DBLP API — A Shortest Path Algorithm

Appendix to the paper “DBLP — Some Lessons Learned” (June 9, 2009)

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The java program\(^1\) documented in this appendix demonstrates the use of one of the DBLP XML services, which were described in section 5 of the paper “DBLP — Some Lessons Learned". It computes the shortest path between two DBLP authors in the coauthor graph. The software works like a little web crawler, it loads the information incrementally from the DBLP server.

The program is structured in two classes: The shortest path algorithm is a variant of the classic breath-first algorithm, it is shown in figure 1. The class Person shown in figure 2 hides all DBLP specific implementation details from the algorithms itself.

The interaction between both classes is very simple: If you have a Person object, you may ask it for its neighbors by applying the method getCoauthors, which returns an array of persons. You can attach a label to each person. A label is an integer. setLabel creates a label, hasLabel tests if a label exists, and getLabel reads a label of a person. The class method resetAllLabels deletes all labels from persons. It is obvious that you may generalize this to a simple interface to access any undirected graph (without weights) from your shortest path algorithm.

To run the algorithm, you have to create two persons and to construct a CoauthorPath object:

```java
Person p1, p2;
p1 = Person.create("Jim Gray", "g/Gray:Jim");
p2 = Person.create(...);
CoauthorPath cp = new CoauthorPath(p1,p2);
Person path[] = cp.getPath();
```

After this you may print out the path.

Next we look at the class Person more closely. In the code snippet above it is noticeable that we use the class method create to produce new Person objects. The class does not have a public constructor because it caches all objects in a class level Map. The create method first tests if there is already an object for the specified name in personMap. A new object is only created, if this test fails.

After creation a Person object only contains the person’s name and the uri. The list of coauthors is only loaded on demand\(^2\). The boolean field coauthorsLoaded contains the required state information. If getCoauthors is called for the first time, loadCoauthors is activated to fetch the information from DBLP.

We use a SAX parser to read the XML file. Because the creation of a SAX parser object is an expensive task, the parser is reused. It is created in the static initialization block just above loadCoauthors at class load time. Additionally the coauthorHandler field is initialised. In loadCoauthors an URL object is constructed to provide an InputStream for the parser. During the parsing process the SAX parser calls the methods startElement, endElement, and characters of the local CAConfigHandler. We are only interested in author elements. The boolean insideAuthor is set true as soon as we recognize an opening author tag. characters collects the element contents in Value. In the method endElement a Person object is created. The coauthors are temporarily stored in plist. This List is converted into the final coauthors array after parsing has been completed.

To make the shortest path algorithm practicable over a slow internet connection, we have to minimize the number co-author lists to be loaded. Two known optimizations of the breadth-first algorithm proved to be essential for searches inside the huge connected component of the DBLP coauthor graph: (1) The search has to start from both persons, and (2) the algorithm should prefer the side with the lower number of persons to be visited next. The method CoauthorPath.shortestPath is a straightforward implementation of these ideas.

The algorithm labels persons p1 with 1 and p2 with −1. The direct neighbors of p1 are set 1, the direct neighbors of p2 are set −2 etc. The variables now1 and now2 contain the sets of persons who form the outer waves of the labeling processes. The main loop flips the side where to advance next depending on the size of these sets. During an expansion step the still unvisited persons are collected in the set next.

If now1 or now2 become empty, the persons are not connected. If the two waves hit each other, the method tracing is called to collect pathes from the meeting point to the starting points.

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\(^1\)An expanded version of this software is available from http://dblp.uni-trier.de/xml/docu/

\(^2\)In the online version of the class the same mechanism is implemented for the list of publications of a person.
import java.util.Collection;
import java.util.HashSet;
import java.util.Iterator;

public class CoauthorPath {
    private Person path[];

    public CoauthorPath(Person p1, Person p2) {
        shortestPath(p1, p2);
    }

    public Person[] getPath() { return path; }

    private void tracing(int position) {
        Person pNow, pNext;
        int direction, i, label;
        label = path[position].getLabel();
        direction = Integer.signum(label);
        label -= direction;
        while (label != 0) {
            pNow = path[position];
            Person ca[] = pNow.getCoauthors();
            for (i=0; i<ca.length; i++) {
                pNext = ca[i];
                if (!pNext.hasNext()) continue;
                if (pNext.getLabel() == label) {
                    position -= direction;
                    label -= direction;
                    path[position] = pNext;
                    break;
                }
            }
        }
    }

