methods often return very different irrelevant documents, but many of the same relevant documents [1]. Second, meta search provides more consistent and reliable performance than individual search engines. Since meta search aggregates the advice of several systems, the fusion tends to smooth out the idiosyncrasies of any one system, yielding a more reliable search system [2]. Third, the meta search architecture is inherently modular. A highly specialized "sub-engine" module can be developed and fine-tuned for each information source about the documents in the collection (such as word frequencies, textual structure within a document, hyperlink structure between documents, etc.). Each sub-engine could be used alone as a search engine. But, by querying all the engines in parallel and combining their results using meta search, performance is improved. Finally, meta search leads to focused ranking algorithms that can take advantage of novel, highly specific information sources within documents. One can use a standard meta search algorithm to fuse the different search results with standard ranking techniques. If the fused result significantly improves upon the standard techniques alone, then they have indeed tapped a source of novel information [3].

The improvement of a Meta-Search engine has been described and the ranking of the queries have been accomplished by implementing

four search based algorithms: Linear, Exponential, Borda Fuse and Condorcet Fuse. The efficiency of each algorithm in terms of accuracy and time has been compared.

1.2 Thesis Objectives

The main objective of the thesis is to improve the query search results by combining different results from different search engines and returning the results in a highly prioritized fashion by using different rank aggregation algorithms.

The development platform is chosen to be Microsoft and .Net framework was used to develop the search engine ,C# for its expeditiousness and ease of use with the web services has been chosen as the development language and web service interfaces from different search engines are consumed for utilizing their functionalities from within the Meta-Search Engine.

The project was developed using Asp.net web services and C# as the main development language .The search engines used are Yahoo and MSN of which the web services are available on their respective web sites mentioned later in the thesis.

1.3 Thesis Outline

In this research I have attempted to provide coverage of important subjects required for Software Development of Meta Search Engine. Chapter 3 describes the work which has already been done in the field of meta search engine and a gist of each algorithm which is to be implemented has been highlighted. Chapter 4 describes the motivation behind the thesis work. Within this chapter I have described the various technologies used in the development of the meta search engine. Furthermore, the working of each algorithm has been elaborated.

Chapter 5 describes the results obtained from the meta search engine and the comparison of the performance of the meta search engine with Top Ten Precision method has been shown further in the Analysis section. Ultimately, conclusion and future works have been implied.

2. Related Work

The use of data fusion to combine document retrieval results has been active in Information Retrieval (IR) research since 1972 when Fisher and Elchesen showed that document retrieval results were improved by combining the results of two Boolean searches: one over the title words of the documents, and one over manually-assigned index terms [3].

Various algorithms have been created to improve the ranking of search engines. But the four best algorithms from my observation are stated here viz.

1) Linear Algorithm

2) Exponential Algorithm

3) Borda Fuse Algorithm

4) Condorcet Fuse Algorithm

2.1 Linear Algorithm

The Linear algorithm is the simplest algorithm and is based on the linear combination of the query results from n number of search engines.

The query is ranked the highest by this method which has the greatest relevant rank on addition of the sub ranks from all the search engines used.

2.2 **Exponential** Algorithm

As the term implies instead of adding linearly we will add the ranks from different search engines exponentially as there is an exponential term in the calculation.

2.3 **Borda** Algorithm

The Borda count is the central representative of one class of voting procedures: positional algorithms. The Borda count is perhaps the most sensible positional voting procedure. In the Borda count, for each voter, the top candidate receives n points (if there are n candidates in the election), the second candidate receives $n-1$ points, and so on [3].

2.4 **Condorcet** Algorithm

The Condorcet-fuse model here is based on the other major class of voting procedures: majoritarian algorithms.

The Condorcet voting algorithm is a majoritarian method which specifies that the winner of the election is the candidate(s) that beats or ties with every other candidate in a pair-wise comparison.

2.5 Summary

In this chapter we have seen the improvement of ranking of the meta search algorithm by using different algorithms such as

- Linear: the ranking is done on the basis of linear fashion
- Exponential : the ranking is done with an exponential component added to the linear algorithm
- Borda Fuse: ranking is carried out more or less like a linear algorithm but much faster due to less overhead in the calculation and depends on the number of voters
- Condorcet Fuse: ranking is conducted on the basis of frequency of ranks rather than the frequency of votes.

3. Methodology

First I would like to give some explanation on the .Net technologies being used for the development of the engine and then I would elaborate on the working principle of the algorithms being implemented with some examples for each for their clarity.

3.1 .Net Framework

The .NET Framework is Microsoft's managed code programming model for building applications on Windows clients, servers, and mobile or embedded devices. Developers use .NET to build applications of many types: Web applications, server applications, smart client applications, console applications, database applications, and more.

.Net platform is the integration of various development languages but the core languages are:

1. C#.Net
2. VB.Net
3. J#.Net

3.2 C#.Net

C# is a simple, type-safe, object oriented, general-purpose programming language. Visual C# provides code-focused developers with powerful tools and language support to build rich, connected web and client applications on the .NET Framework.

3.3 ASP.Net

ASP.NET is a web application framework marketed by Microsoft that programmers can use to build dynamic web sites, web applications and XML web services. It is part of Microsoft's .NET platform and is the successor to Microsoft's Active Server Pages (ASP) technology. ASP.NET is built on the Common Language Runtime, allowing programmers to write ASP.NET code using any Microsoft .NET language.

3.4 Characteristics

ASPX is a text file format used to create Web form pages; in programming jargon, the ASPX file typically contains static HTML or XHTML markup, as well as markup defining Web Controls and Web User Controls where the developers place all the required static and dynamic content for the web page. Additionally, dynamic code which runs on the server can be placed in a page within a block <% -- dynamic code -- %> which is similar to other web development technologies such as PHP, JSP, and ASP, but this practice is generally frowned upon by Microsoft except for the purposes of data binding since it requires more calls when rendering the page.

The method recommended by Microsoft for dealing with dynamic program code is to use the code-behind model, which places this

code in a separate file or in a specially designated script tag. Code-behind files are typically named something to the effect of MyPage.aspx.cs or MyPage.aspx.vb based on the ASPX file name (this practice is automatic in Microsoft Visual Studio and other IDEs). When using this style of programming, the developer writes code to respond to different events, like the page being loaded, or a control being clicked, rather than a procedural walk through the document.

ASP.NET aims for performance benefits over other script-based technologies (including ASP Classic) by compiling the server-side code to one or more DLL files on the web server. This compilation happens automatically the first time a page is requested (which means the developer need not perform a separate compilation step for pages). This feature provides the ease of development offered by scripting languages with the performance benefits of a compiled binary. However, the compilation might cause a noticeable delay to the web user when the newly-edited page is first requested from the web server.

The ASPX and other resource files are placed in a virtual host on an Internet Information Services (or other compatible ASP.NET servers; see Other Implementations, below). The first time a client requests a page, the .NET framework parses and compiles the file(s) into a .NET assembly and sends the response; subsequent

requests are served from the DLL files. By default ASP.NET will compile the entire site in batches of 1000 files upon first request. If the compilation delay is causing problems, the batch size or the compilation strategy may be tweaked.

Developers can also choose to pre-compile their code before deployment, eliminating the need for just-in-time compilation in a production environment.

The Core technology to use search engines facilities lies in the web-service which is consumed in the form of WSDL interfaces provided by different search engines.

3.5 Web-Services

The W3C defines a Web service (many sources also capitalize the second word, as in Web Services) as "a software system designed to support interoperable Machine to Machine interaction over a network." Web services are frequently just Web APIs that can be accessed over a network, such as the Internet, and executed on a remote system hosting the requested services. The main language used for communication is XML.

3.5.1 XML

- XML stands for EXtensible Markup Language
- XML is a markup language much like HTML
- XML was designed to describe data

- XML tags are not predefined. You must define your own tags
- XML uses a Document Type Definition (DTD) or an XML Schema to describe the data
- XML with a DTD or XML Schema is designed to be self-descriptive

The Main Difference between XML and HTML

XML was designed to carry data and it's not a replacement for HTML (Hyper Text Mark-up Language).

XML and HTML were designed with different goals:

XML was designed to describe data and to focus on what data is. HTML was designed to display data and to focus on how data looks.

HTML is about displaying information, while XML is about describing information.

The W3C Web service definition encompasses many different systems, but in common usage the term refers to clients and servers that communicate using XML messages that follow the SOAP (Simple Object Architecture Protocol) standard. Common in both the field and the terminology is the assumption that there is also a machine readable description of the operations supported by the server written in the **Web Services Description Language** (WSDL). The latter is not a requirement of a SOAP *endpoint*, but it is a prerequisite for automated client-side code generation in the mainstream Java and .NET SOAP frameworks. Some industry

organizations, such as the WS-I, mandate both SOAP and WSDL in their definition of a Web service.

3.5.2 Specifications

Core specifications

The specifications that define Web services are intentionally modular, and as a result there is no one document that contains them all. Additionally, there is neither a single, nor a stable set of specifications. There are a few "core" specifications that are supplemented by others as the circumstances and choice of technology dictates, including:

SOAP

An XML-based, extensible message envelope format with "bindings" to underlying protocols. The primary protocols are HTTP and HTTPS, although bindings for others, including SMTP and XMPP, have been written.

