TLCS: A Digital Library with Resources to Teach and Learn Computer Science

Sébastien Combéfis[1] Guillaume de Moffarts[1]
Mile Jovanov[2]

[1]Computer Science and IT in Education ASBL, Belgium

[2]Faculty of Computer Science and Engineering, Ss. Cyril and Methodius University, North Macedonia

August 6, 2019

[IOI 2019, Baku, Azerbaijan]

Context

- Computer science education tends to be everywhere today
  - Concepts taught in some primary and secondary schools
  - Courses and degrees are offered in higher education
  - Contestants challenge themselves with contests
- Computer science concepts are not easy to learn

  Abstraction, algorithmic thinking, creative thinking, etc.
- Website and application to help learning have been developed

  Not always easy to find, not well advertised, not documented

Digital library

- A digital library (DL) is... (Borgman, 1999)

  "a set of electronic resources and associated technical capabilities for creating, searching and using information."

- ...that is typically *"constructed, collected and organised...*

  ...by (and for) a community of users."

- Very few digital libraries with resources to learn CS do exist

  Only some specialised DL for higher education and research

TLCS project

- The TLCS project is a database with a frontend to access it

  Developed as an online web application

- Two main goals for the platform
  - Allows teachers/learners to quickly find relevant resources
  - Get information about how to use those resources

✔ **Setting up a digital library with resources to teach and learn computer science concepts**

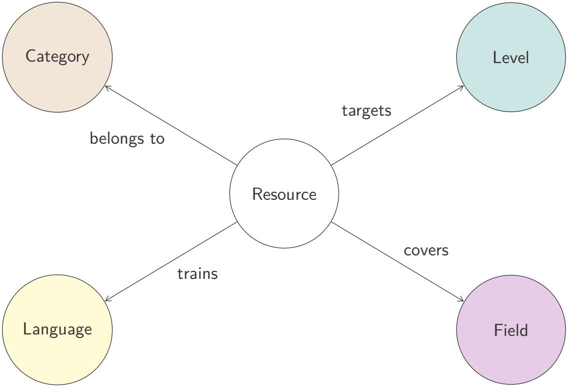
Classifying resources (1)

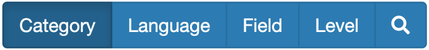
- Important to structure the database to ease searches

  Must satisfy the different categories of users: teacher, learner...

- Several possible ways to classify the resources are proposed
  - **Category** identifies the kind of service provided
  - **Language** is the trained programming language
  - **Field** is the covered computer science field
  - **Level** is the targeted age group

Classifying resources (2)

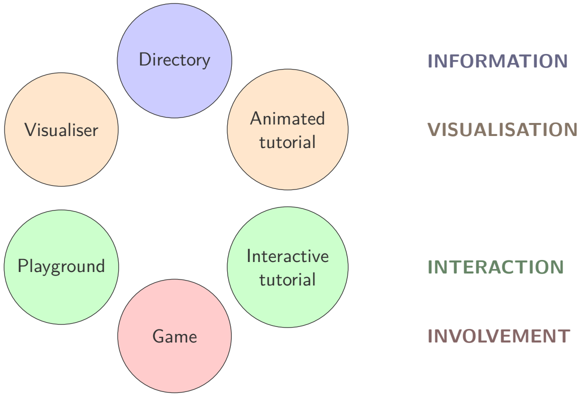




Category

- Six main categories have been identified

  Based on the resources analysed in the frame of this work



Directory

- Directory allows users to navigate a collection

  Resources, technologies, tools, softwares, algorithms...

