Java™ For RPG Programmers

™ Java is a trademark of Sun Microsystems, Inc

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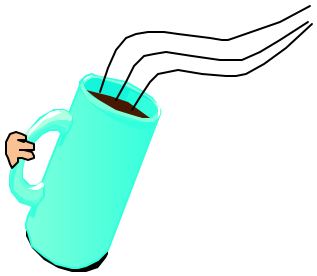
ITSO iSeries Technical Forum

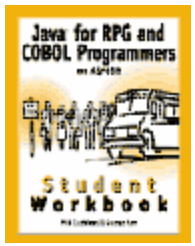
SP10 and SP11



Disclaimer

Acknowledgement:

- This presentation is a collaborative effort of the IBM Toronto AS/400 Applicaiton Development presentation team, including work done by:
  - Phil Coulthard, George Farr
- This presentation is based on the books (**www.mcpressonline/ibmpress)**
  - Java for RPG Programmers, ISBN 1-931182-06-X
  - Java for S/390 and AS/400 COBOL Programmers,1-58347-011-5
- It also contains information from the related Student Workbook (**www.mcpressonline)**
  - Java for RPG and COBOL Programmers on AS/400 Student Workbook



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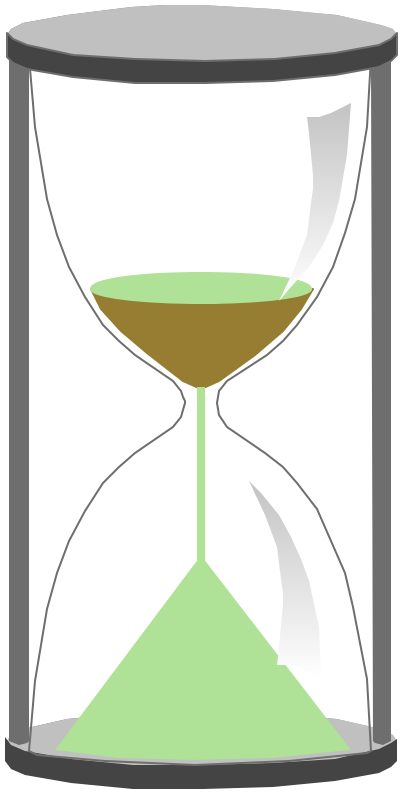
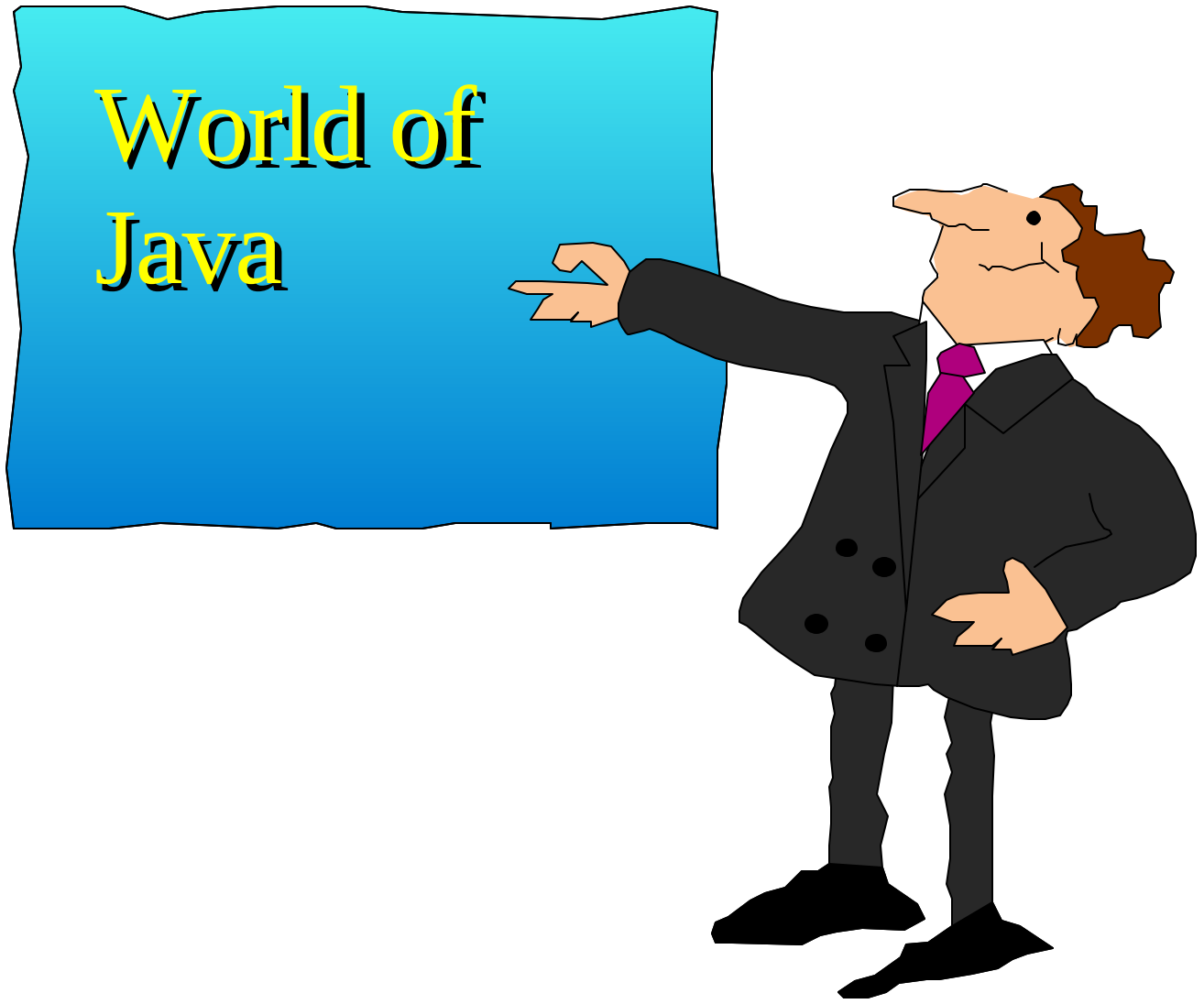
Agenda