Web Services Description Language (WSDL)

An XML format that allows service interfaces to be described along with the details of their bindings to specific protocols. Typically used to generate server and client code, and for configuration.

Universal Description Discovery and Integration (UDDI)

A protocol for publishing and discovering metadata about Web services that enables applications to find them, either at design time or runtime.

Most of these core specifications have come from W3C, including XML, SOAP, and WSDL; UDDI comes from OASIS.

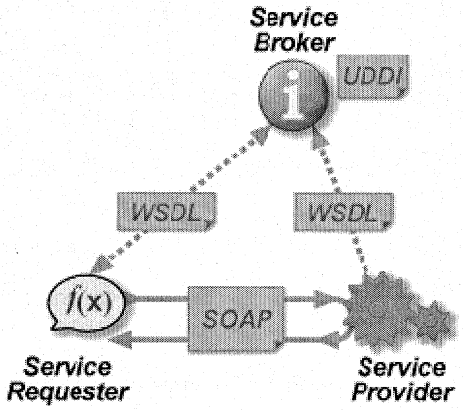

Fig. 3.1: Web services architecture

(http://en.wikipedia.org/wiki/Web_service)

Profiles

To improve interoperability of Web Services, the WS-I publishes profiles. A profile is a set of core specifications (SOAP, WSDL,) in a specific version (SOAP 1.1, UDDI 2, ...) with some additional requirements to restrict the use of the core specifications. The WS-I

also publishes use cases and test tools to help deploying profile compliant Web Service.

Additional specifications, WS-*

Some specifications have been developed or are currently being developed to extend Web Services capabilities. These specifications are generally referred to as WS-*. Here is a non exhaustive list of these WS-* specifications.

WS-Security

Defines how to use XML Encryption and XML Signature in SOAP to secure message exchanges, as an alternative or extension to using HTTPS to secure the channel.

WS-Reliability

An OASIS standard protocol for reliable messaging between two Web services.

WS-Reliable Messaging

A protocol for reliable messaging between two Web services, issued by Microsoft, BEA and IBM. It is currently being standardized by the OASIS organization.

WS-Addressing

A way of describing the address of the recipient (and sender) of a message, inside the SOAP message itself.

WS-Transaction

A way of handling transactions.

Some of these additional specifications have come from the W3C. There is much discussion around the organization's participation, as the general Web and the Semantic Web story appear to be at odds with much of the Web Services vision. This has surfaced most recently in February 2007, at the Web of Services for the Enterprise workshop. Some of the participants advocated a withdrawal of the W3C from further WS-* related work, and a focus on the core Web.

Styles of use

Web services are a set of tools that can be used in a number of ways. The three most common styles of use are RPC (Remote Procedural Call), SOA (Service Oriented Architecture) and REST (Representational State Transfer).

Remote procedure calls

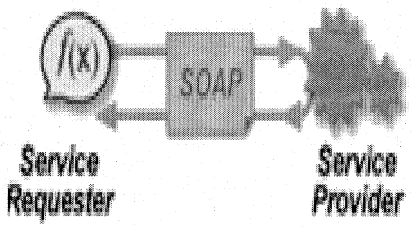

Fig. 3.2: Architectural elements involved in the XML

(http://en.wikipedia.org/wiki/Web_service)

RPC Web services present a distributed function (or method) call interface that is familiar to many developers. Typically, the basic unit of RPC Web services is the WSDL operation.

The first Web services tools were focused on RPC, and as a result this style is widely deployed and supported. However, it is sometimes criticized for not being loosely coupled, because it was often implemented by mapping services directly to language-specific functions or method calls. Many vendors felt this approach to be a dead end, and pushed for RPC to be disallowed in the WS-I Basic Profile.

Service-oriented architecture

Web services can also be used to implement architecture according to Service-oriented architecture (SOA) concepts, where the basic unit of communication is a message, rather than an operation. This is often referred to as "message-oriented" services.

SOA Web services are supported by most major software vendors and industry analysts. Unlike RPC Web services, loose coupling is more likely, because the focus is on the "contract" that WSDL provides, rather than the underlying implementation details.

Representational state transfer

Finally, RESTful Web services attempt to emulate HTTP and similar protocols by constraining the interface to a set of well-known,

standard operations (e.g., GET, PUT, DELETE). Here, the focus is on interacting with stateful resources, rather than messages or operations.

RESTful Web services can use WSDL to describe SOAP messaging over HTTP, which defines the operations, or can be implemented as an abstraction purely on top of SOAP (e.g., WS-Transfer).

WSDL version 2.0 offers support for binding to all the HTTP request methods (not only GET and POST as in version 1.1) so it enables a better implementation of RESTful Web services . However support for this specification is still poor in software development kits, which often offer tools only for WSDL 1.1.

Criticisms

Critics of non-RESTful Web services often complain that they are too complex and biased towards large software vendors or integrators, rather than open source implementations.

One big concern of the REST Web Service developers is that the SOAP WS toolkits make it easy to define new interfaces for remote interaction, often relying on introspection to extract the WSDL and service API from Java or C# code. This is viewed as a feature by the SOAP stack authors (and many users) but it is feared that it can increase the brittleness of the systems, since a minor change on the server (even an upgrade of the SOAP stack) can result in different WSDL and a different service interface. The client-side classes that

can be generated from WSDL and XSD descriptions of the service are often similarly tied to a particular version of the SOAP endpoint and can break if the endpoint changes or the client-side SOAP stack is upgraded. Well designed SOAP endpoints (with handwritten XSD and WSDL) do not suffer from this but there is still the problem that a custom interface for every service requires a custom client for every service.

There are also concerns about performance due to Web services' use of XML as a message format and SOAP and HTTP in enveloping and transport. At the same time there are emerging XML parsing/indexing technologies, such as VTD-XML, that promise to address those XML-related performance issues.

The Web Services for our project can be obtained from the following web sites:

MSN

http://soap.search.msn.com/webservices.asmx?wsdl

Yahoo

http://api.search.yahoo.com/ContentAnalysisService/V1/termExtraction

3.5.3 Summary

In this chapter the method of constructing a web search engine has been described.

The salient features of .Net Framework technologies such as C#.Net and ASP.net have been highlighted. The characteristics of ASP.Net have been delineated. The web services and its constituent elements such as XML, SOAP, WSDL and RPC have also been detailed.

4. Algorithms Working Explanation

The working of algorithms mathematically is described in the light of actual results retrieved from meta search engine using some specific query with Yahoo and MSN search engines.

4. 1 Linear

A score is assigned to each document. It is the length of the result list minus document position, then we will calculate a sum which is taken over all constituent search engine

$$S_f(d) = \sum_i \alpha_i s_i(d)$$

Where α_i is the weight of the data source [5]

and S(d) is the score for each element.

Example:

Search Engine =YAHOO

Query ="ASP.Net"

[1] www.asp.net

[2] ajax.asp.net

[3] weblogs.asp.net/scottgu

[4] weblogs.asp.net

[5] www.asp.net/ajax/ajaxcontroltoolkit/samples

[6] weblogs.asp.net/mschwarz

[7] www.asp.net/learn/videos/default.aspx?tabid=63

[8] weblogs.asp.net/scottgu/.../vs-2008-and-net-3-5-beta-

2-released.aspx

[9] weblogs.asp.net/scottgu/archive/2005/06/28/416185.aspx

[10] www.asp.net/learnmore

Search Engine =MSN

Query ="ASP.Net"

[1] forums.asp.net/default.aspx

[2] www.asp.net

[3] weblogs.asp.net

[4] ajax.asp.net

[5] en.wikipedia.org/wiki/ASP.NET

[6] quickstarts.asp.net

[7] www.microsoft.com

[8] beta.weblogs.asp.net

[9] www.hotscripts.com/ASP.NET/index.html

[10] www.discountasp.net

where [1], [2], [3]...are the actual rankings from the search engine.

Calculation

YAHOO

Length of the list =10

Score s (d) for the link www.asp.net =10-1=9

MSN

Length of the list =10

Score s (d) for the link www.asp.net =10-2=8

Total score =9+8=17

4.2 Exponential

This is similar to Linear method, we multiply the score by a exponential function

(Score (p) = $\sum_i \{1-((-1)/\exp^{rank_i(p)})\}$

Where p is the page and rank $rank_i(p)$ is the ranking of the page p in list and exp is the exponential term [5].

4.3 Borda Fuse

Borda-fuse is based on an optimal voting procedure, the Borda Count which is described in detail below.

We describe our first model for the meta search problem which is based on election strategies. We begin by describing the corresponding problem of voting.