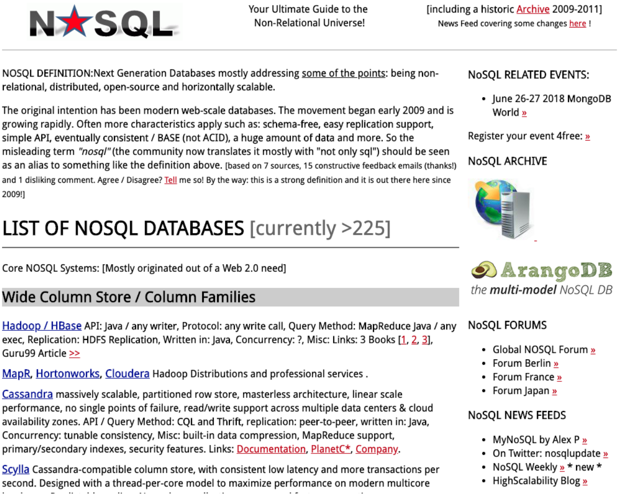
- Help learners to discover resources related to the same topic

  Similar in some ways to the "awesome list" movement

- *"NoSQL Databases"* maintains large list of NoSQL engines

  Website: http://www.nosql-database.org

Directory



N★SQL

Your Ultimate Guide to the Non-Relational Universe!

[including a historic Archive 2009-2011]
News Feed covering some changes here !

NOSQL DEFINITION:Next Generation Databases mostly addressing some of the points: being non-relational, distributed, open-source and horizontally scalable.

The original intention has been modern web-scale databases. The movement began early 2009 and is growing rapidly. Often more characteristics apply such as: schema-free, easy replication support, simple API, eventually consistent / BASE (not ACID), a huge amount of data and more. So the misleading term *"nosql"* (the community now translates it mostly with "not only sql") should be seen as an alias to something like the definition above. [based on 7 sources, 15 constructive feedback emails (thanks!) and 1 disliking comment. Agree / Disagree? Tell me so! By the way: this is a strong definition and it is out there here since 2009!]

LIST OF NOSQL DATABASES [currently >225]

Core NOSQL Systems: [Mostly originated out of a Web 2.0 need]

Wide Column Store / Column Families

Hadoop / HBase API: Java / any writer, Protocol: any write call, Query Method: MapReduce Java / any exec, Replication: HDFS Replication, Written in: Java, Concurrency: ?, Misc: Links: 3 Books [1, 2, 3], Guru99 Article >>

MapR, Hortonworks, Cloudera Hadoop Distributions and professional services .

Cassandra massively scalable, partitioned row store, masterless architecture, linear scale performance, no single points of failure, read/write support across multiple data centers & cloud availability zones. API / Query Method: CQL and Thrift, replication: peer-to-peer, written in: Java, Concurrency: tunable consistency, Misc: built-in data compression, MapReduce support, primary/secondary indexes, security features. Links: Documentation, PlanetC*, Company.

Scylla Cassandra-compatible column store, with consistent low latency and more transactions per second. Designed with a thread-per-core model to maximize performance on modern multicore

NoSQL RELATED EVENTS:

- June 26-27 2018 MongoDB World »

Register your event 4free: »

NoSQL ARCHIVE

ArangoDB
*the **multi-model** NoSQL DB*

NoSQL FORUMS

- Global NOSQL Forum »
- Forum Berlin »
- Forum France »
- Forum Japan »

NoSQL NEWS FEEDS

- MyNoSQL by Alex P »
- On Twitter: nosqlupdate »
- NoSQL Weekly » * new *
- HighScalability Blog »

Visualiser

- Produces static or dynamic visualisations

  Useful for people sensitive to visual learning modalities

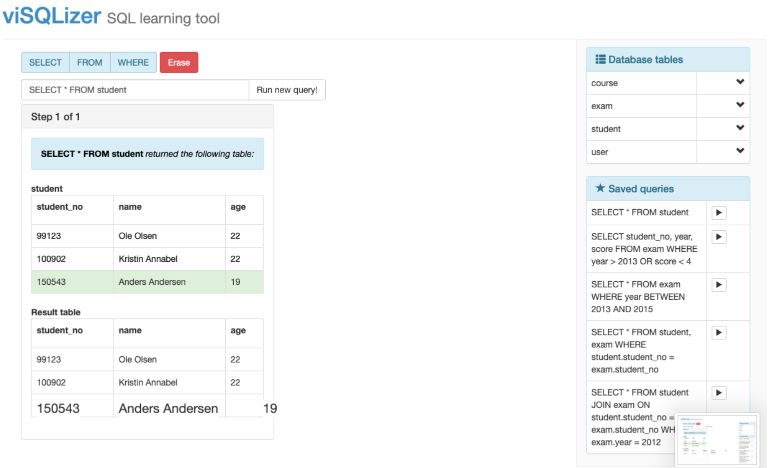
- Help learners to represent themselves concepts to learn