- World of Java
- Java versus RPG:
  - RPG IV and ILE Review
  - Application Anatomy
  - Syntax, Data Types, Variables
  - Operators, Statements
  - Arrays, Strings
- OO Terminology
- Exception Handling



Agenda



What is Java?

- An OO programming language
  - Created by Sun Microsystems Inc, in 1995
  - Adopted by Netscape in 1996
  - Heavy investment by IBM ever since
- Initially for:
  - applets that run in Web Browsers
  - applications that are client-GUI or server non-GUI
- Now also for:
  - Servlets that run in a Web Server
  - Enterprise JavaBeans that run on a server
  - and much more...

Java Mantra

- "Write Once, Run Anywhere"
  - Java code is interpreted
  - Java interpreter has been ported to just about every operating system, Web browser, Web server, and hand-held device in existence today
  - Java language comes with many pre-defined functions and services
    - In the form of "packages"
    - Reduces dramatically the need to rely on operating system APIs
- "Learn Once, Use Everywhere"
  - Use Java for GUI, Web, Business Logic, Tools, Business Applications, Games, . . .

Three Flavors of Java

- Java 2 Standard Edition (J2SE):
  - For JavaBeans, applets, GUI/non-GUI application
  - START HERE
    - but also use Servlet and JSP support from your Web Application Server
- Java 2 Enterprise Edition (J2EE):
  - For Java Servlets, JavaServer Pages
    - Although also available via Application Servers such as WebSphere
  - For Enterprise JavaBeans, Java Naming and Directory Interface, Java Messaging Service, . . . and much more!
  - GROW HERE
- Java 2 Micro Edition (J2ME):
  - For small, embedded devices: chips, phone, hand-helds...