Voting Model

Voting procedures can be considered data fusion algorithms since they combine the preferences of multiple "experts". Many voting procedures, including plurality voting, instant run-off, and approval voting are not directly applicable to the problem of meta search: they assume a few candidates, many-voters scenario. In meta search we have the opposite: many candidates and relatively few voters. The Borda Count voting algorithm, however, is applicable even when the number of voters is small. Interestingly, it has recently been shown that the Borda Count is optimal in the sense that only the Borda Count satisfies all of the symmetry properties that one would expect of any reasonable election strategy. The Borda Count works as follows. Each voter ranks a fixed set of c candidates in order of preference. For each voter, the top ranked candidate is given c points; the second ranked candidate is given $c-1$ points, and so on. If there are some candidates left unranked by the voter, the remaining points are divided evenly among the unranked candidates. The candidates are ranked in order of total points, and the candidate with the most points wins the election. There is a direct analogy between multi-candidate election strategies and the problem of meta search: the set of retrieved documents are the "candidates", and the input retrieval systems are "voters" expressing preferential rankings among these candidates. Applied in this fashion, the Borda Count can be used to combine the

ranked lists returned by multiple retrieval systems. No relevance scores are required, no training data is required, and the combination algorithm is simple and efficient. Furthermore, our experiments detailed below demonstrate that the performance of the Borda Count is quite good. Researchers outside the field of Information Retrieval have also used the Borda Count to combine ranked lists. Van Erp and Schomaker[6] experiment with the Borda Count and two variants to combine simulated classifier ranked data for the field of Handwriting Recognition [4] .

Meta-search algorithms based on the Borda Count have a number of advantages:

(1) They require no training data;

(2) They do not require relevance scores; and

(3) They are surprisingly simple and efficient. Our experiments with *Borda-fuse* show that its performance is competitive with even the best existing meta search strategies which typically require access to relevance scores which are not often available [4].

Example:

Yahoo

[1] www.asp.net

[2] Ajax.asp.net

[3]weblogs.asp.net/scottgu

[4] Weblogs.asp.net

[5]www.asp.net/ajax/ajaxcontroltoolkit/samples

[6]weblogs.asp.net/mschwarz

[7]www.asp.net/learn/videos/default.aspx?tabid=63

[8]weblogs.asp.net/scottgu/.../vs-2008-and-net-3-5-beta-2-released.aspx

[9]weblogs.asp.net/scottgu/archive/2005/06/28/416185.aspx

[10]www.asp.net/learnmore

MSN

[1]forums.asp.net/default.aspx

[2] www.asp.net

[3] Weblogs.asp.net

[4] Ajax.asp.net

[5]en.wikipedia.org/wiki/ASP.NET

[6] Quickstarts.asp.net

[7] www.microsoft.com

[8] Beta.weblogs.asp.net

[9]www.hotscripts.com/ASP.NET/index.html

[10] www.discountasp.net

where [1],[2],[3]...are the actual rankings from the search engine.

Calculation

Yahoo

The score for the link www.asp.net is the length of the list=10

MSN

The score for www.asp.net link is =8

4.4 Condorcet Fuse

A Condorcet method is any single-winner election method that meets the Condorcet criterion, that is, which always selects the Condorcet winner, the candidate who would beat each of the other candidates in a run-off election. In modern examples, voters rank candidates in order of preference. There are then multiple, slightly differing methods for calculating the winner, due to the need to resolve circular ambiguities—including the Kemeny-Young method, Ranked Pairs, and the Schulze method.

Condorcet methods are named for the eighteenth century mathematician and philosopher Marie Jean Antoine Nicolas Caritat, the Marquis de Condorcet. Ramon Llull had devised one of the first Condorcet methods in 1299, but this method is based on an iterative procedure rather than a ranked ballot [3].

4.4.1 Voting

In a Condorcet election the voter ranks the list of candidates in order of preference. So, for example, the voter gives a '1' to their

first preference, a '2' to their second preference, and so on. In this respect it is the same as an election held under non-Condorcet methods such as instant runoff voting or the single transferable vote. Some Condorcet methods allow voters to rank more than one candidate equally, so that, for example, the voter might express two first preferences rather than just one.

Usually, when a voter does not give a full list of preferences they are assumed, for the purpose of the count, to prefer the candidates they have ranked over all other candidates. Some Condorcet elections permit write-in candidates but, because this can be difficult to implement, software designed for conducting Condorcet elections often do not allow this option.

4.4.2 Definition

A Condorcet method is a voting system that will always elect the Condorcet winner; this is the candidate whom voters prefer to each other candidate, when compared to them one at a time. This candidate can easily be found by conducting a series of pair wise comparisons. The family of Condorcet methods is also referred to collectively as Condorcet's method. A voting system that always elects the Condorcet winner when there is one is described by electoral scientists as a system that satisfies the Condorcet criterion.

In certain circumstances an election has no Condorcet winner. This occurs as a result of a kind of tie known as a 'majority rule cycle',

described by Condorcet's paradox. The manner in which a winner is then chosen varies from one Condorcet method to another. Some Condorcet methods involve the basic procedure described below, coupled with a Condorcet completion method—a method used to find a winner when there is no Condorcet winner. Other Condorcet methods involve an entirely different system of counting, but are classified as Condorcet methods because they will still elect the Condorcet winner if there is one.

It is important to note that not all single winner, preferential voting systems are Condorcet methods. For example, neither instant-runoff voting nor the Borda count satisfies the Condorcet criterion.

4.4.3 The Social Choice Voting Model

Our inspiration for the meta search model used in this paper comes from the field of ***Social Choice Theory*** which studies voting algorithms as techniques to make group (social) decisions (choice). More specifically, we apply to meta search the ideas from voting algorithms that emerged in the 18*th* century to address the shortcomings of simple majority voting when there are more than two candidates. Their algorithms for voting have been at the center of a large corpus of research in Social Choice in this century.

An *election* is an instance of a voting problem. The input is called a *voting profile*. For example, consider the following profile of a 5 candidate, 10 voter election: [4]

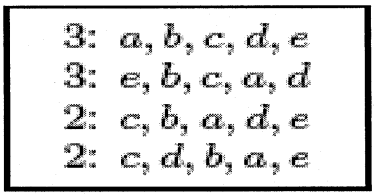

Fig. 4.1: Five candidate profile [3]

In fig. 4.1 a, b, c, d, e are the five candidates and the number beside each row is the number of voters who have ranked the candidates in their own way. For example in the first row three voters have ranked a first, b second, c third, d fourth and e fifth.

A *social choice function* is a function that maps voting profiles to a set of candidates—the winners. For the example profile, the simple majority rule (or *plurality* voting) dictates that candidate *c* wins, since it received four first place rankings, more than any other candidate. Riker [7] distinguishes between majoritarian voting algorithms (which are based on a series of pair wise comparisons of candidates), and *positional* methods (which are based on the ranks a candidate receives.) Positional algorithms compute a score for each candidate based on the positions, or ranks, given to each candidate by the voters. The common plurality algorithm (simple majority), for example, gives one point for each time a candidate is ranked first, and zero points for any other position. The Condorcet voting algorithm is a majoritarian method which specifies that the winner of the election is the candidate(s) that beats or ties with

every other candidate in a pair-wise comparison. In the example profile, candidate *b* is ranked ahead of *c* in six of the ten profiles. Thus in a simple majority run-off election between these two candidates, *b* would receive six of the ten votes cast. Indeed, in this example, *b* beats every other candidate in a head-to-head comparison, so *b* is the Condorcet winner. An important result from the field of Social Choice is May's theorem, which states that in the case of a two candidate election, "majority voting is the only method that is anonymous (equal treatment of all voters), neutral (equal treatment of the candidates), and monotonic (more support for a candidate does not jeopardize its election)" [8]. This lends support to the Condorcet algorithm, since the Condorcet winner is that candidate that wins (or ties in) every possible pair-wise majority contest [4].

N.B Social choice theory studies voting rules for how individual preferences are aggregated to form a collective preference. It dates from Condorcet's formulation of the voting paradox.

4.4.4 Algorithm

The algorithm works as the following:

1: count =0

2: for each of the k search systems S (i) do

3: if S (i) ranks d1 above d2, count++

4: if S (i) ranks d2 above d1, count--

5: If count > 0, rank d1 better than d2

6: Else rank d2 better than d1

In the above algorithm suppose d1 is candidate one and d2 is candidate two. For every search engine a list is generated based on the pair wise comparison. So, for e.g. we will first initialize the counter with '0'. We will then compare one candidate with every other candidate making a pair-wise comparison. If d1 is ranked above d2 then counter is incremented by '1' if not then the counter is decremented by '-1'. Finally, on observing the result of the counter we will decide whether the document is ranked above or below its competitor. So, if the counter is positive then d1 will be ranked above d2 and if not then d2 will be ranked above d1.

Tie rankings are allowed, which express no preference between the tied candidates. Sum these wins for all ballots cast. The candidate with the greatest total wins is the one who is the most preferred, and hence the winner of the election.

In the event of a tie, use a resolution method described below.

A particular point of interest is that it is possible for a candidate to be the most preferred overall without being the first preference of any voter. In a sense, the Condorcet method yields the "best compromise" candidate, the one that the largest majority will find to be least disagreeable, even if not their favorite.