  Teachers can provide visual examples to learners

- *"viSQLizer"* illustrates how SQL SELECT queries are executed

  Website: http://andmark.no/kristin

Visualiser



SELECT * FROM student

Step 1 of 1

SELECT * FROM student *returned the following table:*

student

student_no	name	age
99123	Ole Olsen	22
100902	Kristin Annabel	22
150543	Anders Andersen	19

Result table

student_no	name	age
99123	Ole Olsen	22
100902	Kristin Annabel	22
150543	Anders Andersen	19

- SELECT * FROM student
- SELECT student_no, year, score FROM exam WHERE year > 2013 OR score < 4
- SELECT * FROM exam WHERE year BETWEEN 2013 AND 2015
- SELECT * FROM student, exam WHERE student.student_no = exam.student_no
- SELECT * FROM student JOIN exam ON student.student_no = exam.student_no WH exam.year = 2012

Animated tutorial

- Tutorial to learn new concepts with visualisations

  Can directly present examples with the produced result

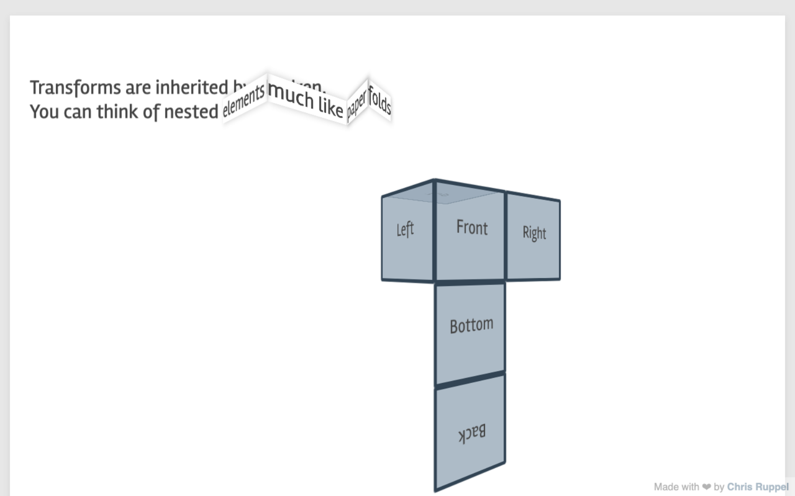
- Help learners to directly see the result of new concepts

  While being guided during the learning thanks to the tutorial

- *"Unfolding the Box Model"* illustrates CSS 3D transforms

  Website: https://rupl.github.io/unfold

Animated tutorial



Transforms are inherited by children.
You can think of nested elements much like paper folds

Made with ❤ by Chris Ruppel

Playground

- Execute and directly get the result of a personal production

  Code, problem instance, situation description, model...

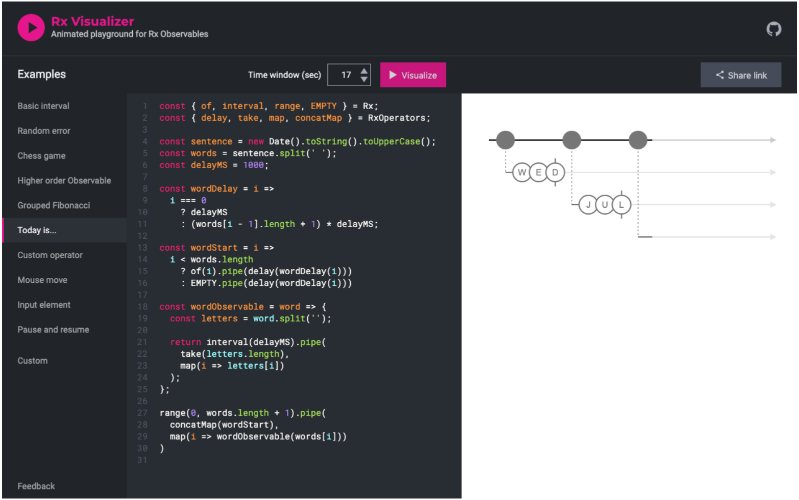
- Help learners to experiment with their own examples