Java Landscape

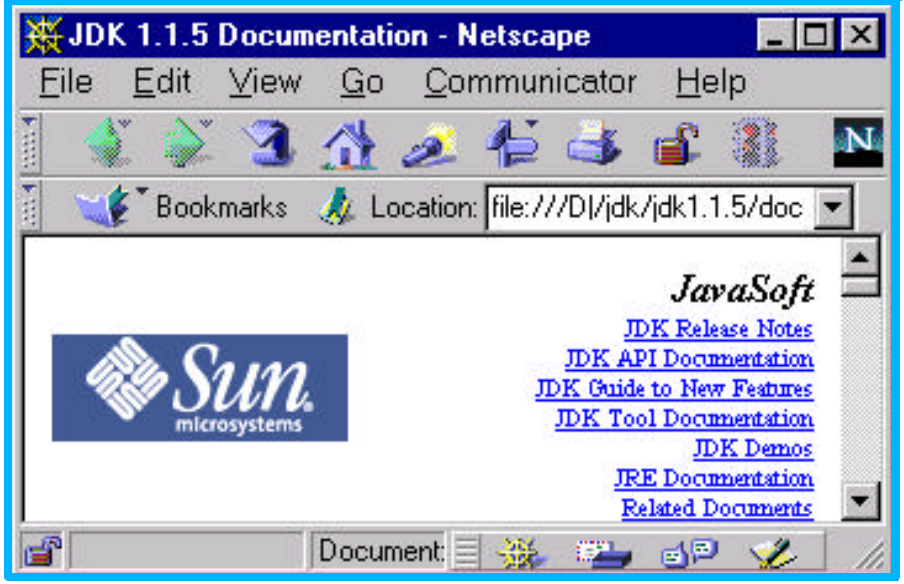
- How is Java packaged?
  - For developers
    - In a "Java Development Kit" (**JDK**)
      - Compiler, runtime, command line tools
  - For runtime
    - In a "Java Virtual Machine" (**JVM**)
      - Interpreter
- How do you get Java?
  - For developers
    - JDK from Sun (www.java.sun.com) or IBM (www.ibm.com/java)
    - JDK also built-in to Java tools like VisualAge for Java, WSSD
  - For runtime
    - JVM built-in to many Operating Systems, Web Browsers, App'n Servers, PDAs, Cell Phones, etc

JDK Contents

Command line tools

- JVM / interpreter ("java")
- Bytecode compiler ("javac")
- Doc'n tool ("javadoc")
- Compression tool ("jar")
- . . .

