What is the Semantic Web?

• The Semantic Web is an extension of the current World Wide Web.

• Content in The Semantic Web is intended to be machine-understandable.

• Currently, the WWW is only human-understandable.
The WWW: What Happened?

• Tim Berners-Lee’s original concept for WWW:
  – Metadata: Data about Data
  – Provide semantic meaning to all documents
  – Software agents could parse document metadata and infer reasoning about document contents.
Existing WWW Content Issues

• Quality:
  • Incorrect Information

• Consistency:
  • Disagreement/Difference of Opinions

• Redundancy & Relevancy:
  • Too much information
Existing WWW Structural Issues

- WWW does not provide underlying structural connection between document data.
- How structured should Semantic Web be?
  - Consider:
    - Relational Database Management Systems: Concepts of Field, Record in Explicit Table Structure.
    - Primary/Foreign Key Pairs connect data among tables.
    - Query of multiple underlying structures presents one unified, non-redundant, relevant result.
  - Is this level of structure really desired?
  - Databases are complex and have a very large overhead.
How Can We Attempt To Resolve These Issues?

– Semantic Web Data: STRICTLY high quality, organized and consistent data is:
  – Not Feasible
  – Not Desired

– Information will have varying degrees of quality and we want to preserve this = the ‘personality’ of the Web.

– Who can we trust to provide Relevant, Consistent and Quality data when we need it?
Idea: Local Consistency

- You understand and can communicate with your neighbors.

- Your neighbors understand and can communicate with their neighbors, etc.

- ‘Recursive access’ to everything on Semantic Web.

- In Practice: P2P Networks: You get information through explicitly chosen neighbors.
Result: ‘Web of Trust’, ie. Combined Trust

- Trust decisions are local.
  - I provide information to those I trust
  - I trust my network of connections.
  - My connections allow me to ‘connect’ to world-wide network of trust.
  - Also connecting centralized information repositories (dictionaries, CiteSeer, etc.)
Idea: Combined Beliefs

- Idea: Users calculate beliefs for any statement reachable through a trust path.
- Users specify what they believe.
- They use ‘Web of Trust’ to estimate their belief in statements supplied by any other user.
- Method: Aggregate the Concatenation of Trusts and Beliefs creating chains of trust and a measure of trust.
‘Web of Trust’

[3]
Result: Web of Trust

- Beliefs may be combined locally yet still maintain global interpretation.

- So, there is a correspondence between Combined Beliefs and Combined Trusts.
“Webs of Trust” in Practice

- Epinions: [www.epinions.com](http://www.epinions.com):
  - “Unbiased Reviews By Real People” [5]
  - “You can read and write reviews on millions of products and services” [5]
  - Users specify which other users they trust
  - Resulting ‘Web of Trust’ custom-tailors the product reviews seen by each person.
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Epinions Most Helpful Reviews

Still need wires elsewhere...
Logitech MXâ‚¢ 1000 (931175)

Reviewed by nad_masters

Author's rating: ★★★★★

The power of laser – oh how it amazes us. We know of them through products such as CD and DVD players, as well as supermarket price scanners. But a mouse? It was a natural progression if you think about it. Optical mouses (yes, mouses is the ... Read the full review
Howard Creech's Profile

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Favorite Websites:
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Howard Creech's Recent Opinions

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<th>Product / Topic</th>
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<td>Canon Digital Rebel XT/ EOS 400D and EF-45-55 EF-S II Zoom</td>
<td>Canon Rebel XT/ EOS 400D Digital Camera</td>
<td>★★★★★</td>
<td>Very Helpful</td>
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<td>Aug 01 '05</td>
<td>The Canon Powershot SD600/Digital IXUS 60 digital camera</td>
<td>Canon PowerShot SD600 Digital Camera</td>
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<td>Very Helpful</td>
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<td>The Sony Cyber-shot DSC H5 How does it compare with the S3, FZ7, and Z612?</td>
<td>Sony Cyber-shot DSC H5 Digital Camera</td>
<td>★★★☆☆</td>
<td>Very Helpful</td>
</tr>
</tbody>
</table>
‘Webs of Trust’ in Practice

• Web Page Ranking:
  – Link Pervasiveness = Measure of Quality:
    • The number and quality of pages linking to a site
    • The number of links on a page
  – Calculate connectivity (sum) between pages.

