

Creating a Database of Peonies and Its Use for Teaching IT Courses

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Abstract

The aim of this paper is to describe one of the possible ways of making IT courses more interesting through collecting practical field data and a subsequent creation of databases. Since the establishment of a specialized peony garden near Prague in 2008, details of the origin of acquired plants and of their cultivation under local conditions have been continuously recorded. The data resulting from the peony research are used as support for our IT courses. They are used in practical modelling of a relational database and in creating student projects focused on responsive web designs. The peonies data make the IT courses more attractive and stimulating for students.

Literature survey of the peony research publications and our own data obtained from the peony garden revealed some of the main problems in cultivating and identification of peonies. Herbaceous peonies are widespread perennials. Mostly "historical" varieties of *Paeonia lactiflora* are cultivated. However, these plants have long and weak stems, which are bent down by heavy flowers and must therefore be mechanically held up by stakes or support rings. By contrast, the new cultivars have solid stems, such as the hybrid herbaceous peonies and intersectional hybrids (Itoh hybrids) and do not require as much labour but are not commonly cultivated. Our research has discovered that most peony cultivars in home gardens have not been properly identified. Great emphasis has, therefore, been placed on the correct identification of peony cultivars.

Keywords

IT, peony, *Paeonia*, cultivar identification, database, responsive web design.

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Introduction

Information technology (IT) requires suitable teaching materials and examples to explain how new applications operate in different work environments. The authors of this paper have selected peonies as one of the primary sources of raw data for teaching IT courses since they are all involved in IT research at the Czech University of Life Sciences Prague in the vicinity of peony garden. Below they are presenting a data model for the creation of a specialized database of peonies.

Peonies (lat. *Paeonia spp.*) are one of the most versatile perennial garden plants in many countries. Peonies are wonderful, fully hardy and long living herbaceous or tree plants. Their flowers have different colours and shapes and are often sweet smelling. Cut peonies are very popular, especially for weddings. The Netherlands is the main producer of cut peonies with approximately 55 million stems annually (Kamenetsky and Dole, 2012).

There are thousands of cultivars of peonies. Some gardeners occasionally sell peonies under names, which are not correct. We often get peonies from our neighbours or find them in the garden inherited from the parents and have no idea what cultivar they are. On the other hand, there are gardening shops or farms specialised in breeding peonies where the cultivar origin is more certain. Rogers (1995) gives an example of how the Brand Nursery Company sold the 'Edulis Superba' cultivar under 22 different names at the beginning of the 20th century. Therefore, in 1903 the American Peony Society (APS) was founded in order to maintain an official register of the cultivars origin. The key purpose of the plant registration is to give a unique label to a plant within a genus, or to place cultivated plants in an appropriate denomination class (Jakubowski, 2016). At present, the APS Registry of Peony Cultivars contains 6455 items.

The wide use of Internet technology now provides

access to information, which was previously difficult to obtain and was processed only by specialists. Rogers (1995) in his respected book “Peonies” describes more than 600 cultivated and commercially available cultivars of peonies. He had obtained details of the cultivars from the nurseries catalogues published in North America, Europe, New Zealand, Japan and China. The use of the search engines makes it now possible to find web sites of companies specialized in cultivating and breeding peonies easily, and to instantly compare cultivars in online catalogues (Hollingsworth, 2016), (Klehm, 2016) and (Warmerdam, 2016).

When creating a web site we usually use a three-layer architecture client server (browser, web server and database server). An accurate content of the web site is ensured by a properly designed database. The majority of current databases are based on the relational data model. Entity Relationship Diagram usually designs a conceptual scheme of a database.

Modern web architecture depends on a high number of web technologies such as Hypertext Markup Language (HTML), scripting languages (PHP, JavaScript) and protocols such as HTTP or TCP/IP. Thanks to these technologies students are able to develop their knowledge in life-long education (Lagakos, 2010). All of these technologies rely on deep knowledge and can be difficult to learn for some students. With the ability to connect these technologies to the real world it is believed that students may understand better the purpose and reason why they should learn them.