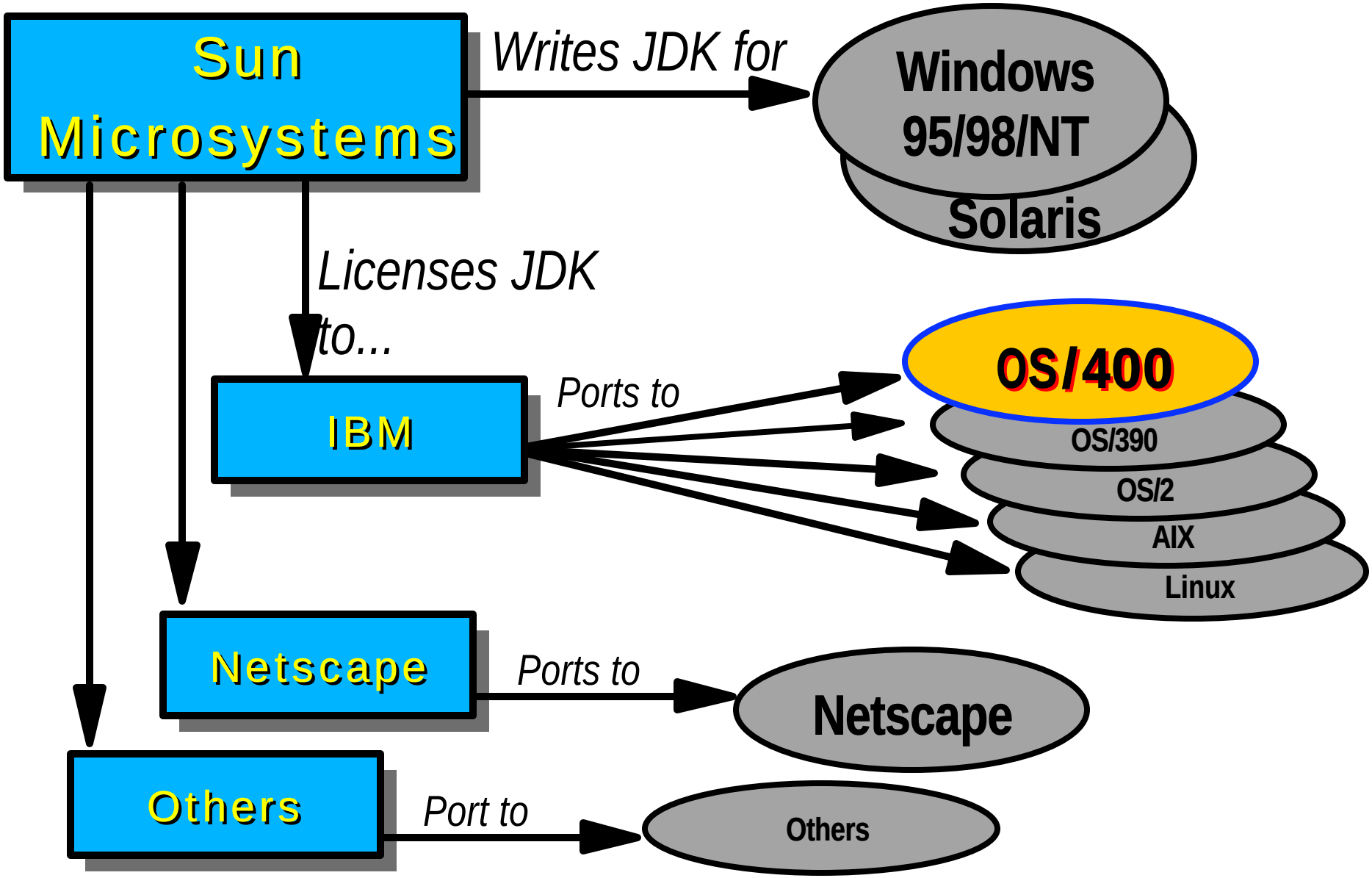
Documentation



Packages

- language
- database access
- math
- graphics
- file system
- . . .
- networking
- utilities

JDK Licensing



Java Classes

- Classes
  - ►Compilation unit
    - •no matter what you are using Java for!
  - ►All fields and executable code are inside classes
  - ►Source files are compiled into class files

- Bytecode
  - ►What are inside class files
  - ►Assembler language for Java
    - •what the JVM "interprets"

Java Beans

- JavaBeans™
  - ► Classes designed for fine-grained re-use
    - Java's components, like Microsoft VB's VBX
    - Not to be confused with Enterprise JavaBeans!!
  - ► Beans contain
    - **properties** (fields),
    - **methods** (paragraphs),
    - **events** **(eg, button-pressed)**
  - ► Tools can discover contents dynamically
    - ► And present list to use to select from or change
- JAR™ Files (Java ARchive)
  - ► Java way to group/compress class files
    - for easy distribution (uses ZIP technology)

Using Java

- Applications
  - Java command line programs (you call)
- Applets™
  - Java Web Browser programs (Web Browser calls)
- Enterprise JavaBeans™
  - Enterprise-scale re-usable components (Application Server calls)
  - Large scale (eg payroll) versus JavaBeans (eg, tax)
- Java Servlets™
  - Java Web Server programs (Web Server calls)
- JavaServer Pages™
  - HTML plus embedded Java (Servlets call)

Java Tools

- Java Tools are
  - ►Optional
    - minimal requirement: JDK + editor
  - ►Productive
    - eg, wizards and debuggers
  - ►Numerous
    - From IBM, Symantec, Sun, Inprise, ...
- IBM Java Tool story
  - ►"Next generation" tools are
    - **WebSphere Studio Site Developer** (Java, Web, XML tooling)
    - **WebSphere Studio Application Developer** (+ EJB tooling)
  - ►For iSeries, there is
    - **WebSphere Development Studio Client** 4.0 (follow-on to WDT)

Java and the Web

- Java and Web are a good fit!
  - Most common use of Java today for business is:
    - Glue between business logic / transactions, and Web pages
  - This is done by
    - Wrapping the business logic / transaction in a JavaBean/EJB
    - Calling the JavaBean/EJB from a Java Servlet
    - Creating JavaServer Pages (JSPs) that
      - Are simply HTML static pages with "holes" for dynamic data
      - Are called by the Java Servlet, which passes the dynamic data in the form of a simple Java Bean (think of this bean as a data structure)
      - Are resolved into straight HTML by the JSP engine and passed to the Web Browser
- Java Servlets and JSPs...
  - are industry standard
    - run in a Web Application Server that meets industry standard