4.4.5 Finding the winner

The count is conducted by pitting every candidate against every other candidate in a series of imaginary one-on-one contests. The winner of each pairing is the candidate preferred by a majority of voters. The candidate preferred by each voter is taken to be the one in the pair that the voter ranks highest on their ballot paper. For example, if Alice is paired against Bob it is necessary to count both the number of voters who have ranked Alice higher than Bob, and the number who have ranked Bob higher than Alice. If Alice is preferred by more voters then she is the winner of that pairing. When all possible pairings of candidates have been considered, if one candidate beats every other candidate in these contests then they are declared the Condorcet winner. As noted above, if there is no Condorcet winner a further method described later must be used to find the winner of the election, and this mechanism varies from one Condorcet method to another.

4.4.6 Counting with matrices

In a Condorcet election votes are often counted, and results illustrated, in the form of matrices such as those below. In these matrices each row represents each candidate as a 'runner', while each column represents each candidate as an 'opponent'. The cells at the intersection of rows and columns each show the result of a

particular pair wise comparison. Certain cells are left blank because it is impossible for a candidate to be compared with herself.

Imagine there is an election between four candidates: A, B, C and D. The first matrix below records the preferences expressed on a single ballot paper, in which the voter's preferences are (B, C, A, D); that is, the voter ranked B first, C second, A third, and D fourth. In the matrix a '1' indicates that the runner is preferred over the 'opponent', while a '0' indicates that the runner is defeated.

		Opponent			
		A	B	C	D
Runner	A	—	0	0	1
	B	1	—	1	1
	C	1	0	—	1
	D	0	0	0	—

A '1' indicates that the runner is preferred over the opponent; a '0' indicates that the runner is defeated.

Fig.4.2: Matrix result for Condorcet

Matrices of this kind are useful because they can be easily added together to give the overall results of an election. The sum of all ballots in an election is called the sum matrix. Suppose that in the imaginary election there are two other voters. Their preferences are (D, A, C, B) and (A, C, B, D). Added to the first voter, these ballots would give the following sum matrix:

		Opponent			
		A	B	C	D
R	A	—	2	2	2
u	B	1	—	1	2
n	C	1	2	—	2
n	D	1	1	1	—
e					
r					

Fig.4.3: Sum Matrix for new Condorcet members

4.4.7 Circular ambiguities

As noted above, sometimes an election has no Condorcet winner because there is no candidate who is preferred by voters to all other candidates. When this occurs the situation is known as a 'majority

rule cycle', 'circular ambiguity' or 'circular tie'. This situation emerges when, once all votes have been added up, the preferences of voters with respect to some candidates' form a circle in which every candidate is beaten by at least one other candidate. For example, if there are three candidates, Andrea, Carter and Delilah, there will be no Condorcet winner if voters prefer Andrea to Carter and Carter to Delilah, but also Delilah to Andrea. Depending on the context in which elections are held, circular ambiguities may or may not be a common occurrence. Nonetheless there is always the possibility of an ambiguity, and so every Condorcet method must be capable of determining a winner when this occurs. A mechanism for resolving an ambiguity is known as ambiguity resolution or Condorcet completion method.

Circular ambiguities arise as a result of the paradox of voting—the result of an election can be intransitive (forming a cycle) even though all individual voters expressed a transitive preference. In a Condorcet election it is impossible for the preferences of a single voter to be cyclical, because a voter must rank all candidates in order and can only rank each candidate once, but the paradox of voting means that it is still possible for a circular ambiguity to emerge.

The idealized notion of a political spectrum is often used to describe political candidates and policies. This means that each candidate

can be defined by her position along a straight line, such as a line that goes from the most right wing candidates to the most left wing, with centrist candidates occupying the middle. Where this kind of spectrum exists and voters prefer candidates who are closest to their own position on the spectrum there is a Condorcet winner (Black's Single-Peakedness Theorem).

In Condorcet methods, as in most electoral systems, there is also the possibility of an ordinary tie. This occurs when two or more candidates tie with each other but defeat every other candidate. As in other systems this can be resolved by a random method such as the drawing of lots.

4.4.8 Two method systems

One family of Condorcet methods consists of systems that first conduct a series of pairwise comparisons and then, if there is no Condorcet winner, fall back to an entirely different, non-Condorcet method to determine a winner. The simplest such methods involve entirely disregarding the results of pairwise comparisons. For example, the Black method chooses the Condorcet winner if it exists, but uses the Borda count instead if there is an ambiguity (the method is named for Duncan Black).

Example

For the query ASP.Net we get the following results with [1], [2], [3]..... [10] being the actual ranking of the documents:

Assume:

A= [1] www.asp.net

B= [2] ajax.asp.net

C= [3]weblogs.asp.net/scottgu

D= [4] weblogs.asp.net

E= [5]www.asp.net/ajax/ajaxcontroltoolkit/samples

F= [6]weblogs.asp.net/mschwarz

G= [7]www.asp.net/learn/videos/default.aspx?tabid=63

H=[8]weblogs.asp.net/scottgu/.../vs-2008-and-net-3-5-beta-2-released.aspx

I= [9]weblogs.asp.net/scottgu/archive/2005/06/28/416185.aspx

K=[10]www.asp.net/learnmore

where [1],[2],[3]...are the actual rankings from the search engine.

x	A	B	C	D	E	F	G	H	I	J
A	-	1	1	1	1	1	1	1	1	1
B	0	-	1	1	1	1	1	1	1	1
C	0	0	-	1	1	1	1	1	1	1
D	0	0	0	-	1	1	1	1	1	1

E	0	0	0	0	-	1	1	1	1	1
F	0	0	0	0	0	-	1	1	1	1
G	0	0	0	0	0	0	-	1	1	1
H	0	0	0	0	0	0	0	-	1	1
I	0	0	0	0	0	0	0	0	-	1
J										

Fig.4.4: In a pair wise comparison link A beats every other candidate in the ranking

4.5 Summary

In this chapter I have described how the algorithms Linear, Exponential, Borda Fuse and Condorcet Fuse work mathematically by supplying a query to the search engine. We get the actual ranking from the search engine which is then modified by each algorithm.

5. Results and Analyses

5.1 Results

First I will show the actual results from both yahoo and msn search engines and then compare them with each of my Meta search results using a manual approach known as "Top 10 precision technique" [9]. Secondly we will see which algorithm queried the results in the smallest possible time.

Query: "Asp.Net"

The following are the results from the Yahoo search engine when the query is "ASP.Net" and 1. 2., 3....are the actual rankings:

1. Microsoft ASP.NET

Official Microsoft site for ASP, the programming framework that enables the development of web applications and services.

www.asp.net - 43k - Cached

2. AJAX: The Official Microsoft ASP.NET Site

Microsoft portal site for the ASP.NET development community. Download Visual Web Developer, post to the forums, read ASP.net blogs and learn about ASP.net.

ajax.asp.net - 28k - Cached

3. ScottGu's Blog

ASP.NET, Visual Studio, ASP.NET 2.0, .NET ... Steps to Uninstall VS 2008 Beta2 before installing the VS 2008 Final Release by ScottGu ...

weblogs.asp.net/scottgu - 47k - Cached

4. ASP.NET Blogs

News and commentary devoted to ASP.NET developments.

weblogs.asp.net - 38k - Cached

5. ASP.NET AJAX Control Toolkit

Welcome to the ASP.NET AJAX Control Toolkit sample website. ... This Toolkit release targets two different versions of the .NET Framework: ...

www.asp.net/ajax/ajaxcontroltoolkit/samples - 13k - Cached

6. Michael's Blog

AJAX library for the Microsoft .NET framework.

weblogs.asp.net/mschwarz - 57k - Cached

7. Videos: The Official Microsoft ASP.NET Site

Microsoft portal site for the ASP.NET development community. ... If you have a bit of development experience, you will learn how to employ some...

www.asp.net/learn/videos/default.aspx?tabid=63 - 52k - Cached

8. VS 2008 and .NET 3.5 Beta 2 Released - ScottGu's Blog

ASP.NET, Visual Studio, ... ScottGu's Blog. Scott Guthrie lives in Seattle and builds a few ... You can alternatively download the smaller VS 2008...

weblogs.asp.net/scottgu/.../vs-2008-and-net-3-5-beta-2-released.aspx - 504k - Cached

9. Atlas Project - ScottGu's Blog

ASP.NET, Visual Studio, ASP.NET 2.0, .NET ... Having reached our ZBB (Zero Bug Bounce), we are now locked down on our feature ...

weblogs.asp.net/scottgu/archive/2005/06/28/416185.aspx - 183k - Cached

10. Get Started: The Official Microsoft ASP.NET Site

Microsoft portal site for the ASP.NET development community. ... ASP.NET can be used to create anything from small, personal websites through to...

www.asp.net/learnmore - 67k - Cached

The following are the results from the MSN search engine when the query is "ASP.Net" :

MSN

1. Forums.asp.net · 23/11/2007 · Cached page

PHP to ASP.NET Migration Assistant Alpha - ASP.NET Forums

Microsoft's Joe Stagner recommends the following books to help with moving to ASP.NET.

forums.asp.net/133.aspx · Cached page

Show more results from forums.asp.net

2. The Official Microsoft ASP.NET Site

Official site maintained by Microsoft with links to information, IBuySpy and other community sites and resources.

www.asp.net · 24/11/2007 · Cached page

Essential Downloads: The Official Microsoft ASP.NET Site

Microsoft portal site for the ASP.NET development community. Download Visual Web Developer, post to the forums, read ASP.net blogs and learn about ASP.net. ... To get started ...

www.asp.net/downloads/essential · Cached page

Show more results from www.asp.net

Blogs - ASP.NET Weblogs

3. Months Free on Award Winning, Developer Ready ASP.NET Web Hosting. ASP.NET 2.0, ASP.NET 1.1; ASP.NET AJAX 1.0; 50+ Free ASP.NET Components; ASP.NET Starter Kit Compatible; MS SQL ...