  Without the need to install anything on their computers

- *"RxViz"* execute and show result of RxJs observable programs

  Website: https://rxviz.com

Playground



```
const { of, interval, range, EMPTY } = Rx;
const { delay, take, map, concatMap } = RxOperators;

const sentence = new Date().toString().toUpperCase();
const words = sentence.split(' ');
const delayMS = 1000;

const wordDelay = i =>
  i === 0
    ? delayMS
    : (words[i - 1].length + 1) * delayMS;

const wordStart = i =>
  i < words.length
    ? of(i).pipe(delay(wordDelay(i)))
    : EMPTY.pipe(delay(wordDelay(i)))

const wordObservable = word => {
  const letters = word.split('');

  return interval(delayMS).pipe(
    take(letters.length),
    map(i => letters[i])
  );
};

range(0, words.length + 1).pipe(
  concatMap(wordStart),
  map(i => wordObservable(words[i]))
)
```

Interactive tutorial

- Tutorial with interactives related to the concepts

  Challenges/problems to be solved by the learners

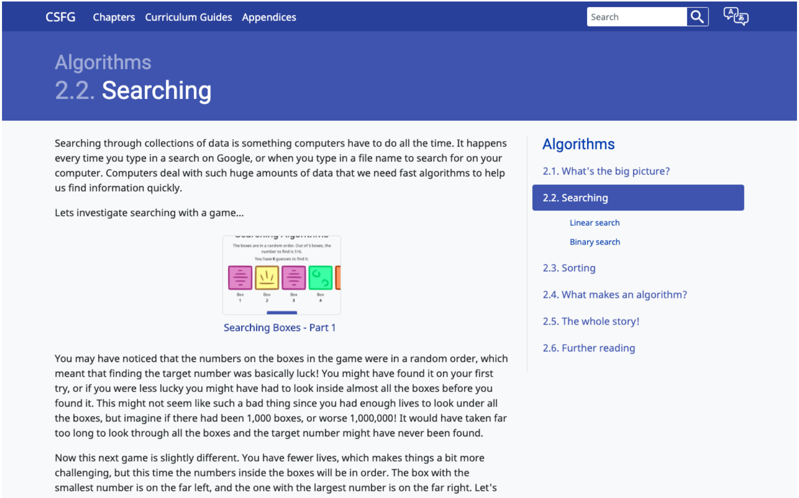
- Help the learners to directly practice with new concepts

  Check the understanding of the learners

- *"CS Field Guide"* online interactive book to learn CS concepts

  Website: https://csfieldguide.org.nz

Interactive tutorial



Algorithms

2.2. Searching

Searching through collections of data is something computers have to do all the time. It happens every time you type in a search on Google, or when you type in a file name to search for on your computer. Computers deal with such huge amounts of data that we need fast algorithms to help us find information quickly.

Lets investigate searching with a game...

Searching Algorithms

The boxes are in a random order. Out of 5 boxes, the number to find is 516.

You have **6** guesses to find it.

Searching Boxes - Part 1

You may have noticed that the numbers on the boxes in the game were in a random order, which meant that finding the target number was basically luck! You might have found it on your first try, or if you were less lucky you might have had to look inside almost all the boxes before you found it. This might not seem like such a bad thing since you had enough lives to look under all the boxes, but imagine if there had been 1,000 boxes, or worse 1,000,000! It would have taken far too long to look through all the boxes and the target number might have never been found.

Now this next game is slightly different. You have fewer lives, which makes things a bit more challenging, but this time the numbers inside the boxes will be in order. The box with the smallest number is on the far left, and the one with the largest number is on the far right. Let's

Algorithms

Game

- Require a big involvement of the learners

  Challenge to solve given a set of rules and an environment

- Help learners to surpass themselves and to make progress

  Increased motivation with goals, scoreboards, competitions...