- Runtime engine for JSPs and Servlets
  - ►Plugs into Web server such as
    - •IBM HTTP Server "classic", Apache, IIS, Domino
  - ►Runs on many platforms
    - •OS/400, OS/390, Windows, Unix, Linux, Solaris, ...
- Runtime engine for EJBs
  - ►Only for Advanced Edition prior to 4.0 release
  - ►In all editions as of 4.0

www.ibm.com/software/webservers

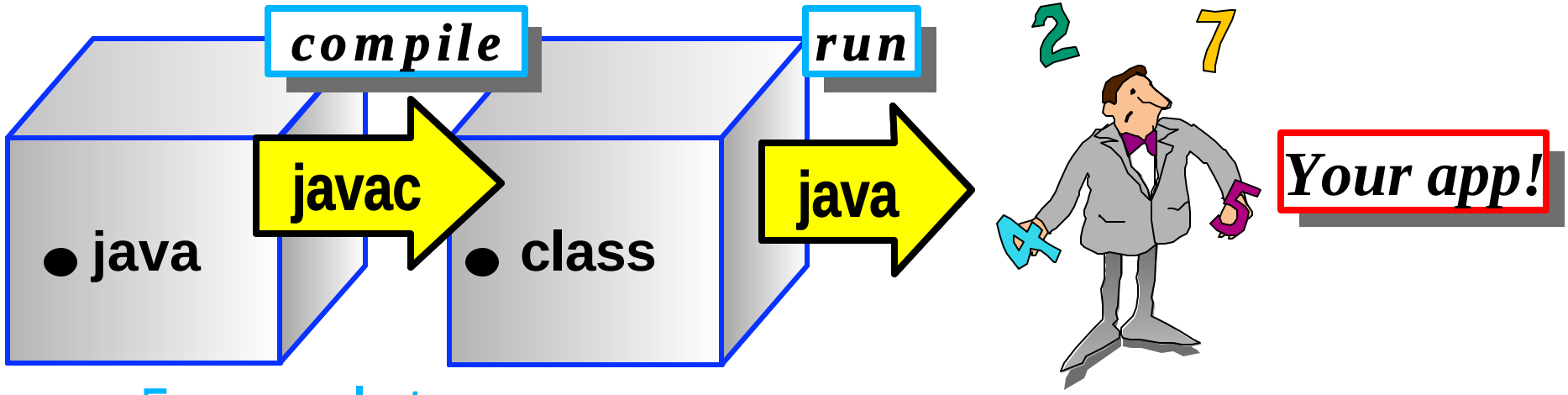
www.ibm.com/iseries/websphere

Web Tools

- Web Tools are for
  - Web site management
    - Organizing Web projects and files
    - Publishing to test and product application servers
  - HTML and other static content
    - Images, audio, video, etc
  - Java Servlets and JavaServer Pages
    - For designing JSPs, generating servlets and JSPs via wizards
- IBM Web Tool story
  - "Classic" tool is WebSphere Studio
    - What is in current release of **WDT for iSeries**
  - "Next generation" tool is
    - **WebSphere Studio Site Developer** (Java, Web, XML tooling)
    - **WebSphere Studio Application Developer** (+ EJB tooling)

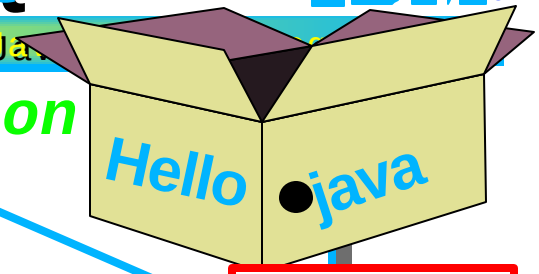
Java LifeCycle

- Use **javac** to compile
  - Use java to run from command line
    - if it is application or to unit-test this individual class



  - For applets
    - Use HTML/JSP file with <APPLET> tag pointing to the applet
  - For servlets
    - Use HTML/JSP file with <FORM> tag pointing to the servlet
  - For EJBs
    - Include in Web Application that is deployed to a J2EE Container

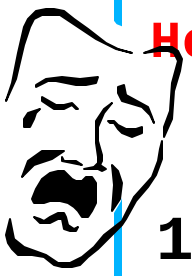
Compiling Java




```
/* Prototypical Hello World application
public class Hello
{
     public static void main(String args[])
     {
          System.lout.println("Hello World!");
     }
}
```

"main" method called by JVM

```
E:\mycode>javac Hello.java
Hello.java:6: No variable lout defined in class System
          System.lout.println("Hello World!");
                 ^
1 error
```

