Advanced Course
Object Oriented JAVA programming
for GIS applications development
A Open Source perspective to stand-alone and Web solutions

Scope

The course aims at developing analytical and programming skills for spatial applications. Based on a step-by-step, still ambitious, path, the course covers fundamental concepts in OO (Object Oriented) programming, while focusing on JAVA syntax and programming philosophy addressing geodata management, visualization and querying tasks.

JAVA is well known for its flexibility in developing distributed Web applications, also thanks to its multiplatform architecture (write once, run anywhere) and it is particularly well suited for approaching modern programming paradigm. Despite its syntax being similar to C++, JAVA is effectively much simpler, while its study still provides consistent foundation to professional programming in other languages, as Visual Basic or PHP, as well as a consistent framework for better understanding of more complex concepts underlying ESRI component based environment VBA/ArcObjects for ArcGIS 8/9.

The course adopts the quite advanced, still didactic, textbook “Java Programming for Spatial Sciences” by Jo Wood (City University, London). Programs developed in the course will be based on Jo Wood’s source code, providing a full support to a consistent learning path.

At the end of the course, participants will have an in-depth knowledge of software engineering principles, OO constructs, JAVA syntax and spatial applications development techniques. Based on both formal lectures on underlying theory and hands-on experience, participants will gradually develop two distinct applications, addressing dynamic behaviour of most environmental and social phenomena and supporting data management, visualization, querying and analysis of geospatial vector and raster data. Both stand-alone and Web based applications (applets) will be considered.
The course is part of a wider GIScience learning project, addressing both introductory and advanced issues, including a specialization path in environmental applications development and management, with interests spanning through such different fields as geology, environmental sciences, urban planning, land use, IT, just to recall few of them.

**Program**

Detailed course program, based on a mixed theory and hands-on formula, follows:

**Introduction to fundamental concepts in OO programming and software engineering**

- Short introduction to course objectives and structure;
- Introduction to procedural and OO programming from a historical perspective, focusing on relevant features of JAVA and its key-role in distributed applications development;
- Classes and objects. Definitions, development, class state and behaviour, objects instantiation. JAVA and BlueJ editor: installation, fundamentals and references;
- Software engineering, UML fundamentals and guidelines of best practice in code development;
- Fundamental types, variables, and typecasting.

**Classes development and objects instantiation**

- Classes vs. objects, objects instantiation, inheritance, fundamental methods (constructors, accessors and mutators), parameters passing, abstract methods and interfaces;
- Overview of graphical classes (AWT and SWING). Development of classical introductory program Hello. Classes design face to reusability requirements, relationship types and code development;
- Case study A: design and development of a class hierarchy after the analysis of an ant colony dynamic behaviour within a confined spatial context. Software engineering and source code development will provide hands-on evidence of OO concepts, namely inheritance, composition and interfaces implementation. The example introduces the requirements for a conceptual design of a spatial class to handle the dynamic behaviour of a single ant.

**Flow control**

- Variables, arithmetic and logical operators, precedence operators, precision, iterator controls (for, do while and while do), nested loops, monodimensional and multidimensional arrays (declaration and initialization, raster model development), design and dynamic management of graphical components (Flow, Border e Grid Layout);
- Case study B: analysis, design and development of a GUI (Graphical User Interface) to address raster visualization tasks, by extending native JPanel class. Screen coordinates transformation to
Decisions management

- Case study A: development of a spatial class (Footprint), to manage point or rectangular elementary vectr geometries. Generalization of raster and vector model by developing a common interface (SpatialModel). Class variables and elementary topological algorithms analysis and development (separation, adjacency, intersection, enclosure, coincidence after the simplified classification of Molenaar, 1998).

Classes sharing

- Variables scope (local, method, object and class), modifiers (private, public e protected) to enhance their visibility. JAVA code documentation via Javadoc, main JAVA libraries (packages as awt, swing, event, util, io and applet). New packages creation and organization, naming rules to avoid conflicts, paths management.(classpath).
- Case study A: GUI design based on swing package, using the delegation model of event handling, relevant to flexibility requirements for extension to alternative approaches (i.e. use of awt and applets). In the framework of a rigorous OO approach, each class is responsible for its graphical output, focusing on the 3w (what, when and where) rule.

Objects collections

- Modeling of vector spatial objects by using arrays. Theory on dynamic groups creation and management (iterators and collections - List, Set, Map and their ordered counterparts, SortedSet e SortedMap), TreeMap and HashMap. Database connectivity fundamentals. Development of a more efficient vector model based on dynamic collections, by implementino the two new classes GISVector e VectorMap.
- Case study A: dynamic behaviour programming of moving, feeding and food transport. Previous model is extended by adding support to food (energy) and to a complex ants colony, modelled as an objects collection. JAVA potentials in modelling dynamic behaviour is fully investigated.

Dynamic events control

- JAVA delegated events, Threads creation, their relevance and usefulness in implementation of GUIs. Analysis of WindowListener interface and delegated event handling to manage interaction with GUI. Short programming examples relevant to analysis of Threads key role in managing regular time events (Timer class);
- Case study B: further improvement of GUI (Graphical User Interface), to manage visualization of both vector and raster coverages by implementing event listeners to keep trace of windows resizing and mouse querying. Textual metadata integration within the general framework, local to geographical coordinates transformation, high quality vector output management after JAVA2D classes.

