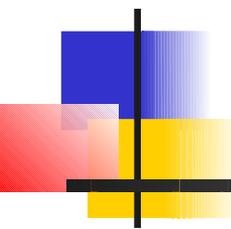


COMP 211

Principles of Program Design

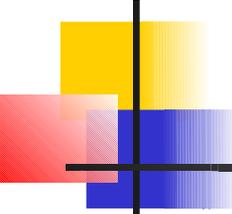
Spring 2011



Prof. Robert “Corky” Cartwright

Dr. Stephen Wong

Rice University



Instructor Information

Corky Cartwright (cork@oplink.net, cork@rice.edu)

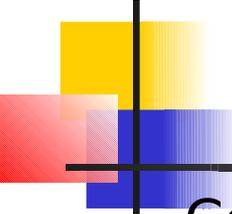
- Duncan Hall (DH) 3104, 713-348-6042
- www.cs.rice.edu/~cork
- Office hours: MWF 9-10am, and by appointment

Stephen Wong [swong@rice.edu]

- Duncan Hall (DH) 3102, 713-348-3814
- www.cs.rice.edu/~swong
- Office hours: TBA

Teaching Assistants:

- Alina Simion
- Kamal Sharma



Course Materials

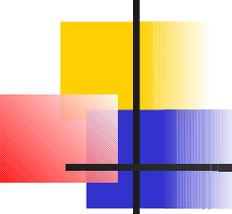
Course web page:

<https://wiki.rice.edu/confluence/display/cswiki/S11>

(or search for the terms **COMP211 wiki S11**)

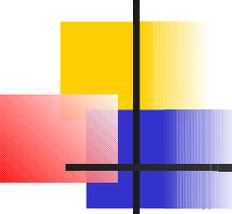
Note: Spring10 wiki still exists and has preference in Google searching

- This is a new wiki associated with the **CLE@R** educational computing facility.
- If you forget the long URL given above, you can simply go to www.cs.rice.edu/~cork and follow the link to Comp 211.
- Course information like TAs, office hours, *etc.* are covered on the course web site. Some of that information is still TBA but will be resolved by the end of this week (14 Jan 2011).



Course Demands

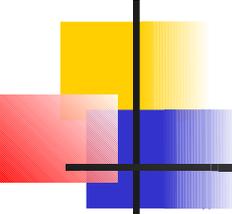
- Prerequisite: some programming experience
- Workload: difficult, time-consuming course, requiring about 8-15 hours outside of lectures each week.
- Weekly homework assignments, all of which involve programming; submitted electronically
- Two “segmented” take-home exams.
- Grading: 50% homework 50% exams



Course Mechanics

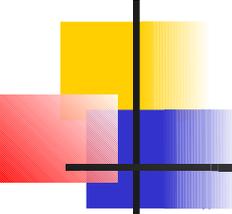
Immediate Concerns

- Take Short Entrance Survey (on wiki web page)
- Our only lab slot (not under our control)
Tu 10:50-12:05
- Labs begin tomorrow. First lab is primarily course emigration.
- HW0 posted on the course wiki is *due* on Wednesday!
 - You should all have a Rice NetID; if not see me.
 - Pick a homework partner if possible; easier to do homework (after HW0) in pairs.
 - Download DrRacket 5.0.2 on your personal computer; it runs on Windows (XP/Vista/7), Mac OS X, and all varieties of Unix. if you do not have a personal computer you can use any CLEAR lab machine.



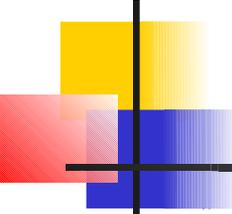
Course Policies

- No late assignments will be accepted--except assignments that draw on 7 slip days granted to each student for use during the term.
- Programs are graded according to a precise formula described on the course wiki. Whether a program “works” or not (including adequate *unit testing*) constitutes half the grade for that program. Program design (including design documentation), unit test cases, program coding style, code documentation all matter a great deal.
- We know from experience as professional software developers that good design, proper program documentation, appropriate tests, and clean program are critical in practice.