    private void shortestPath(Person p1, Person p2) {
        Collection<Person> h, nowI = new HashSet<Person>(), now2 = new HashSet<Person>(), next = new HashSet<Person>();
        int direction, label, n;
        Person.resetAllLabels();
        if (p1 == null || p2 == null) return;
        if (p1 == p2) {
            p1.setLabel(1); nowI.add(p1);
            p2.setLabel(-1); now2.add(p2);
            while (true) {
                if (nowI.isEmpty() || now2.isEmpty()) return;
                if (now2.size() < now1.size()) {
                    h = now1; now1 = now2; now2 = h;
                }
            }
        }
    }

    public static void main(String[] args) {
        // Main method
    }

    Figure 1: A shortest path algorithm
import ...;

public class Person {
    private static Map<String, Person> personMap =
        new HashMap<String, Person>();
    private String name;
    private String urlpt;

    private Person(String name, String urlpt) {
        this.name = name;
        this.urlpt = urlpt;
        personMap.put(name, this);
        coauthorsLoaded = false;
        labelvalid = false;
    }

    static public Person create(String name, String urlpt) {
        Person p;
        p = searchPerson(name);
        if (p == null)
            p = new Person(name, urlpt);
        return p;
    }

    static public Person searchPerson(String name) {
        return personMap.get(name);
    }

    private boolean coauthorsLoaded;
    private Person coauthors[];

    static private SAXParser coauthorParser;
    static private CAConfigHandler coauthorHandler;
    static private List<CAConfigHandler> coauthorHandlerList =
        new ArrayList<CAConfigHandler>();

    static private class CAConfigHandler extends DefaultHandler {
        private String Value;
        private int label;
        private boolean insideAuthor;

        public void startElement(String namespaceURI,
                String localName, String rawName,
                Attributes atts) throws SAXException {
            if (insideAuthor == rawName.equals("author")) {
                Value = "";
                urlpt = atts.getValue("urlpt");
            }
        }

        public void endElement(String namespaceURI,
                String localName, String rawName)
            throws SAXException {
            if (rawName.equals("author") &
                    Value.length() > 0) {
                plist.add(create(Value, urlpt));
            }
        }

        public void characters(char[] ch, int start, int length)
            throws SAXException {
            if (insideAuthor)
                Value += new String(ch, start, length);
        }
    }

    public void warning(SAXParseException e)
        throws SAXException {
    }

    public void error(SAXParseException e)
        throws SAXException {
    }

    public void fatalError(SAXParseException e)
        throws SAXException {
    }

    static {
        try {
            coauthorParser = SAXParserFactory.newInstance().newSAXParser();
            coauthorHandler = new CAConfigHandler();
            coauthorParser.setXMLReader().setFeature("http://xml.org/sax/features/validation",
                false);
        } catch (ParserConfigurationException e) {
            return;
        } catch (SAXException e) {
            return;
        } catch (IOException e) {
            return;
        }
    }

    private void loadCoauthors() {
        if (!coauthorsLoaded)
            return;
        plist.clear();
        try {
            URL u = new URL("http://dblp.uni-trier.de/rec/pers/
                +urlpt+"xc");
            coauthorParser.parse(u.openStream(),
                coauthorHandler);
        } catch (IOException e) {
            return;
        } catch (SAXException e) {
            return;
        } coauthors = new Person[plist.size()];
        coauthors = plist.toArray(coauthors);
        coauthorsLoaded = true;
    }

    public Person[] getCoauthors() {
        if (!coauthorsLoaded)
            loadCoauthors();
        return coauthors;
    }

    private int label;
    private boolean labelvalid;

    public int getLabel() {
        return (labelvalid) ? label;
    }

    public void resetLabel() {
        labelvalid = false;
    }

    public boolean hasLabel() {
        return labelvalid;
    }

    public void setLabel(int label) {
        this.label = label;
        labelvalid = true;
    }

    static public void resetAllLabels() {
        Iterator<CAConfigHandler> i = personMap.values().iterator();
        while (i.hasNext()) {
            Person p = i.next();
            p.labelvalid = false;
            p.label = 0;
        }
    }

    public String toString() {
        return name;
    }

    Figure 2: The Class “Person”