Weblogs.asp.net · Cached page

"**ASP.NET** 2.0 Web Server Here" Shell Extension - Robert McLaws

... script type="text/javascript"><! -- google_ad_client = "pub-4330602465258980"; google_hints = "ASP.NET, VB.NET, C#, C#.NET, WindowsForms, .NET Framework, VS2005, Visual Studio ...

Weblogs.asp.net/rmclaws/archive/2005/10/25/428422.aspx · Cached page

Show more results from weblogs.asp.net

4. AJAX: The Official Microsoft ASP.NET Site

Microsoft portal site for the ASP.NET development community. Download Visual Web Developer, post to the forums, read ASP.net blogs and learn about ASP.net. ... ASP.NET AJAX is a ...

Ajax.asp.net · 23/11/2007 · Cached page

5. ASP.NET - Wikipedia, the free encyclopedia

ASP.NET is a web application framework marketed by Microsoft that programmers can use to build dynamic web sites , web applications and XML web services

en.wikipedia.org/wiki/ASP.NET · Cached page

Microsoft .NET Framework

6. Ajax.asp.net/default.aspx?tabid=47 · Cached page

7. ASP.NET QuickStart Tutorial

Welcome to the ASP.NET 2.0 QuickStart Tutorial. To access the ASP.NET 1.0 Tutorials hosted at DotNetJunkies.com, click here. The ASP.NET QuickStart is a series of ASP.NET samples...

Quickstarts.asp.net/QuickStartv20/aspnet · Cached page

8. Microsoft Corporation

Main site for product information, support, and news.

www.microsoft.com · Cached page

9. Microsoft Corporation

Main site for product information, support, and news.

www.microsoft.com · Cached page

10. ASP.NET Hosting, ASP .NET Web Hosting, SQL Hosting, Windows Webhosting ...

www.discountasp.net · Cached page

Method Comparison

The results obtained from Linear, Exponential, Borda and Condorcet algorithms are illustrated in **Appendix A.**

5.2 Analyses

Top Ten Precision

This can be defined as "the number of hits by the meta search engine for each algorithm on the search results created by manual observation".

Manual Observation List

1. www.asp.net
2. Ajax.asp.net
3. Weblogs.asp.net
4. forums.asp.net/default.aspx
5. en.wikipedia.org/wiki/ASP.NET
6. www.asp.net/learnmore
7. URL: http://www.asp.net/Default.aspx?tabindex=0&tabid=1
8. www.asp.net/learn/videos/default.aspx?tabid=63
9. http://weblogs.asp.net/scottgu/
10. www.asp.net/ajax/ajaxcontroltoolkit/samples

Calculation

The calculation is done as follows:

With the manual observation list created by an observer with the top ten best answers, we will compare the actual results from each algorithm by noticing the number of hits by each algorithm on the top-ten precision list.

Linear Method

Top Ten Precision=4/10=0.4

Time to execute =0.028486 seconds

Exponential

Top Ten Precision=4/10=0.4

Time to execute =0.0292168 seconds

Borda Fuse

Top Ten Precision=5/10=0.5

Time to execute=0.0287106s

Condorcet Fuse

Top Ten Precision =7/10=0.7

Time to execute=0.0299106s

Summary of the Result in a Table Form

Search Engine	Top Ten Precision	*Execution Time(s)
Query	ASP.net	
Yahoo	0.2	
MSN	0.2	
Algorithm		
Linear	0.4	0.028486
Exponential	0.4	0.0292168
Borda Fuse	0.5	0.0287106
Condorcet Fuse	0.7	0.0299106s

Fig.5.1: Performance comparison of different algorithms with query "ASP.NET"

Please see the **Appendix B** for the query results lists from different search engine and for different algorithms for the query "Bicycling"

Query	**bicycling**	
Yahoo	0.4	
MSN	0.2	
Algorithm		
Linear	0.5	0.029304
Exponential	0.2	0.0327843
Borda Fuse	0.5	0.036975
Condorcet Fuse	0.5	0.0374006

Fig.5.2: Performance comparison of different algorithms with query "bicycling"

***Execution time does not include the time taken by web services to return the results**

5.3 Summary

In this chapter I have compared the performance of each ranking algorithm by calculating "Top-ten precision" [9] and the time taken to execute and also compared yahoo and msn results separately with each algorithm.

6. Conclusion and Future works

We have seen that Meta Search Engine has an excellent performance gain over individual search engines. It provides the best results for any query which are relevant and useful to the user. We have also seen how different algorithms help us in returning the precise results in a different time span. Condorcet Fuse method seems to return the most relevant results while its time of execution is the longest. Followed by Condorcet is Borda, then Linear and finally Exponential.

The future works in this area are being carried out day in and day out by improvising the existing algorithms and inventing new techniques to rank the queries in a better way. Meta search engine is becoming the need of every online user to find a plethora of information in the least possible time.

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Appendix A

Results for the query "ASP.Net" from the Meta Search Engine

Linear Method

[1]Title: The Official Microsoft ASP.NET Site

Description: Official Microsoft site for ASP, the programming framework that enables the development of web applications and services.

URL: http://www.asp.net/

[2]Title: AJAX: The Official Microsoft ASP.NET Site

Description: Microsoft portal site for the ASP.NET development community. Download Visual Web Developer, post to the forums, read ASP.net blogs and learn about ASP.net.

URL: http://ajax.asp.net/

[3]Title: Blogs - ASP.NET Weblogs

Description: News and commentary devoted to ASP.NET developments.

URL: http://weblogs.asp.net/

[4]Title: ScottGu's Blog

Description :ASP.NET, Visual Studio, ASP.NET 2.0, .NET ... Steps to Uninstall VS 2008 Beta2 before installing the VS 2008 Final Release by ScottGu ...

URL: http://weblogs.asp.net/scottgu/

[5]Title: ASP.NET - Wikipedia, the free encyclopedia

Description: ASP.NET is a web application framework marketed by Microsoft that programmers can use to build dynamic web sites , web applications and XML web services

URL: http://en.wikipedia.org/wiki/ASP.NET

[6]Title: Forums - ASP.NET Forums

Description: 3 Months Free Award Winning, Developer ready ASP.NET Web Hosting. Host up to two ASP.NET websites; ASP.NET 2.0, ASP.NET AJAX 1.0; Silverlight Ready! ASP.NET Starter Kit Ready...

URL: http://forums.asp.net/

[7]Title: The Official Microsoft ASP.NET Site

Description: Microsoft portal site for the ASP.NET development community. ... Experience the latest release of the most productive and powerful development...

URL: http://www.asp.net/Default.aspx?tabindex=0&tabid=1

[8]Title: General ASP.NET - ASP.NET Forums

Description: DiscountASP.NET - Voted "Best ASP.NET Host" by asp.netPRO Magazine 3 Years Running ('05, '06, '07) & by Visual Studio Magazine for 2007

URL: http://forums.asp.net/default.aspx?GroupID=7

[9]Title: ASP.NET AJAX Control Toolkit

Description: Welcome to the ASP.NET AJAX Control Toolkit sample website. ... This Toolkit release targets two different versions of the .NET Framework: ...

URL: http://www.asp.net/ajax/ajaxcontroltoolkit/samples/

[10]Title: Microsoft .NET Homepage

Description: General information slanted towards business.

URL: http://www.microsoft.com/net/

[11]Title: Michael's Blog

Description: AJAX library for the Microsoft .NET framework.

URL: http://weblogs.asp.net/mschwarz

[12]Title: Videos: The Official Microsoft ASP.NET Site

Description: Microsoft portal site for the ASP.NET development community. ... If you have a bit of development experience, you will learn how to employ some...

URL: http://www.asp.net/learn/videos/default.aspx?tabid=63

[13]Title: VS 2008 and .NET 3.5 Beta 2 Released - ScottGu's Blog

Description: ASP.NET, Visual Studio,... ScottGu's Blog. Scott Guthrie lives in Seattle and builds a few ... You can alternatively download the smaller VS 2008...

URL: http://weblogs.asp.net/scottgu/archive/2007/07/26/vs-2008-and-net-3-5-beta-2-released.aspx

[14]Title: ASP.NET QuickStart Tutorial

Description: Welcome to the ASP.NET 2.0 QuickStart Tutorial. To access the ASP.NET 1.0 Tutorials hosted at DotNetJunkies.com, click here. The ASP.NET QuickStart is a series of ASP.NET samples...

URL: http://quickstarts.asp.net/QuickStartv20/aspnet/

[15]Title: Atlas Project - ScottGu's Blog

Description: ASP.NET, Visual Studio, ASP.NET 2.0, .NET ... Having reached our ZBB (Zero Bug Bounce), we are now locked down on our feature...