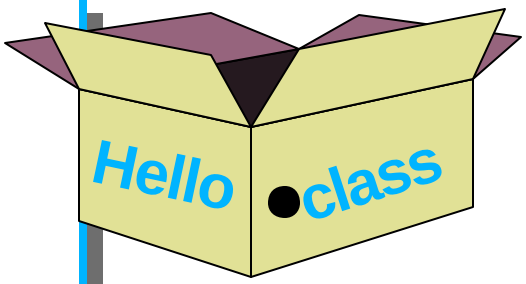


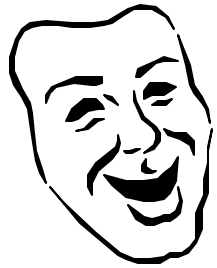
```
System.out.println("Hello World!");
```

```
E:\mycode>javac Hello.java
```

Running Java Apps

```
E:\mycode>java Hello
Hello World!
```



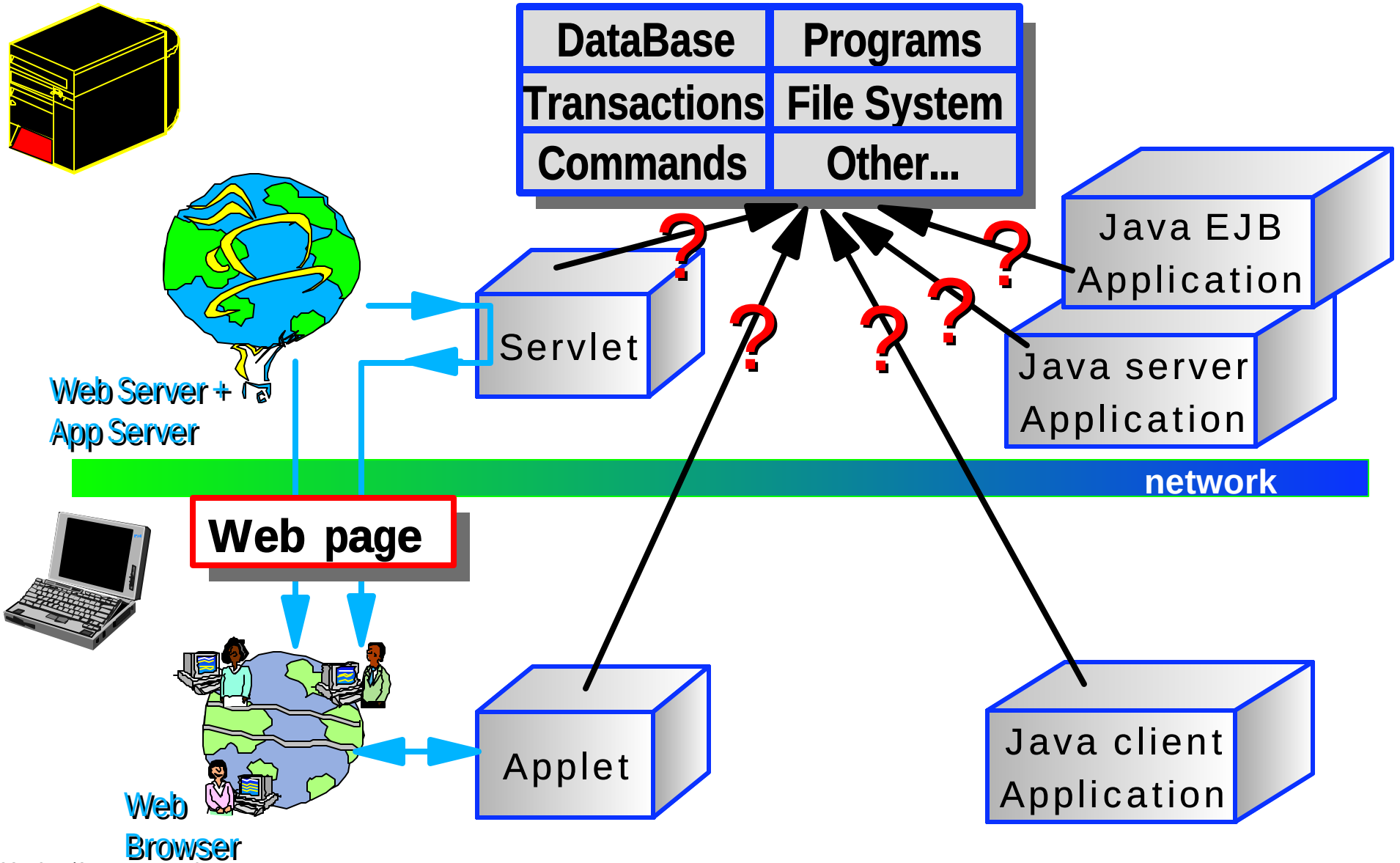


Java Entry Points

	Appl'n	Applet	Servlet
Where runs	Anywhere	Web Browser	Web Server
Who calls	User	Browser	Web Server
How invoked	java command	<APPLET> html tag	By mapping to URL
Entry point	main method	init, then paint	init, then doGet / doPost
Security restrictions	No	Yes	Optional

Non-Java Resources

- How to access non-Java resources?



Accessing Data

- Standards for Accessing Data
  - ► JDBC™
    - Dynamic SQL access to relational data or stored procedures
    - Part of the Java standard
    - Patterned after ODBC, but with OO versus C-APIs