The main purpose of this paper is to give an example of how use the data obtained through the creation of a specialized peony garden to provide field data support for teaching IT courses.

Materials and methods

In 2007, a dedicated Peony garden was established near Prague on a field of 2000 m². By the end of 2016 the garden contained more than 600 cultivars and nearly 1500 peony plants.

Vegetative reproduction by roots only is used for peony propagation. The roots were obtained from various sources (78), which included suppliers from the Czech Republic, and specialist growers of peonies from the EU (Holland, France, Belgium and Austria).

From the very beginning, details of every plant, its

purchase, cultivation and flowering were recorded. The plants were photographed several times during the flowering stage. Approximately 5000 photos per year were taken. The data and photographs of flowers were compared with catalogues to verify the authenticity of cultivars and to ensure accuracy of the records in database.

The background of the records is outlined below. Few plants have such a long and rich history as peonies. The roots of herbaceous peonies were (and are) used in medicine. The earliest mention of the therapeutic use of the peonies comes from China Xia dynasty (2000 – 1500 BC).

For practical purposes Page (2005) divided peonies into seven main categories:

1. The species
2. Cultivars of *Paeonia lactiflora*
3. Hybrid Herbaceous Peonies
4. Chinese Tree Peonies
5. Japanese Tree Peonies
6. Hybrid Tree Peonies
7. Intersectional hybrid or “Itoh” Peonies.

Each of these categories is discussed briefly below.

The species

The genus *Paeonia* is very complex taxonomically. Sekerka (2004) provides a detailed overview on the Subgenus, Sections and Subsections. Only some species have practical significance as garden plants or the source for hybridization. Wild peonies were cultivated in Europe from the Middle Ages in monastery gardens originally for medical purposes, therefore referred to as *Paeonia officinalis*. Peony plants are sometimes small rockery, ie. *Paeonia tenuifolia*, which blooms first, has a height of just 30 cm.

Cultivars of *Paeonia lactiflora*

Most commonly grown cultivars of herbaceous peonies originate from *Paeonia lactiflora*, which was brought to Europe in 18th century from China. These cultivars are often called the Chinese peonies. Some of these classical 19th century cultivars without specific names are present in many gardens. They are offered cheaply to attract buyers, but according to some authors (Hodgson, 2011) they should no longer appear in gardens, because require too much care. New cultivars are primarily produced in USA. Plants have strong stems and don't need to be supported by a ring.

Hybrid herbaceous peonies

Great progress in breeding peonies in the 20th century was carried out in the USA. Breeders like A. P. Saunders, E. Auten, L. Glasscock and others crossed wild species to create new cultivars, which will gradually come to our gardens. These cultivars grow more upright and the flowers do not need support. Some have new colour as 'Coral Charm'. Some red cultivars are very popular as 'Red Charm'.

Chinese Tree Peony

Tree peony has a long tradition among the "sacred symbols" in China. Over the centuries Chinese people have learned to admire her, especially in paintings. In 1903, peony has been declared the national flower of China. The white cultivar 'Feng Dan Bai' is used in Chinese herbal medicine.

Japanese Tree Peony

Tree peonies from the 8th century have similar popularity in Japan. Peony seeds were brought into the country from China by monks. While the Chinese prefer plants with large flowers, Japanese breeders have focused on simple flowers, i.e. to the detail and beauty of individual flowers. Very impressive cultivars are 'Yachiotsubaki' and 'Shima Nishiki'.

Tree peony hybrids

They were produced by crossing cultivars of the Japanese tree peonies and wild species. These tree peonies are shrubs that grow well and after flowering they create beautiful solitaires. Cultivars as 'High Noon', 'Souvenir de Maxime Cornu' or 'Gauguin' are very good ornamental plants in the garden.

Intersectional hybrids

In 1948, Japanese breeder Tochi Itoh successfully crossed tree peony with herbaceous peony for the first time and thus provided the basis for a new group of cultivars, the so called Itoh hybrids (also known as intersectional hybrids). The plants grow luxuriantly to a height of around one metre. They are woody at the ground level while the upper parts are herbaceous. Itoh hybrid cultivars such as 'Bartzella', 'Cora Louise' and others are currently fashionable.