URL:http://weblogs.asp.net/scottgu/archive/2005/06/28/416185.aspx

[16]Title: Hot Scripts :: ASP.NET

Description: Hot Scripts is the net's largest PHP, CGI, Perl, JavaScript and ASP script collection and resource web portal. We are an Internet directory that compiles and distributes Web...

URL: http://www.hotscripts.com/ASP.NET/index.html

Exponential Method

[1]Title: The Official Microsoft ASP.NET Site

Description: Official Microsoft site for ASP, the programming framework that enables the development of web applications and services.

URL: http://www.asp.net/

[2]Title: AJAX: The Official Microsoft ASP.NET Site

Description: Microsoft portal site for the ASP.NET development community. Download Visual Web Developer, post to the forums, read ASP.net blogs and learn about ASP.net.

URL: http://ajax.asp.net/

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URL: http://weblogs.asp.net/scottgu/

[5]Title: The Official Microsoft ASP.NET Site

Description: Microsoft portal site for the ASP.NET development community. ... Experience the latest release of the most productive and powerful development...

URL: http://www.asp.net/Default.aspx?tabindex=0&tabid=1

[6]Title: ASP.NET AJAX Control Toolkit

Description: Welcome to the ASP.NET AJAX Control Toolkit sample website. ... This Toolkit release targets two different versions of the .NET Framework: ...

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Description: Microsoft portal site for the ASP.NET development community. ... If you have a bit of development experience, you will learn how to employ some...

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[10]Title: Atlas Project - ScottGu's Blog

Description: ASP.NET, Visual Studio, ASP.NET 2.0, .NET ... Having reached our ZBB (Zero Bug Bounce), we are now locked down on our feature...

URL:http://weblogs.asp.net/scottgu/archive/2005/06/28/416185.aspx

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Description: DiscountASP.NET - Voted "Best ASP.NET Host" by asp.net PRO Magazine 3 Years Running ('05, '06, '07) & by Visual Studio Magazine for 2007

URL: http://forums.asp.net/default.aspx?GroupID=7

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Description: General information slanted towards business.

URL: http://www.microsoft.com/net/

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Description: Welcome to the ASP.NET 2.0 QuickStart Tutorial. To access the ASP.NET 1.0 Tutorials hosted at DotNetJunkies.com, click here. The ASP.NET QuickStart is a series of ASP.NET samples...

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Borda Fuse

[1]Title: The Official Microsoft ASP.NET Site

Description: Official Microsoft site for ASP, the programming framework that enables the development of web applications and services.

URL: http://www.asp.net/

[2]Title: AJAX: The Official Microsoft ASP.NET Site

Description: Microsoft portal site for the ASP.NET development community. Download Visual Web Developer, post to the forums, read ASP.net blogs and learn about ASP.net.

URL: http://ajax.asp.net/

[3]Title: Blogs - ASP.NET Weblogs

Description: News and commentary devoted to ASP.NET developments.

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[4]Title: ScottGu's Blog

Description :ASP.NET, Visual Studio, ASP.NET 2.0, .NET ... Steps to Uninstall VS 2008 Beta2 before installing the VS 2008 Final Release by ScottGu ...

URL: http://weblogs.asp.net/scottgu/

[5]Title: ASP.NET - Wikipedia, the free encyclopedia

Description: ASP.NET is a web application framework marketed by Microsoft that programmers can use to build dynamic web sites , web applications and XML web services

URL: http://en.wikipedia.org/wiki/ASP.NET

[6]Title: Forums - ASP.NET Forums

Description: 3 Months Free Award Winning, Developer ready ASP.NET Web Hosting. Host up to two ASP.NET websites; ASP.NET 2.0, ASP.NET AJAX 1.0; Silverlight Ready! ASP.NET Starter Kit Ready ...

URL: http://forums.asp.net/

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[8]Title: General ASP.NET - ASP.NET Forums

Description: DiscountASP.NET - Voted "Best ASP.NET Host" by asp.netPRO Magazine 3 Years Running ('05, '06, '07) & by Visual Studio Magazine for 2007

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[9]Title: ASP.NET AJAX Control Toolkit

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[10]Title: Microsoft .NET Homepage

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Description: AJAX library for the Microsoft .NET framework.

URL: http://weblogs.asp.net/mschwarz

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URL: http://www.asp.net/learn/videos/default.aspx?tabid=63

[13]Title: VS 2008 and .NET 3.5 Beta 2 Released - ScottGu's Blog

Description: ASP.NET, Visual Studio,... ScottGu's Blog. Scott Guthrie lives in Seattle and builds a few ... You can alternatively download the smaller VS 2008...

URL: http://weblogs.asp.net/scottgu/archive/2007/07/26/vs-2008-and-net-3-5-beta-2-released.aspx

[14]Title: ASP.NET QuickStart Tutorial

Description: Welcome to the ASP.NET 2.0 QuickStart Tutorial. To access the ASP.NET 1.0 Tutorials hosted at DotNetJunkies.com, click here. The ASP.NET QuickStart is a series of ASP.NET samples...

URL: http://quickstarts.asp.net/QuickStartv20/aspnet/

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URL:http://weblogs.asp.net/scottgu/archive/2005/06/28/416185.aspx

[16]Title: Hot Scripts:: ASP.NET

Description: Hot Scripts is the net's largest PHP, CGI, Perl, JavaScript and ASP script collection and resource web portal. We are an Internet directory that compiles and distributes Web ...

URL: http://www.hotscripts.com/ASP.NET/index.html

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Appendix B

Results for the query "Bicycling" from the search Engine "Yahoo":

Yahoo.com

1-10 of 14,400,000 for bicycling (About) - 0.15 sec

1. Bicycling

   Road and mountain biking magazine. Provides reviews, gear, cycling tips, and training information.

   www.bicycling.com - 63k - Cached

2. Tour de France 2007 at Bicycling Magazine.com

   Complete Tour de France 2007 coverage at Bicycling Magazine. ... up for our newsletter and get Bicycling news and updates delivered to your inbox. ...

   www.bicycling.com/tourdefrance - 49k - Cached

3. Bicycling - About.com

   Learn all about bikes, from beginners to racing pros. Offers chats, forums, and more.

   bicycling.about.com - 37k - Cached

4. WSDOT - Biking in Washington

State Bicycling Laws. State Highway Sections Closed to Bicycles. Sharing Trails with Horses. Tour Planning and Bicycling Maps. Bicycle Tour Operators ...

www.wsdot.wa.gov/bike - 22k - Cached

5. Bicycling Life Home Page

Focuses on the good news about bicycling as a means of transportation and recreation in everyday life.

www.bicyclinglife.com - 18k - Cached

6. bicyclinginfo.org

... and resources they need to create safe places for walking and bicycling. ... If your community is considering building a new bicycle facility, you can use ...

www.bicyclinginfo.org - 23k - Cached

7. Bicycling Magazine Forums - Powered by eve community

Bicycling Rides Forum ... Bicycling Fitness Forum ... Bicycling Training Forum ...

forums.bicycling.com - 94k - Cached

8. Cycling - Wikipedia, the free encyclopedia

... Service has recently introduced bicycling paramedics, who can often get ... which began in 1891, is the oldest bicycling event still run on a regular basis ...

en.wikipedia.org/wiki/Bicycling - 86k - Cached

9. 511.org - Bicycling

Welcome to the Bay Area's resource for bicycling information. Here you'll find the new 511 BikeMapper, route maps, locations of lockers and ...

bicycling.511.org - 16k - Cached

10. City of Phoenix, Arizona, Official Municipal Web site

... the city's most popular bicycling routes parallel water canals, ... bicycling ... Greater Arizona Bicycling Association. Salt River Project's canal map ...

phoenix.gov/DISCOVER/AROUND/BICYCLING/index.html - 22k - Cached

Results for the query "Bicycling" from the Search Engine "MSN":

MSN.com

1. Bicycling Magazine: Bikes, Gear, Training, Reviews, Maintenance

   Bicycling Magazine features bikes, bike gear, equipment reviews, training plans, bike maintenance how tos, and more, for cyclists of all levels. ... Women on Wheels For all of our ...

   - www.bicycling.com/home/0,6608,,00.html?location=_*topnav*
   - · Cached page

2.Bicycling

   How To Take Off And Put On Your Bicycle Wheels

   - video.bicycling.com/embed/iframe/bicycling_recent
   - · Cached page

- Bicycling: Tour de France, Bicycle, Road Biking, Mountain Bike, and ...

  Find and share videos at Bicycling. ... Insane trails, exposed riding and some beautiful scenery help make this montage one of our can't miss videos.

