Object-Oriented Design Heuristics

Univ.Prof. Dipl.-Ing. Dr. techn.

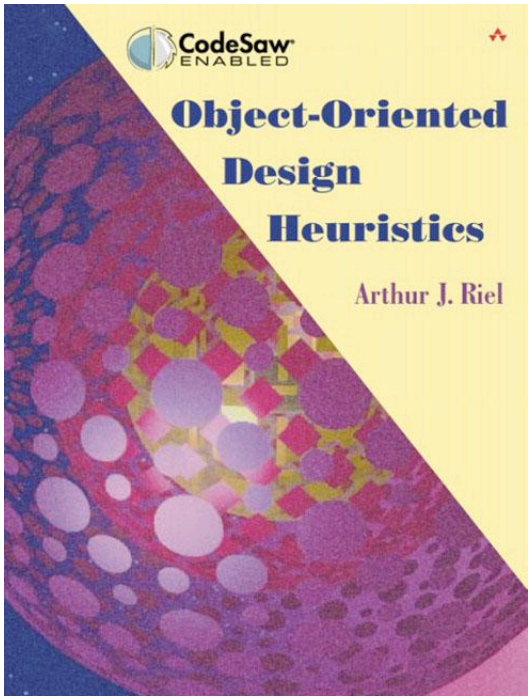
Harald GALL

Universität Zürich

Technische Universität Wien

Design Heuristics

- Object-Oriented Design Heuristics by Arthur Riel, Addison-Wesley, 1996.



Goal

- Insights into oo design improvement.
- More than sixty guidelines are language-independent and allow one to rate the integrity of a software design.
- The heuristics are not written as hard and fast rules; they are meant to serve as warning mechanisms which allow the flexibility of ignoring the heuristic as necessary.

Classes and Objects: The Building Blocks of the Object-Oriented Paradigm

Hidding Data

- Heuristic #2.1
  All data should be hidden within its class

No Dependence on Clients

- Heuristic #2.2
  Users of a class must be dependent on its public interface, but a class should not be dependent on its users

Support Class = one Clear Responsibility

- Heuristic #2.3
  Minimize the number of messages in the protocol of a class

Supporting Polymorphism and Communication

- Heuristic #2.4
  Implement a minimal public interface which all classes understand (e.g. operations such as copy (deep versus shallow), equality testing, pretty printing, parsing from a ASCII description, etc.).
- To send the same message to different objects
- To be able to substitute them

- Example: Object>>printString, Object>>copy…

Clear Public Interface

- Heuristic #2.5
  Do not put implementations details such as common-code private functions into the public interface of a class

- Example:
  - ☞ Private/protected in C++
  - ☞ Private method categories in Smalltalk

- Do not clutter the public interface of a class with items that clients are not able to use or are not interested in using

Minimize Classes Interdependencies

- Heuristic #2.7
  A class should only use operations in the public interface of another class or have nothing to do with that class

Support a Class = one Responsibility

- Heuristic #2.8
  A class should capture one and only one key abstraction

Strengthen Encapsulation

- Heuristic #2.9
  Keep related data and behavior in one place
- Spin off non related information into another class

- -> Move Data Close to Behavior

Object: a Cohesive Entity

- Most of the methods defined on a class should be using most of the instance variables most of the time

Roles vs. Classes

- Heuristic #2.11
  Be sure the abstractions you model are classes and not the roles objects play

- Are mother and father classes or role of Person?
- No magic answer: Depends on the domain
- Do they have different behavior? So they are more distinct classes

Topologies of Action-Oriented Vs. Object-Oriented Applications

Support one Class = one Responsibility

- Heuristic #3.1
  Distribute system intelligence horizontally as uniformly as possible, i.e., the top-level classes in a design should share the work

Support one Class = one Responsibility

- Heuristic #3.2
  Do not create god classes/objects (classes that control all other classes). Be very suspicious of classes whose name contains Driver, Manager, System, SubSystem

Model and Interfaces

- Heuristic #3.5
  Model should never be dependent on the interface that represents it. The interface should be dependent on the model

- What is happening if you want two different UIs for the same model?

Basic Checks for God Class Detection

- Heuristic #3.3
  Beware of classes that have many accessor methods defined in their public interface. May imply that data and behavior is not being kept at the same place

- Heuristic #3.4
  Beware of classes having methods that only operate on a proper subset of the instance variables.

One Class: One Responsibility

- One responsibility: coordinating and using other objects
  - ☞OrderedCollection maintains a list of objects sorted by arrival order: two indexes and a list

- Class should not contain more objects than a developer can fit in his short-term memory. (6 or 7 is the average value)

Classes Evaluation

- Model the real world whenever possible
- Eliminate irrelevant classes
- Eliminate classes that are outside of the system
- A method is not a class. Be suspicious of any class whose name is a verb or derived from a verb, especially those that only one piece of meaningful behavior

The Relationships Between Classes and Objects

Minimizing Coupling between Classes

- Minimize the number of classes with which another class collaborates
- Minimize the number of messages sent between a class and its collaborators
  - ☞ Counter example: Visitor pattern
- Minimize the number of different messages sent between a class and its collaborators

About the Use Relationship

- When an object use another one it should get a reference on it to interact with it

- Ways to get references
  - (containment) instance variables of the class
  - Passed has argument
  - Ask to a third party object (mapping…)
  - Create the object and interact with it (coded in class: kind of DNA)

Containment and Uses

- Heuristic #4.5
  If a class contains object of another class, then the containing class should be sending messages to the contained objects (the containment relationship should always imply a uses relationships)

- A object may know what it contains but it should not know who contains it.