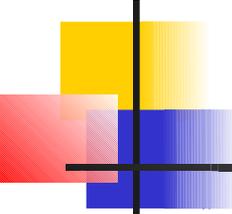
Why Focus on Program Design?

- *Program Design* is the core of Computer Science
 - Why not *Algorithms*?
 - Software is the dominant artifact of modern civilization
 - “Code is Law” [Lessig]
<http://harvardmagazine.com/2000/01/code-is-law.html>
Code regulates many aspects of our lives:
e-media, e-commerce, e-billing, e-voting, e-medical records, e-tax-filing
 - Code is emerging medium for expressing knowledge (HTML, XML, PDF)
 - Code is omnipresent in manufactured goods
 - Airplanes, cars, blenders, phones, toys, greeting cards, ...
- *Program Design* is *intellectually challenging*



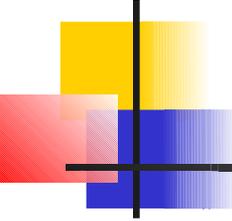
Why COMP 211?

- Repackaging of innovative curriculum for better marketing
 - Comp 210/212 → Comp 211 developed at Rice, with major NSF funding
 - DrScheme/DrRacket, DrJava, *How to Design Programs*, *OO Design Notes* were developed to support this curriculum
- How it is different from other introductory courses?
 - Focus on principles of design, not on details of a particular language or software platform
 - Programming as mathematics
 - Lean, elegant linguistic frameworks (Core Scheme/Java)
 - **Data definitions (types)** drive the design process
 - Follow leading edge software engineering practices
- Program design is **not coding** (e.g., iterators not Java **for** loops) anymore than architecture is *drafting*.
- Course theme: **Built to Last (Change)**



Course Overview

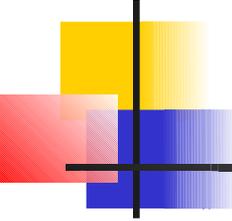
- Functional program design in Scheme (6 wks)
 - Data-directed (functional) program design 2-10
 - Algorithm design 11-14
 - Applied functional programming and review 15-17
- Object-oriented (OO) design in Java (8 wks)
 - Rudiments of the OO programming model 18-19
 - Data-directed OO program design 20-25
 - Advanced OO constructs (inner classes) 26-29
 - Fundamental data structures and algorithms 30-38
 - Event-driven programming, GUIs, concurrency 39-40



OO Design Patterns Covered

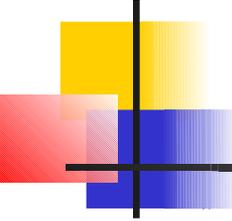
Design pattern = template for solving a computational problem In OO

- union/composite/interpreter
- singleton
- command/strategy
- factory method
- Visitor
- iterator
- model-view-controller
- decorator?
- template method?
- adapter?
- factory?



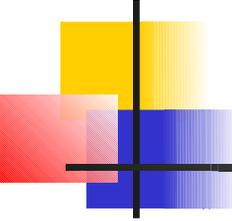
Why Scheme?

- Functional programming (FP) is the key to understanding programming as mathematics; programs are simply function definitions.
- FP underlies many aspects of good programming design—particularly in the context of concurrent programming.
- Good notation for FP facilitates creating FP solutions
- Scheme is the simplest functional language and we will use only the core constructs:
 - Function and constant definition
 - Function application
 - Conditionals
 - Structure definitions
 - Local definitions (blocks) and single assignment (binding)
 - Functional abstraction (lambda-notation)
- Simple formal semantics: rewrite program source text. Scheme is an extension of conventional arithmetic.
- Very good pedagogic IDE: DrScheme/DrRacket



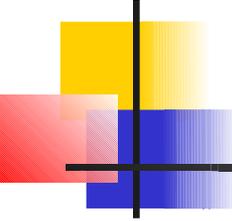
Why Java?