  - video.bicycling.com
  - · 01/12/2007
  - · Cached page
  - Show more results from video.bicycling.com

3. Bicycling Magazine Forums - Powered by eve community

General discussion forum. Note that this particular forum contains subject matter not always appropriate for kids! Be advised.

a. forums.bicycling.com/eve?location=_*topnav*

b. · 02/12/2007

c. · Cached page

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General discussion forum. Note that this particular forum contains subject matter not always appropriate for kids! Be advised.

a. forums.bicycling.com

b. · Cached page

c. Show more results from forums.bicycling.com

4. Bicycling - About.com

Ready to ride? Pedal into a world of cycling with tips and information on bicycle riding, equipment, training and bike culture and more with your About.com Guide to Bicycling ...

a. bicycling.about.com

b. · Cached page

5.Tour de France, Lance Armstrong, Graham Watson, bike maintenance, road ...

Bicycling brings a new book about Lance Armstrong with photos by Graham Watson, Images of a Champion, plus

Graham Watson posters of the Tour de France, Lance Armstrong, and more ...

c. shop.bicycling.com

d. · 02/12/2007

e. · Cached page

6.Bicycling - World's Leading Bike Magazine

Your Christmas Gift Guide 'Tis the season for giving and Bicycling has gone searching far and wide to bring you the latest and fu Read more

f. www.bicycling.co.za

g. · 02/12/2007

h. · Cached page

7.Bicycling Race Event Management

First time user? Click here to Register (you only need to do this once) ATTENTION! EVENT DIRECTORS... Sign up today for the Bicycling Event Series! The Bicycling Event Series is a ...

i. eventseries.bicycling.com

j. · 02/12/2007

k. · Cached page

8. City of Phoenix, Arizona, Official Municipal Web site

A few of the city's most popular bicycling routes parallel water canals, making them smooth and nearly traffic-free. The Arizona Canal path runs all the way from Glendale to the ...

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- · Cached page

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a. www.bicyclinglife.com

b. · Cached page

10. bicyclinginfo.org

... and Bicycle Information Center's purpose is to connect communities with the information and resources they need to create safe places for walking and bicycling.

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[15]Title :Bicycling Magazine

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[16]Title :WSDOT - Biking in Washington

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[17]Title :Grand Canyon National Park - Bicycling Information (U.S. National Park ...

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Description :Learn all about bikes, from beginners to racing pros. Offers chats, forums, and more.

URL :http://bicycling.about.com/

[4]Title :Bicycling Magazine: Bikes, Gear, Training, Reviews, Maintenance

Description :Bicycling Magazine features bikes, bike gear, equipment reviews, training plans, bike maintenance how tos, and more, for cyclists of all levels.

URL :http://www.bicycling.com/home/0,6608,,00.html

[5]Title :The Latest From Floyd - bicycling.com

Description :An exclusive interview with Bicycling.com finds Landis out of post-op, hanging in chat rooms, and back on his bike ... February issue of Bicycling Magazine. ...

URL :http://www.bicycling.com/article/1,6610,s1-3-9-15273-1,00.html

[6]Title :Bicycling Magazine: Bikes, Gear, Training, Reviews, Maintenance

Description :Bicycling Magazine features bikes, bike gear, equipment reviews, training plans, bike maintenance how tos, and more, for cyclists of all levels.

URL

http://www.bicycling.com/0,6608,,00.html?location=_*topnav*

[7]Title :Tour de France 2007 at Bicycling Magazine.com

Description :Complete Tour de France 2007 coverage at Bicycling Magazine. ... up for our newsletter and get Bicycling news and updates delivered to your inbox. ...

URL :http://www.bicycling.com/tourdefrance/0,6805,,00.html

[8]Title :Adios, Discovery - bicycling.com

Description :The owner of the Discovery team announced the team will disband after this year ... About Bicycling | Customer Service | Contact Us| Site Map. CORPORATE: ...

URL :http://www.bicycling.com/article/1,6610,s1-3-12-16357-html

[9]Title :WSDOT - Biking in Washington

Description :State Bicycling Laws. State Highway Sections Closed to Bicycles. Sharing Trails with Horses. Tour Planning and Bicycling Maps. Bicycle Tour Operators ...

URL :http://www.wsdot.wa.gov/bike/

[10]Title :Bicycling Magazine: Bikes, Gear, Training, Reviews, Maintenance

Description :Bicycling Magazine features bikes, bike gear,

equipment reviews, training plans, bike maintenance how tos, and more, for cyclists of all levels.