Flowers

Peony flowers are pentamerous, which means that the various parts of the flower are in groups of five, or multiples of five. The flower has

a classical structure and consists of four parts: sepals, coloured petals, stamens and the carpel. It is possible to distinguish five shapes of peony flowers as follows: single, Japanese, semi-double, double and bomb. These basic shapes of flowers have many different transient variations, even on the same plant the flowers can vary.

The colour ranges from white blossoms through pink to dark red, but there are peony blossoms of yellow or orange colour too. The size of flowers usually varies from 5 cm to 25 cm.

Results and discussion

Database for the peony garden

The first purchases of peonies were made in 2007 from mail-order businesses in the Czech Republic. Purchases from specialized peony producers in the EU started in 2011. Since the establishment of the garden, detailed records of individual plants have been kept. Collected and processed data were stored in a specialized relational database "My Peony" which was developed specially for this purpose.

The obtained data were processed using MySQL database system (later MariaDB) with the help of the phpMyAdmin user interface. The visual editor of MySQL Workbench was used to create the conceptual scheme of a new database. Table 1 describes the structure of "My Peony" database.

The central entity of the database is called Cultivar and it describes attributes of cultivated peony varieties. Entities Bloom_Time, Fragrance, Colour, Flower_Type, Genus, Country and Hybridizer are in hierarchical relationships (one to many type) with Cultivar entity. Entity Relationship (ER) Diagram is shown in Figure 1.

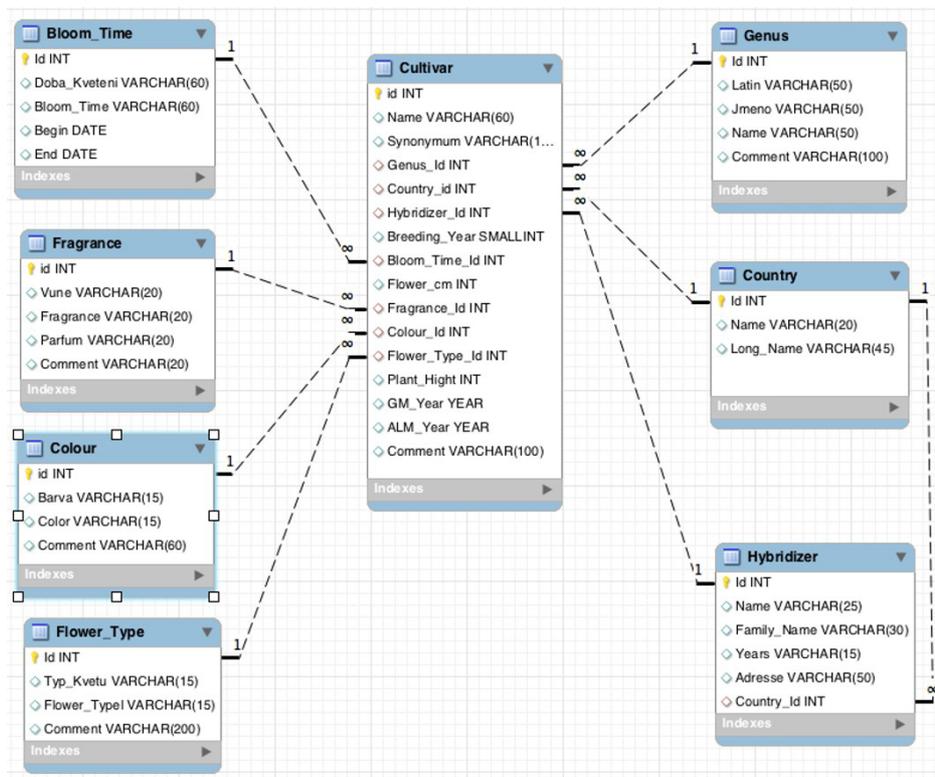
The relationship between the entities Cultivar and Place is of a many to many type and it is described by inserting a new entity Plant that contains data about individual plants. The entity Plant is in a hierarchical relationship with entity Acquisition as shown in Figure 2.