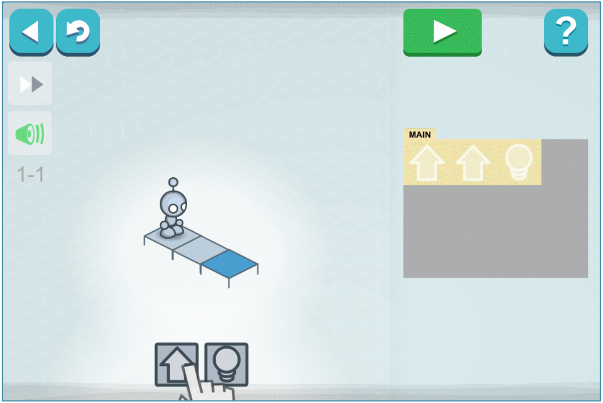
- *"Blockly Games"* introduces to basic programming concepts

  Website: https://blockly-games.appspot.com

Game

Program Lightbot to light up all of the blue squares!

Language Select and **Full Screen** options can be found in the game menu along the right side.



I'm finished with my Hour of Code™

Language, field and level

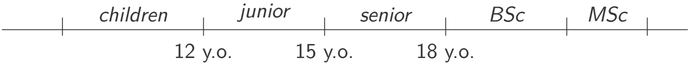
- Three other classification ways to help searching resources

  Programming language, computer science field and age groups

- Simply general CS fields in current version

  Database, artificial intelligence, algorithmics, data structure...

- Most suited age groups organised by level of education



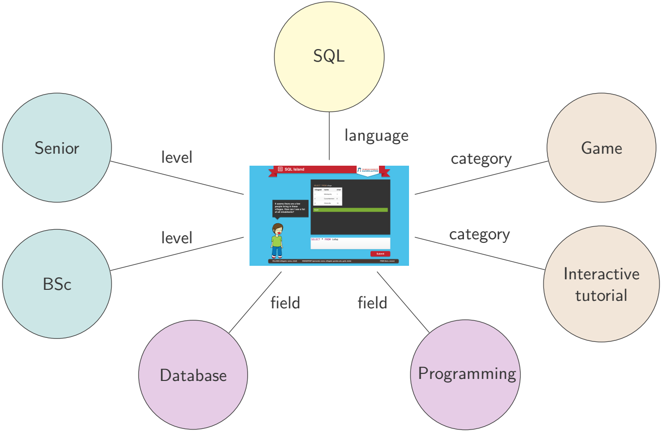
children *junior* *senior* *BSc* *MSc*

12 y.o. 15 y.o. 18 y.o.

Resource example

- SQL Island is an adventure game to learn SQL fundamentals

Speaking SQL with inhabitants of an island to escape it



Pedagogical information

- Additional informations to help specific public

  Four main audiences: learner, teacher, researcher and developer

- Optional pedagogical information to improve resource use
  - **Prerequisite** mandatory to be able to use the resource
  - **Learning outcomes** list what learner will be able to do
  - **Methodology** explain how the resource can be used

- Two other pieces of additional information can be provided
  - **Service** offered by the resource
  - **Reference** to scientific papers

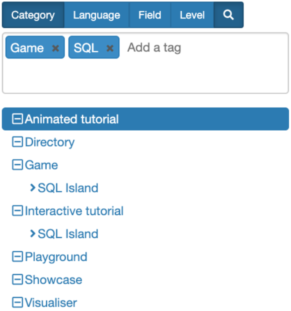
The TLCS platform

- TLCS platform used to search for resources

  How they can be used to teach and learn CS

- Simple and easy navigation and search tool

  "Are there any games to learn about the SQL programming language?"



Social and community aspects

- Content created and proposed by the community
  - Information must be correct, complete, relevant and up-to-date
  - Review and quality check about entries made by CSITEd ASBL
- Should support knowledge sharing and foster social interaction
  - Users will be able to create their own personal tags
  - It will be possible to grade resources with stars
  - More information will be available depending on the user type

Conclusion

- TLCS is a digital library with websites and applications

  Resources to use to teach and learn computer science concepts

- Proposition of a multi-criteria categorisation of resources

  Help people to search information relevant to them

- About twenty resources have already been encoded

  Only in English with the mandatory information

Call to contribute

Want to contribute?

Please do! Come and talk to us!

Or just drop me an email: sebastien@combefis.be.