Coherence in Classes

- Heuristic #4.6
  Most of the methods defined on a class should be using most of the data members most of the time.

- Heuristic #4.7
  Classes should not contain more objects than a developer can fit in his or her short term memory. A favorite value for this number is six.

- Heuristic #4.8
  Distribute system intelligence vertically down narrow and deep containment hierarchies.

Representing Semantics Constraints

- How do we represent possibilities or constraints between classes?
  - ☞ Appetizer, entrée, main dish…
  - ☞ No peas and corn together…
- It is best to implement them in terms of class definition but this may lead to class proliferation
- => implemented in the creation method

Objects define their logic

- Heuristic #4.9
  When implementing semantic constraints in the constructor of a class, place the constraint definition as far down a containment hierarchy as the domain allows

=> Objects should contain the semantic constraints about themselves

Third party constraint holder

- Heuristic #4.11
  The semantic information on which a constraint is based is best placed in a central third-party object when that information is volatile.

- Heuristic #4.12
  The semantic information on which a constraint is based is best decentralized among the classes involved in the constraint when that information is stable.

The Inheritance Relationship

Classes - Subclasses

- Superclass should not know its subclasses
- Subclasses should not use directly data of superclasses
- If two or more classes have common data and behavior, they should inherit from a common class that captures those data and behavior

Inheritancs for Specialization

- Heuristic #5.1
  Inheritance should only be used to model a specialization hierarchy.

- Vererbung ist ein White-box-Entwurf
- Aggregation oder Komposition definieren einen Black-box-Entwurf
- Richtiger Einsatz von Vererbung erleichtert das Programmverständnis enorm!

Base Class Knowledge

- Heuristic #5.2
  Derived classes must have knowledge of their base class by definition, but base classes should not know anything about their derived classes.

Base Class Data is Private

- Heuristic #5.3
- All data in a base class should be private, i.e. do not use protected data.

Inheritance Depth

- Heuristic #5.4
  Theoretically, inheritance hierarchies should be deep, i.e. the deeper the better.

- Heuristic #5.5
  Pragmatically, inheritance hierarchies should be no deeper than an average person can keep in their short term memory. A popular value for this depth is six.

Controversial

- All abstract classes must be base classes

- All base classes should be abstract classes

  ☞> Not true they can have default value method

Interfaces

- Heuristic #5.8
  Factor the commonality of data, behavior, and/or interface as high as possible in the inheritance hierarchy.

- Heuristic #5.10
  If two or more classes have common data and behavior (i.e. methods) then those classes should each inherit from a common base class which captures those data and methods.

Inheritance (2)

- Heuristic #5.9
  If two or more classes only share common data (no common behavior) then that common data should be placed in a class which will be contained by each sharing class.

- Heuristic #5.11
  If two or more classes only share common interface (i.e. messages, not methods) then they should inherit from a common base class only if they will be used polymorphically.

Avoid Type Checks

- Explicit case analysis on the type of an objects is usually an error.
- An object is responsible of deciding how to answer to a message
- A client should send message and not discriminate messages sent based on receiver type

Dynamic semantics

- Heuristic #5.14
  Do not model the dynamic semantics of a class through the use of the inheritance relationship. An attempt to model dynamic semantics with a static semantic relationship will lead to a toggling of types at runtime.

- Heuristic #5.15
  Do not turn objects of a class into derived classes of the class. Be very suspicious of any derived class for which there is only one instance.

Multiple Inheritance

Prove Multiple Inheritance

- Heuristic #6.1
- If you have an example of multiple inheritance in your design, assume you have made a mistake and prove otherwise.

Question it

- Heuristic #6.2
- Whenever there is inheritance in an object-oriented design ask yourself two questions: 1) Am I a special type of the thing I'm inheriting from? and 2) Is the thing I'm inheriting from part of me?

- Heuristic #6.3
- Whenever you have found a multiple inheritance relationship in a object-oriented design be sure that no base class is actually a derived class of another base class, i.e. accidental multiple inheritance.

The Association Relationship

Containment

- Heuristic #7.1
- When given a choice in an object-oriented design between a containment relationship and an association relationship, choose the containment relationship.

Class Specific Data and Behavior

Use of Class Variables & Methods

- Heuristic #8.1
- Do not use global data or functions to perform bookkeeping information on the objects of a class, class variables or methods should be used instead.

Summary

- Use the guidelines for
  - insightful analysis
  - critical reviews
  - as guide for better oo design
  - to build reusable components and frameworks