The proposed conceptual scheme is fully functional and is used to teach database technologies and Internet technologies courses. The scheme is prepared basically in English, but text items are also in Czech, eg. the entity Colour contains two items for colour name – Colour and Barva.

Entity	Content	Primary key	Number of attributes	Foreign key	Number of records in DB "My peony"
Acquisition	List of purchases	Id	8	Country_Id	78
Bloom_Time	List of bloom periods (1= very early, 2=early,...)	Id	5		7
Colour	List of peony colours (1=white, 2=red, ...)	Id	5		10
Country	List of countries (1=France, 2=GB, ...)	Id	3		18
Cultivar	List of cultivars	Id	21	Genus_Id, Country_Id, Hybridizer_Id, Bloom_Time_Id, Fragrance_Id, Color_Id, Flower_Type_Id	614
Flower_type	List of flower types (1=Single, 2=Japanese, ...)	Id	5		5
Fragrance	List of fragrances (0=no fragrance, 1=very light, ...)	Id	5		6
Genus	List of peonies categories as defined by Page (2005)	Id	5		8
Hybridizer	List of peony breeders (1=Auten, 2=Bigger, ...)	Id	6	Country_Id	113
Place	List of flower beds in the field	Id	11		97
Plant	List of cultivated plants	Id	16	Cultivar_Id, Place_Id, Acquisition_Id	1500

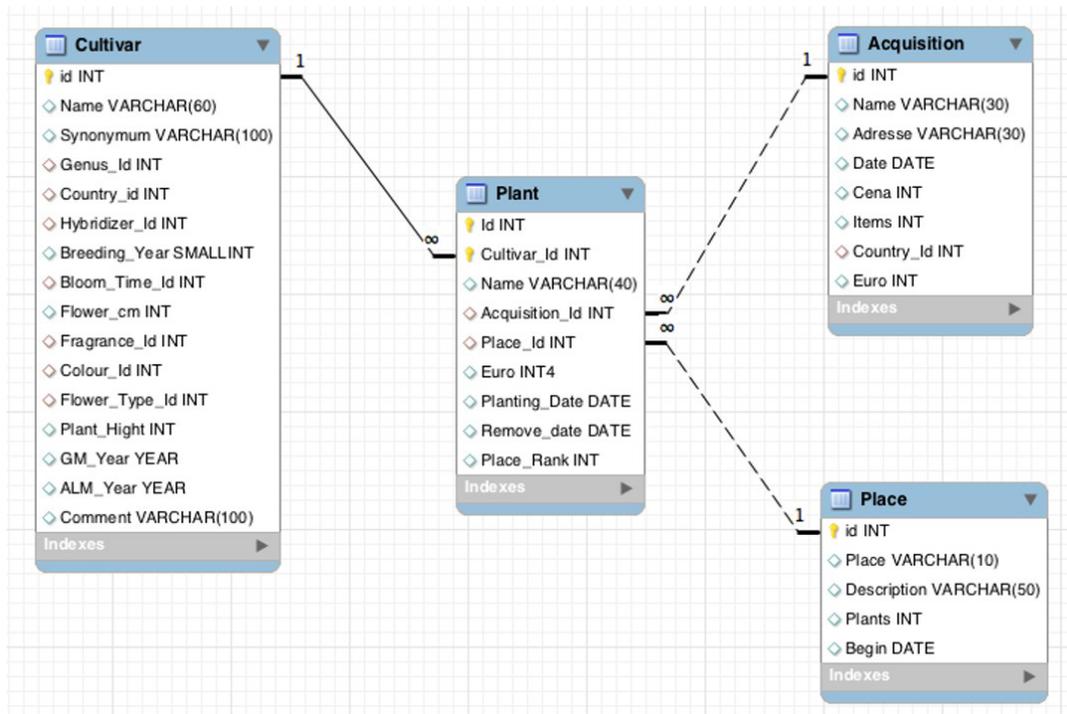
Source: own processing

Table 1: Structure of database "My Peony".