URL: http://www.bicycling.com/home/

Appendix C

Source Code:

```
using System;
using System.Data;
using System.Configuration;
using System.Web;
using System.Web.Security;
using System.Web.UI;
using System.Web.UI.WebControls;
using System.Web.UI.WebControls.WebParts;
using System.Web.UI.HtmlControls;
using System.IO;

public partial class _Default : System.Web.UI.Page
{

    public static int count=0;
    StringWriter sw = new StringWriter();
    StringWriter sw1 = new StringWriter();
    private const String document
```

```
= "c:\\Test\\yahoo.xml";

private const String document2 = "c:\\Test\\msn.xml";

static int remIndex;

static int i;
ArrayList node2;
ArrayList node;
ArrayList score;

ArrayList intArr;
bool flag = false;
string strOuter;
string var;

ArrayList arrScore ;

ArrayList arrScr ;
ArrayList arrScr1 ;

ArrayList arrScore1 ;
ArrayList arrScr2 ;
ArrayList arrScr3 ;

ArrayList scrFinal ;
```

```
ArrayList arrclone ;
ArrayList arrReCalc;

ArrayList arrRecalc1;
ArrayList arrRecalc2;

string srchVar = "Ryerson.ca";     //default

 protected void Page_Load(object sender, EventArgs e)
 {

     {
         srchVar = TextBox2.Text;
     }

     MSNLive();

     localhost.Service srv = new localhost.Service();
     localhost.ResultSet resultSet
     = new localhost.ResultSet();

    resultSet = srv.MetaSearchResult(srchVar);

     xw1.WriteElementString("website", null);
```

```
        xw1.WriteEndElement();

XmlTextWriter xw = new
XmlTextWriter("c:\\test\\msn2.xml",null);
        xw.Formatting = Formatting.Indented;
        xw.WriteStartElement("root");
        xw.WriteElementString("website", null);
        xw.WriteString(sw.ToString());
        xw.WriteElementString("website", null);
        xw.WriteEndElement();

        sm.Close();
        sm2.Close();
        xw.Close();
        xw1.Close();

    }

     public void MSNLive()
     {

SourceRequest[] sr = new SourceRequest[arraySize];

                sr[0] = new SourceRequest();
                sr[0].Source = SourceType.Web;
```

```
                searchRequest.Query = srchVar;
                searchRequest.Requests = sr;
                searchRequest.AppID                              =
"***********************************";
                searchRequest.CultureInfo = "en-US";
                SearchResponse searchResponse;

                searchResponse = s.Search(searchRequest);

            //     StringWriter sw = new StringWriter();

                foreach (SourceResponse sourceResponse in

                searchResponse.Responses)
                {
Result[] sourceResults = sourceResponse.Results;
foreach (Result sourceResult in sourceResults)
                 {
                        sw.WriteLine("<website>");
                        if  ((sourceResult.Title  !=  null)
&& (sourceResult.Title != String.Empty))
                            sw.WriteLine("<Title>"       +
sourceResult.Title + "</Title>");
                        if  ((sourceResult.Description  !=
null) && (sourceResult.Description != String.Empty))
```

```
                        sw.WriteLine("<Description>"
+ sourceResult.Description + "</Description>");
                    if ((sourceResult.Url != null) &&
(sourceResult.Url != String.Empty))
                        sw.WriteLine("<URL>"          +
sourceResult.Url + "</URL>");
                    sw.WriteLine("</website>");
                }



            }
        }
protected    void    TextBox2_TextChanged(object    sender,
EventArgs e)
    {

    }
protected void Button1_Click(object sender, EventArgs e)
    {

      XmlDocument myXMLDocument = new XmlDocument();
      Stopwatch a = new Stopwatch();

     a.Start();
```

```
Run(document, ref myXMLDocument,this.var);

a.Stop();

double time = a.Elapsed.TotalSeconds;

Response.Write(time);

Directory.CreateDirectory("C:\\RankMethod");

    if(var=="Linear")
    {

File.Copy("C:\\Test\\YahooNew.xml","C:\\RankMethod\\Linea
r\\Yahoonew.xml",true);

    }
    else if (var == "Exponential")
    {
        File.Copy("C:\\Test\\YahooNew.xml",
"C:\\RankMethod\\Exponential\\Yahoonew.xml",true);

    }
    else if (var == "Borda Fuse")
```

```
        {
 File.Copy("C:\\Test\\YahooNew.xml",
"C:\\RankMethod\\Borda Fuse\\Yahoonew.xml",true);

        }
        else if (var == "Condorcet Fuse")
        {
            File.Copy("C:\\Test\\YahooNew.xml",
"C:\\RankMethod\\Condorcet Fuse\\Yahoonew.xml",true);

        }

    }
public    void    Run(String    args,    ref    XmlDocument
myXMLDocument,string varnew)
    {

        XmlDocument myXMLDocument2 = new XmlDocument();

        try
        {

            myXMLDocument.Load(args);
            myXMLDocument.PreserveWhitespace = false;
```

```
XPathNavigator myXPathNavigator =
myXMLDocument.CreateNavigator();


myXPathNavigator.MoveToRoot();

XPathNodeIterator myXPathNodeIterator =
myXPathNavigator.Select("descendant::URL");

            bool edit = myXPathNavigator.CanEdit;


            ArrayList myArray = new ArrayList();

            node = new ArrayList();

            while (myXPathNodeIterator.MoveNext())
            {

myArray.Add(myXPathNodeIterator.Current.Value);
                Console.WriteLine("<" +
myXPathNodeIterator.Current.Name + ">" +
myXPathNodeIterator.Current.Value);


node.Add(myXPathNodeIterator.Current.Value);
```

```
            }



            ArrayList nodnew = new ArrayList();
            int x = node.Count, z = 0;

            for (z = 0; z < x; z++)
            {
                nodnew.Add(node[z].ToString());
                // nodnew = node;
            }

            myXMLDocument2.Load(document2);
            myXMLDocument2.PreserveWhitespace = false;
            XPathNavigator        myXPathNavigator2        =
myXMLDocument2.CreateNavigator();
            myXPathNavigator2.MoveToRoot();
            XPathNodeIterator     myXPathNodeIterator2     =
myXPathNavigator2.Select("descendant::URL");

            bool edit2 = myXPathNavigator2.CanEdit;

            ArrayList arr1 = new ArrayList();
```

```
            node2 = new ArrayList();

            while (myXPathNodeIterator2.MoveNext())
            {

node2.Add(myXPathNodeIterator2.Current.Value);

            }

            int x2 = node2.Count, z2 = 0;

            for (z2 = 0; z2 < x2; z2++)
            {
                arr1.Add(node2[z2].ToString());
                // nodnew = node;
            }


            if (var == "Linear")
            {
                arrScore = Linear(nodnew);

                arrScr = (ArrayList)arrScore[0];
                arrScr1 = (ArrayList)arrScore[1];
```

```
        arrScore1 = Linear(arr1);
        arrScr2 = (ArrayList)arrScore1[0];
        arrScr3 = (ArrayList)arrScore1[1];

        scrFinal = new ArrayList();

        arrclone = new ArrayList();
        arrclone = arrScr;

        scrFinal.Add(arrclone);

        bool flagnew = false;

        int a, y;

        arrReCalc = Linear(arrScr);

        arrRecalc1 = (ArrayList)arrReCalc[0];
        arrRecalc2 = (ArrayList)arrReCalc[1];

    }

    else

        if (var == "Exponential")
```

```
{
    arrScore = Exponential(nodnew);

    arrScr = (ArrayList)arrScore[0];
    arrScr1 = (ArrayList)arrScore[1];

    arrScore1 = Exponential(arr1);
    arrScr2 = (ArrayList)arrScore1[0];
    arrScr3 = (ArrayList)arrScore1[1];

    scrFinal = new ArrayList();

    arrclone = new ArrayList();
    arrclone = arrScr;

    scrFinal.Add(arrclone);

    bool flagnew = false;

    int a, y;

    arrReCalc = Exponential(arrScr);

    arrRecalc1 = (ArrayList)arrReCalc[0];
    arrRecalc2 = (ArrayList)arrReCalc[1];
```

```
}

else if(var=="Borda Fuse")
{
arrScore = BordaFuse(nodnew);

arrScr = (ArrayList)arrScore[0];
arrScr1 = (ArrayList)arrScore[1];

arrScore1 = BordaFuse(arr1);
arrScr2 = (ArrayList)arrScore1[0];
arrScr3 = (ArrayList)arrScore1[1];

scrFinal = new ArrayList();

arrclone = new ArrayList();
arrclone = arrScr;

scrFinal.Add(arrclone);

bool flagnew = false;

int a, y;
```

```
    arrReCalc = BordaFuse(arrScr);

    arrRecalc1 = (ArrayList)arrReCalc[0];
    arrRecalc2 = (ArrayList)arrReCalc[1];

}

else if (var == "Condorcet Fuse")
{

    CondorcetFuse(nodnew, arr1);

    goto A;

}



int i, j, k, m, n;
arrclone = new ArrayList();
for (i = 0; i < arrScr.Count; i++)
{
    for (j = 0; j < arrScr2.Count; j++)
    {
        if (arrScr[i].Equals(arrScr2[j]))
        {
```

```
            k   =   Convert.ToInt32(arrScr1[i])   +
            Convert.ToInt32(arrScr3[j]);

                object obj = k;
                arrclone.Add(obj);
                flag = true;
            }


        }

        if (flag != true)
        {
            n = Convert.ToInt32(arrScr1[i]);
            object obj = n;
            arrclone.Add(obj);

        }

        flag = false;

    }

    for (i = 0; i < arrScr2.Count; i++)
    {
```

```
                for (j = 0; j < arrScr.Count; j++)
                {
                    if (arrScr2[i].Equals(arrScr[j]))
                    {
                 flag = true;
                    }


                }
                if (flag != true)
                {
                    k = Convert.ToInt32(arrScr3[i]);
                    object obj = k;
                    arrclone.Add(obj);
                    //                  (arrclone[0]    as
ArrayList).Add(arrScr[i]);
                    (scrFinal[0]                        as
ArrayList).Add(arrScr2[i]);


                }

                flag = false;

            }
```

```
            scrFinal.Add(arrclone);

            string deref = ((scrFinal[1] as
ArrayList)[2].ToString());

            //  object deref = arrCon.GetValue(0, 0);
            ArrayList hghscr = (ArrayList)scrFinal[0];
            ArrayList hghscr1 = (ArrayList)scrFinal[1];

            // hghscr1.Sort();

            int max;    // first element be the max
            int max2;
            object rnk;

            for (max2 = 1; max2 < hghscr1.Count; max2++)
            {
                max = (int)hghscr1[max2 - 1];

                for (i = max2; i < hghscr1.Count; i++)
                {
                    if ((int)hghscr1[i] > max)
                    {
                        max = (int)hghscr1[i];
```

```
                    rnk = hghscr[i];
                    hghscr1[i] = hghscr1[max2 - 1];
                    hghscr[i] = hghscr[max2 - 1];
                    hghscr1[max2 - 1] = max;
                    hghscr[max2 - 1] = rnk;

                } //end of if

            }//

        }

        /**********code for ranking
o/p***************/

        if((File.Exists("C:\\Test\\yahoonew.xml"))&
(File.Exists("C:\\Test\\yahoo1.xml"))                    &
(File.Exists("C:\\Test\\msn1.xml")))
        {

        File.Delete("C:\\Test\\yahoo1.xml");
        File.Delete("C:\\Test\\msn1.xml");
        File.Delete("C:\\Test\\yahoonew.xml");
```

```
            }

 File.Copy("C:\\Test\\yahoo.xml",
"C:\\Test\\yahoo1.xml");
 File.Copy("C:\\Test\\msn.xml", "C:\\Test\\msn1.xml");
FileStream file = new
FileStream("c:\\test\\yahoonew.xml",FileMode.CreateNew);
StreamWriter sw = new StreamWriter(file);
            XmlDocument xd = new XmlDocument();
            xd.Load("c:\\Test\\yahoo1.xml");
            XmlNode xn;
            XmlElement root1 = xd.DocumentElement;
            int rnkCount;

            sw.Flush();
            sw.WriteLine("<root>");
            for (rnkCount = 0; rnkCount < hghscr.Count;
rnkCount++)
            {
xn = root1.SelectSingleNode("/root/website[URL='" +
hghscr[rnkCount].ToString() + "'" + "]");
                if (xn == null)
                {

                    XmlDocument xd2 = new XmlDocument();
```

```
                    xd2.Load("c:\\Test\\msn1.xml");
                    //XmlNode xn;
                    XmlElement root2 =
xd2.DocumentElement;
                    xn =
root2.SelectSingleNode("/root/website[URL='" +
hghscr[rnkCount].ToString() + "'" + "]");


                }

                string str = xn.OuterXml;


                sw.Write(str);


            }
            sw.Write("</root>");
            sw.Close();
            file.Close();

StreamReader strm = new
StreamReader("c:\\Test\\yahoonew.xml");

            while (strm.ReadLine()!=null)
```

```
        {

            strOuter += strm.ReadLine();

        }


    }
    catch (Exception e)
    {
   Console.WriteLine("Exception: {0}",
   e.ToString());
    }
}


public static ArrayList Linear(ArrayList arr)
{

    _Default a = new _Default();

    int n = arr.Count;
    int i;
    int scr;
```

```
        a.score = new ArrayList();
        a.score.Add(arr);

        arr = new ArrayList();

        for (i = 0; i < n; i++)
        {
            //string str1 = arr[0].ToString();
            scr = n - i;
            arr.Add(scr);

        }

        a.score.Add(arr);

        return a.score;
    }
    public static ArrayList Exponential(ArrayList arr)
    {

        _Default a = new _Default();
        int n = arr.Count;
        int i;
        int scr;
        double dbl;
```

```
        a.score = new ArrayList();
        a.score.Add(arr);

        arr = new ArrayList();

        for (i = n; i > 0; i--)
        {
            scr = i;
            dbl = 1 - (-1 / Math.Exp(scr));
            arr.Add(dbl);

        }

        a.score.Add(arr);

        return a.score;

    }
```