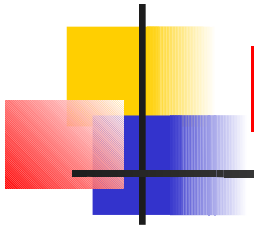
COMP 211
Principles of Program Design
Spring 2010

Prof. Robert “Corky” Cartwright

Rice University



Instructor Information

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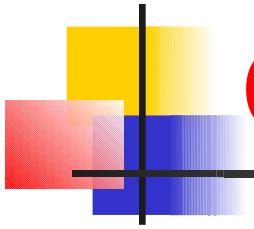
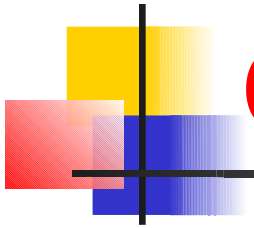


Course Materials

Course web page:
https://wiki.rice.edu/confluence/display/cswiki/211
(or search for the terms “confluence” “comp” “211”)

- This is a new wiki associated with the new 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 (15 Jan 2010).

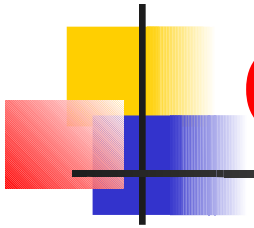


Course Demands

- Prerequisite: some programming experience

- Workload: difficult, time-consuming course, requiring about 10-12 hours outside of lectures each week.
- Weekly homework assignments, all of which involve programming; submitted electronically
- Two “segmented” take-home exams.

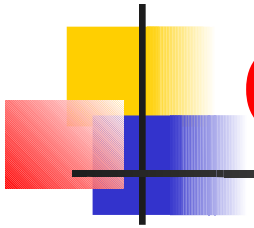
- Grading: 50% homework 50% exams



Course Mechanics

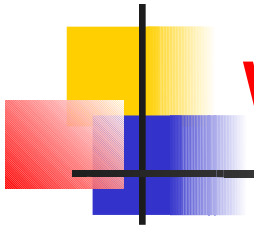
Immediate Concerns

- Take Short Entrance Survey (on wiki web page)
- Contact Zung (by email or in person) if you have not already signed up for a lab section. Available times: M 2, M 3:30, Tu 2:30 (approx 90 minutes long)
- Labs begin today at 2pm. First lab is primarily course emigration.
- HW0 posted on the course wiki is *due* on Wednesday!
  - Sign up for a CLE@R account
  - Pick a homework partner, preferably someone in the same lab (pair-programming)
  - Download PLT Scheme 4.2.3



Course Policies

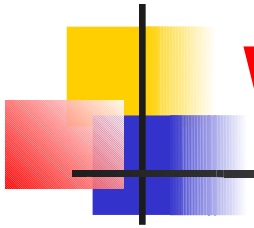
- No late assignments will be accepted--except assignments that draw on 7 slip days granted to each student for use during the term.
- Programs are graded according to a precise formula described on the course wiki. Whether a program “works” or not constitutes less than half the grade for that program. 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, (the right form of) program documentation, appropriate tests, and clean program are critical in practice.



Why Focus on Program Design?

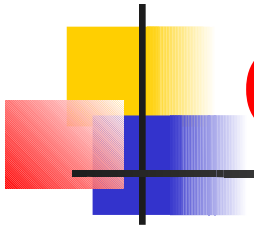
- *Program Design* is the core of Computer Science
  - Why not *Algorithms?*
  - Software is the dominant artifact of modern civilization
    - "Code is Law" [Lessig]

      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*



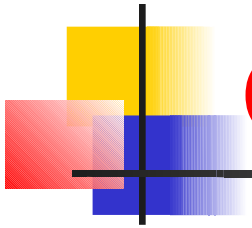
Why COMP 211?

- Repackaging of innovative curriculum for better marketing
  - Comp 210/212 developed at Rice, with major NSF funding
  - DrScheme, 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 Overview

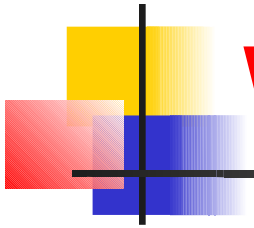
- Functional program design in Scheme (6 wks)
  - Data-directed (functional) program design 2-10
  - Algorithm design 11-14
  - Applied functional programming and review 15-17
- Object-oriented (OO) design in Java (8 wks)
  - Rudiments of the OO programming model 18-19
  - Data-directed OO program design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



OO Design Patterns Covered

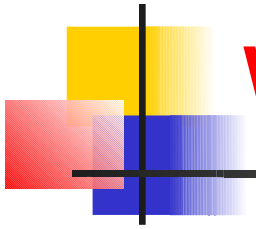
Design pattern = template for solving a computational problem

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



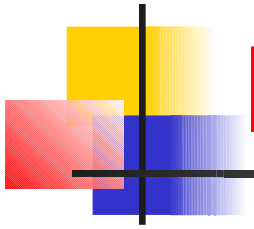
Why Scheme?

- Functional programming (FP) is the key to understanding programming as mathematics
- FP underlies many aspects of good programming design—particularly in the context of concurrent programming.
- Good notation for FP (provided by a functional language derived from mathematics) facilitates 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)
- Simple formal semantics: rewrite program source text. Scheme is an extension of conventional arithmetic
- Very good pedagogic IDE: DrScheme.



Why Java?

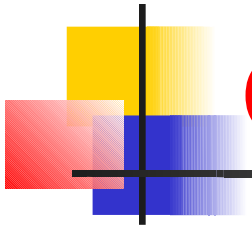
- Object-oriented (OO) programming is a powerful generalization of functional programming that decomposes programs into a collection of code units called classes.
- Widely used in mainstream software development.
- Classes support incremental test-driven development.
- Java/C# now dominate application 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

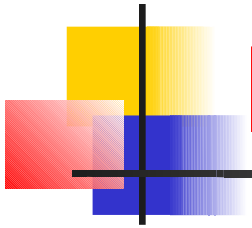
- F# (supported as a language in Microsoft .NET) is a modern OO language with a rich functional subset akin to Ocaml. Potential problems: complex type system, only runs on Windows platform, no pedagogic IDE, not Java.

- Scala is a modern OO language with a rich functional subset that runs on the Java Virtual Machine. Potential problems: primarily an academic research project, no pedagogic IDE, not Java.



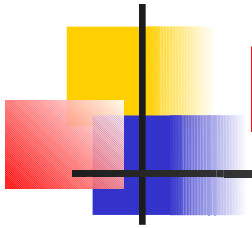
COMP 211 Prepares You to…

- Design well-engineered programs without focusing on language features.
- Work as a junior Java software developer.
- Learn deeper concepts of computing:
  - Programing 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)



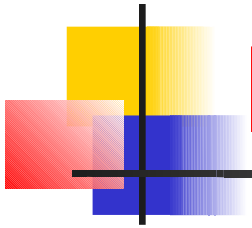
More on Grading

- 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%



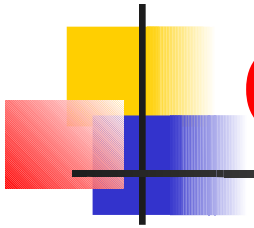
How to Succeed

- 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 Lecture

- Fill out entrance survey
- Contact Zung if you have not already requested a lab section
- Attend your assigned lab today or 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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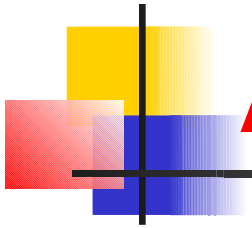

About Your Instructors

- 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”),