Source: own processing

Figure 1: ER Diagram – Data modelling by MySQL Workbench.



Source: own processing

Figure 2: ER Diagram – Data modelling by MySQL Workbench

Using the peonies topic in education of web technologies

During the years from 2006 to 2016, we supervised student teams which were developing web sites with use of different approaches and technologies. There were projects based on Joomla, Prestashop, Moodle and Wordpress conducted on our departments' server kitlab.pef.czu.cz. Every year, there were hundreds of projects, for example 149 website projects in 2015 and 172 in 2016. One of the education and research results was the design of a new agritourism portal in 2010. It enabled the entrepreneurs in agritourism to present themselves on the web easily and with minimum cost using the Web Content Management System (WCMS) (Havlíček, 2010).

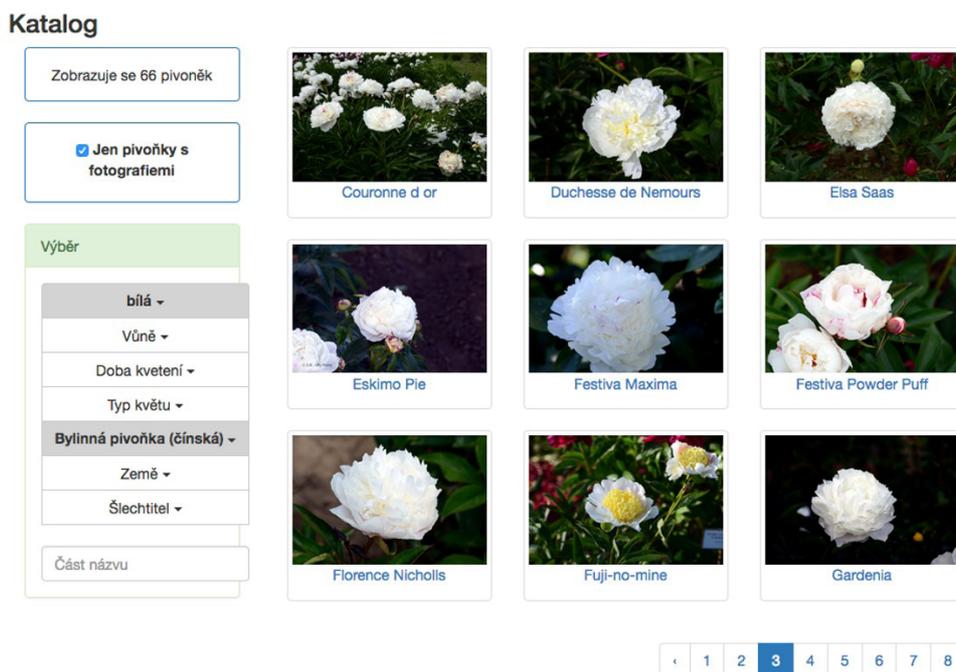
Every website should perform as a responsive and dynamic heap of web pages (Šimek et al., 2015). To enhance the learning process in the web development course at CULS the students were offered to create websites about peonies. Students who chose this topic worked mostly with HTML, CSS and JavaScript and they were able to create modern responsive websites. This idea was based on other studies with similar approach (Örtegren, 2012). Proper formatting in students' project respects CSS3 specifications, and students also implemented plugins like weather widget

of meteorology station at CULS Prague.

It was discovered that the integration of peony photos (which were taken during the flowering period) in the website is not easy. Most of image data came from DSLR in 36MPx JPG files. This size was unacceptable for the responsive web site because of the limits in the data transfers and memory capacity especially for mobile devices. This means that image data must be compressed to suitable size and dimensions. It was also taken into account that JPEG algorithm is not ideal for web based presentations due to its compression limits. This fact leads to an other research, which attempts to provide better compression algorithms (Mehrabi, 2016).