- Object-oriented (OO) programming is a powerful generalization of functional programming that decomposes programs into a collection of code units called classes.
- Widely used in mainstream software development.
- Classes support incremental test-driven development.
- Java/C#/C++ now dominate application programming
 - Only Java is almost completely platform independent: “write once; run anywhere.”
 - A good (but not great) OO language.
 - Efficiently implemented except for VM startup and memory footprint.
- Very good pedagogic design environment (IDE): DrJava



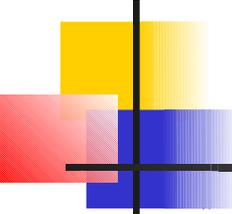
Future Options

- F# (supported as a language in Microsoft .NET) is a modern OO language with a rich functional subset akin to Ocaml. Potential problems: complex type system, only runs on Windows platform, no pedagogic IDE, not Java.
- Scala and X10 are modern OO languages with a rich functional subset that runs on the Java Virtual Machine. Potential problems: not yet mainstream languages; no pedagogic IDE; not Java; functional notation is still wordy



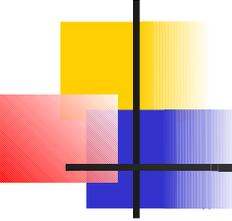
COMP 211 Prepares You to...

- Design well-engineered programs without focusing on language features.
- Work as a junior Java software developer.
- Learn deeper concepts of computing:
 - Programming languages (design and implementation)
 - Formal methods (program semantics, verification, formal logic)
 - Algorithms (including ideas central to artificial intelligence, data-mining, bioinformatics)
 - Systems (networks, operating systems, compilers)
 - Software engineering (application architecture, test-driven development, unit testing, refactoring)



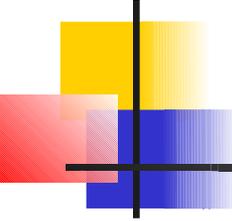
More on Grading

- Homeworks (50%)
 - Usually once a week, Friday-to-Friday timeframe is most common.
 - Work jointly in teams of two. Do **not** divide work up.
 - No late homework will be accepted, except for *7 slip* days to be used during the term. A fraction of a day counts as a full day. Advice: hoard your slip days until late in the course.
- Exams (50%)
 - Sample exams will be available online.
 - Take home, pledged, closed book.
 - First exam during week 7 counts 20%
 - Second exam during last week 15 counts 30%



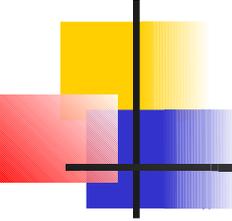
How to Succeed

- Do the reading before class
 - This will help you understand our lectures.
- Attend class and mandatory labs
 - Reading, lectures, and hands-on instruction complement one another
 - Exam questions will be drawn from all three.
- Take homework assignments seriously; **follow our examples**
 - A program that simply “works” may get a failing grade.
- Use office hours
 - Asking questions is a sign of intelligent life.
- Ask questions in class
 - No dumb questions; only inappropriate ones



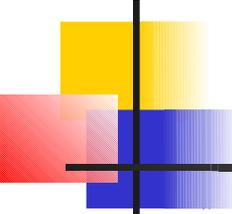
For Next Class

- Fill out entrance survey
- Attend lab tomorrow
- Make sure you have done Homework 0
 - Already posted online on web-page
 - Due next class (Wednesday)
 - Individual help is available in lab!
- Next class will cover:
 - More details on how to create and submit programming assignments.
 - The building blocks of functional programming



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About Your Instructors

- Our research programs are concerned with
 - Improving programming technology including
 - Language design
 - Developing optimizing compilers
 - Programming tools: IDEs, “soft” typers, testing frameworks
 - Programming pedagogy
 - Improving programmer productivity, using
 - Automatic program generation,
 - Lightweight formal verification (type systems),
 - Higher-order typed languages (ML, Haskell, Java+, Fortress)
 - Improving productivity of people building:
 - Real-time and embedded systems,
 - Hardware (microprocessors or “chips”),