Streams, files and errors management

- Input and output streams, keyboard standard input, catching exceptions, opening, reading, writing and
closing of files, GUI interaction with the file system, strings analysis and object serialization.

- Case study B: prototype extension to file management, textual files importing, serialization of spatial objects and additional GUI facilities. Description of ASCII format examples (ArcInfo raster grid and GRASS generic vector), as well as their serialization and deserialization.

JAVA distributed Web programming

- JAVA Applets, HTML (HyperText Markup Language) fundamentals, Applets calls embedding in Web pages, parameters passing, security and Browser restrictions. Development of a simple cartographic applet, with elementary querying functionalities embedded in HTML code.

GIScience project

The course fits in the framework of a wider learning GIScience project. Supported by high-level professional and academic profiles focused on the fields of GIScience and Environmental protection and remediation, the project addresses introductory issues in the GIScience introduction course and in a seminar devoted to Business Geographics & Geodemographics, and more advanced topics in software engineering and programming in the two courses on VBA/ArcObjects for ArcGIS 8/9 and JAVA.

The new advanced courses on environmental project management and groundwater flow and transport modelling focus on the growing environmental market, with its demand for high specialization. These courses perfectly fit in the project framework, being focused on EIS (Environmental Information Systems) design and development, including advanced issues as spatial statistics, modelling, ESDA (Exploratory Spatial Data Analysis) and 3D/time-dependent visualization.

Following a complex and coherent learning path, after principles of traditional part-time and distance learning philosophy, and thanks to previous 2003-2005 editions experience, the course is based on both formal classes and self-learning, making course accessibility easier and final learning targets more realistic.

Software

MsOffice™, RDBMS MsAccess™ (www.microsoft.com), JAVA™ (http://java.sun.com) and BlueJ™ (www.bluej.org). Both the interpreter and the language are free and can be downloaded from the above websites.

Who is it for?

Professionals working for both private and public sector interested in planning, environment and programming for spatial sciences, graduate and post-graduate students in similar disciplines.

It is required: a deep knowledge of PC/MsOffice™ environment, a personal interest in application development GIS platforms. No formal programming language knowledge is required, even if it could be useful a previous experience in basic software customisation.

Experience in GIS platforms like ESRI ArcView 3.x™, ArcGIS 8.x/9™, Geomedia™, Grass™ or Idrisi™ can be useful in algorithms analysis.

The course requires a strong interest in the subject and the capacity to work at home pursuing the objectives. The structure and the textbook support this approach by allowing long periods of time between lessons and by giving a well known reference manual.
Location & dates

The course will take place at the multimedia Centre located in Monte Porzio (PU), where 12 last-generation PCs are available. The course will have a duration of 56 hours in the period May - October 2006, with 8 hours lessons on fridays and saturdays once a month, except summer time, following a calendar balancing the needs for didactic continuity and in-depth learning requirements. Lessons calendar is defined as follows: 5-6/5, 23-24/6, 22-23/9 and 7/10.

Registration

Registration forms are available at the Administration Office of Monte Porzio Cultura, they can be downloaded in PDF format or they can be requested via Email at info@giscience.it or infompcultura@virgilio.it.

Course fees are 1200 € + VAT (20%) in a unique payment before course starting, or in two payments of 650 € + VAT (20%) each one, at the beginning and in the middle of the course. Fees must be payed by bank transfer to “Associazione Monte Porzio Cultura”, Account # 000020111416, “BANCA SUASA – Credito Cooperativo, Filiale di Castelvecchio”, Strada Cesanense, 137 – 61040 Castelvecchio (PU) - ABI 08839, CAB 68451, CIN J, with the clear statement “Participation in course Object Oriented JAVA programming”. If 10% discount conditions are satisfied, they must be explicitly reported on the registration. Both registration form and photocopy of bank transfer must be sent by fax to 0721-862724 at the attention of Ing. D. Guanciarossa.

Participants in previous GIScience courses promoted by the Association, students regularly enrolled in degree, post-degree and Phd courses at Italian or foreign universities at the moment of registration, as well as education Institutions, public and private companies enrolling more than one person will benefit of a 10% discount.

The course will be activated with a minimum of 5 participants, while maximum of 10 participants will be accepted.

Certificate

At the end of the course, participants attending at least 70% of the lessons will be awarded a Completion certificate.

Didactic material

The course book provided to each participant is:


A rich reference bibliography is available either in paper and digital format. A web reference is the JAVA™ development section (http://java.sun.com) in the Sun website. Good manuals are also:


For the programming issues related to GIS please consult:
Ormsby T., Napoleon E., Burke R., Groessl C. e Feaster L., 2001. *Getting to know ArcGIS desktop: basics of ArcView, ArcEditor and ArcInfo.* ESRI Press (include CDROM con una copia trial a tempo valida per 180 giorni di ArcGIS)


**Info**

For further information, please refer to Ing. David Guanciarossa, President of “Associazione Monte Porzio Cultura”, Email address info@giscience.it or infompcultura@virgilio.it or go to the Contacts section of this website.