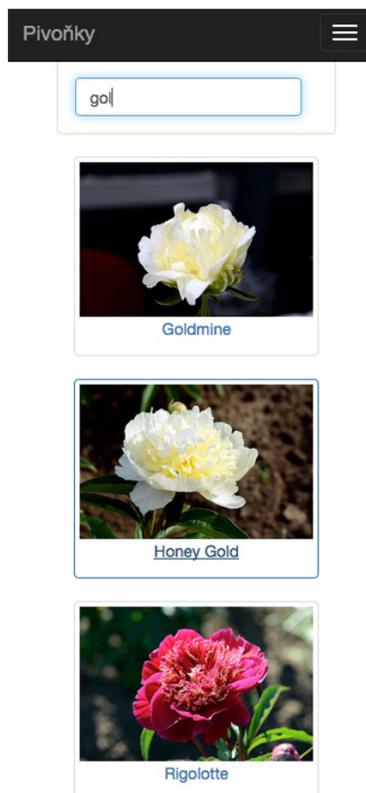
All of these findings point to the conclusion that integration of real world topics – in this case the world of peonies – might be helpful. What seems interesting is that the whole problem of designing a suitable database with interface is not as simple as it might look. Structural and biological complexity of peonies leads to a complex database and interface, which must reflect all data requirements.

Screenshots (Figure 3 and 4) of student's project based is on Peony database URL: <http://kitlab.pef.czu.cz/1516zs/ete89e/08/>.



Source: own processing

Fig. 3: Peony Catalogue prepared by students.



Source: own processing

Figure 4: Peony Catalogue – responsive design for mobile devices.

Peony cultivar identification

Identifying varieties of peonies is quite difficult. When planting the roots of peonies one needs to rely on the quality and reliability of the supplier. The plant blossoms usually appear in the second or third year after planting. At the end of 2016 the peony garden described above had properly determined only 415 cultivars from a total of 614 cultivars recorded in the peony database. Verification of purchased cultivars was confirmed by comparison with the specialized books (Page, 2005); (Rivière, 1992); (Rivière, 2009). The correctness of the cultivar name was determined by comparing our own photos with the internet peony catalogues of specialized companies.

Visual identification of peony cultivars is only possible through the flower. For more than 200 years of horticultural cultivation, many cultivars have had two or three names. For example, the ‘Souvenir de M. Cornu’ tree peony bred in France is called ‘Kinkaku’ in Japan. Conversely, the herbaceous peony with yellow flower called ‘Goldmine’ or sometimes ‘Golden Wheel’ originally had a Chinese name ‘Huang Jin Lun’.

The problem with the exact specification of cultivars can be solved only through the study of DNA, as reported by Hao et al (2008), Gilmore et al. (2013). However the DNA determination

of cultivars is beyond the scope of this paper.

Peony cultivation is not very demanding for labour. Herbaceous peonies can be planted during dormancy (autumn or early spring). Tree peonies from the container can be planted throughout the year. Peonies do not suffer too much from diseases or pests. Peony blight is caused by *Botrytis paeoniae* and can seriously damage tree peonies. Due to the severity of this disease, a set of Internet sensors measuring the conditions of the plants is being prepared. The measured data will be used to predict the spread of the disease.

Conclusion

The peony database has already been used a number of times in IT courses at CULS Prague for explaining the principles of databases. The use of complex peonies data has made teaching of IT more interesting for students. It has proved that data and especially photos of plant flowers can be successfully used for identification of species and cultivars as well as for the creation of catalogues. This paper describes an example of the database use in students' web sites projects.

Students were able to create web applications with responsive web design.

Analysis of research publications and their comparison with data from new peony garden showed the following practical problems in peony identification:

1. Exact identification of the different cultivars of peonies is only possible in flowering period or through DNA analysis.
2. Correct identification of cultivars is an essential prerequisite for their inclusion in the database.

In sum, the peony database proved to be successful in identification of peony cultivars. More research is needed to create an application, which would make an automatic identification of peony cultivars possible.

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