• Collaborative Filtering: Estimate user belief by considering the beliefs of users with similar interests.
  – Amazon.com Book and Product recommendations
Public Key Cryptography and ‘Webs of Trust’

– Sender A must get Receiver B’s public key in order to send a secret message to B.
– Sender A encrypts message with Receiver B’s public key.
– Receiver B has secret private key in order to decrypt message received from A.
Public Key Cryptography and ‘Webs of Trust’

- How Can A Trust the Key received actually belongs to B? MITM Attack?
- Digital Signature = Trust
- Also: Imagine A verifying B’s public key through a network of trusted users, ie. a Web of Trust.
- This would allow us to Reason and Infer new Relationships About Who We Trust.
Opportunistic Networks

How does The Semantic Web relate?

• Main Oppnets Issue: Linguistic Barriers for communication between devices.
  – WWW Primary Object: A document
  – Oppnet Primary Object: A device

• Need a Language: Trying to create a basis for communication between unrelated, unorganized devices.

• The Language = The Semantic Web
Semantic Web Architecture

- Each layer provides services to layer above.
• **Layer 1: Unicode, URI**
  - **Uniform Resource Identifier:**
    - How to identify a data resource. (think URL)
    - Unique, accessible
    - A different URI used for each data concept in order to distinguish similar but unequal resources (address: mailing box v. street)

• **Layer 2: XML**
  - Tags add structure, metadata.
  - Result is self-descriptive data, but NO semantics.
  - XML Namespaces and Schema: Add URI to elements.
• **Layer 3: RDF**
  - Resource Description Framework: Semantics
  - Defines relationships between tagged data resources.
  - Data Model: (Subject, Predicate, Object) triplets
  - Equivalent to (Resource, Property Type, Value)
  - Subject, Predicate, Object are each URIs themselves.
  - Schema defines relationships
  - RDF Document Example:
    - Dr. Lilien teaches CS 691.
    - The teacher of CS 691 is Dr. Lilien.
    - Equal to us (humans), but not equal to machines.

```xml
<RDF:RDF>
    <DC:Course>CS 691</DC:Course>
    <DC:Teacher>Dr. Lilien</DC:Teacher>
    <DC:School>Western Michigan University</DC:School>
  </RDF:Description>
</RDF:RDF>
```
• **Layer 4: Ontology Vocabulary**
  – Formal Description of Terms, Interrelationships of Terms.
  – Expands on RDF to include more detailed properties, classes.
  – Derive data/classes from already known data/classes. Think: Inheritance
  – Why? To increase number of relationships.

• **Digital Signature (vertical layer):**
  – Added to RDF document to authenticate source
  – Used by Trust Layer
• **Layer 5,6: Logic & Proof:**
  - Use to reason by inference using logic & rules, validate logic via proof.

• **Layer 7: Trust**
  - Uses Digital Signature
  - Can we trust this subject, property, or value object identified by this URI?
  - Imagine the ‘Webs of Trust’ that could be established with objects at this level of granularity!!!
Opportunistic Networks

How does The Semantic Web relate?

- Each device has services to contribute to the network.

- The Semantic Web gives us a ‘bridge’, ie. a common language, between devices. Think: third party ‘Interpreter’

- With each node locally defining its own level of trust, trusted neighbors can be identified (using the Semantic Web architecture’s built-in trust via Digital Signatures).

- And the ‘Web of Trust’ can propagate into a larger network of devices with services to offer.
References