    - JDBC driver manager comes with Java
    - JDBC drivers supplied by DB vendors or others
      - ► IBM UDB, HIT Software, Oracle, Sybase, Inprise, . . .
  - ► SQL/J
    - Static SQL embedded inside Java
    - Created by Oracle, supported by IBM UDB
  - ► Java Stored Procedures
    - IBM UDB supports writing stored procedures in Java

AS/400 Toolbox For Java

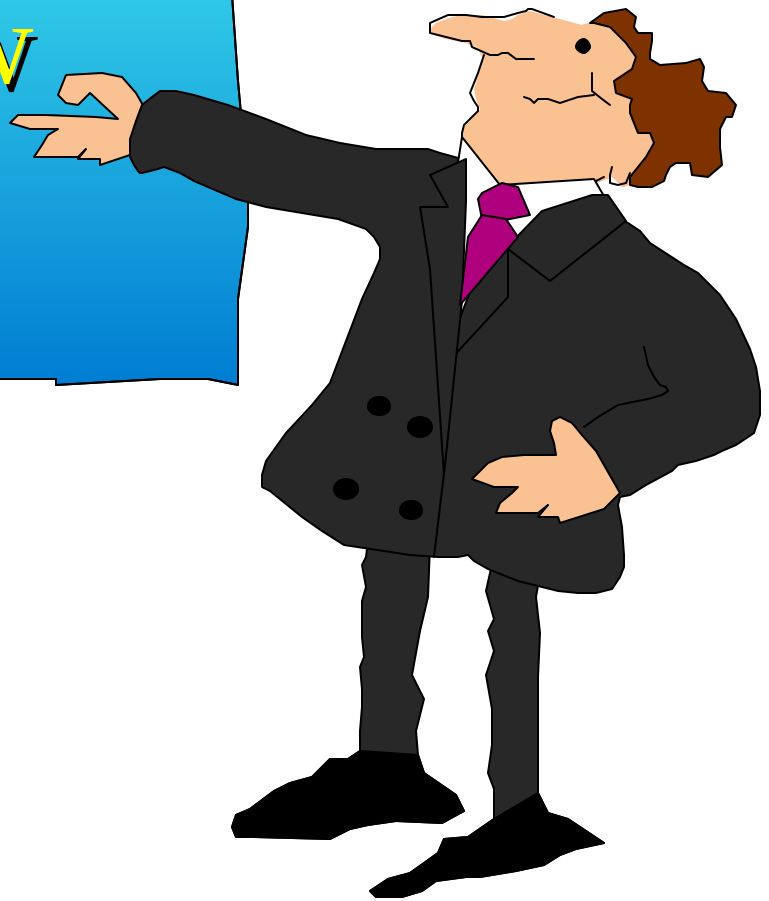
- 100% Java classes for:
  - JDBC access to DB2/400
  - DDM record level access to DB2/400
  - Data Queue access
  - Print access
  - Program Call, Command Call
  - File system access
  - Client to server connections, remote login
  - Much more...
- Runs anywhere
  - OS/400, Windows, Linux, Unix, . . .

free!

Shipped with OS/400, WDSc

Agenda

RPG IV and
ILE review



The Java Language

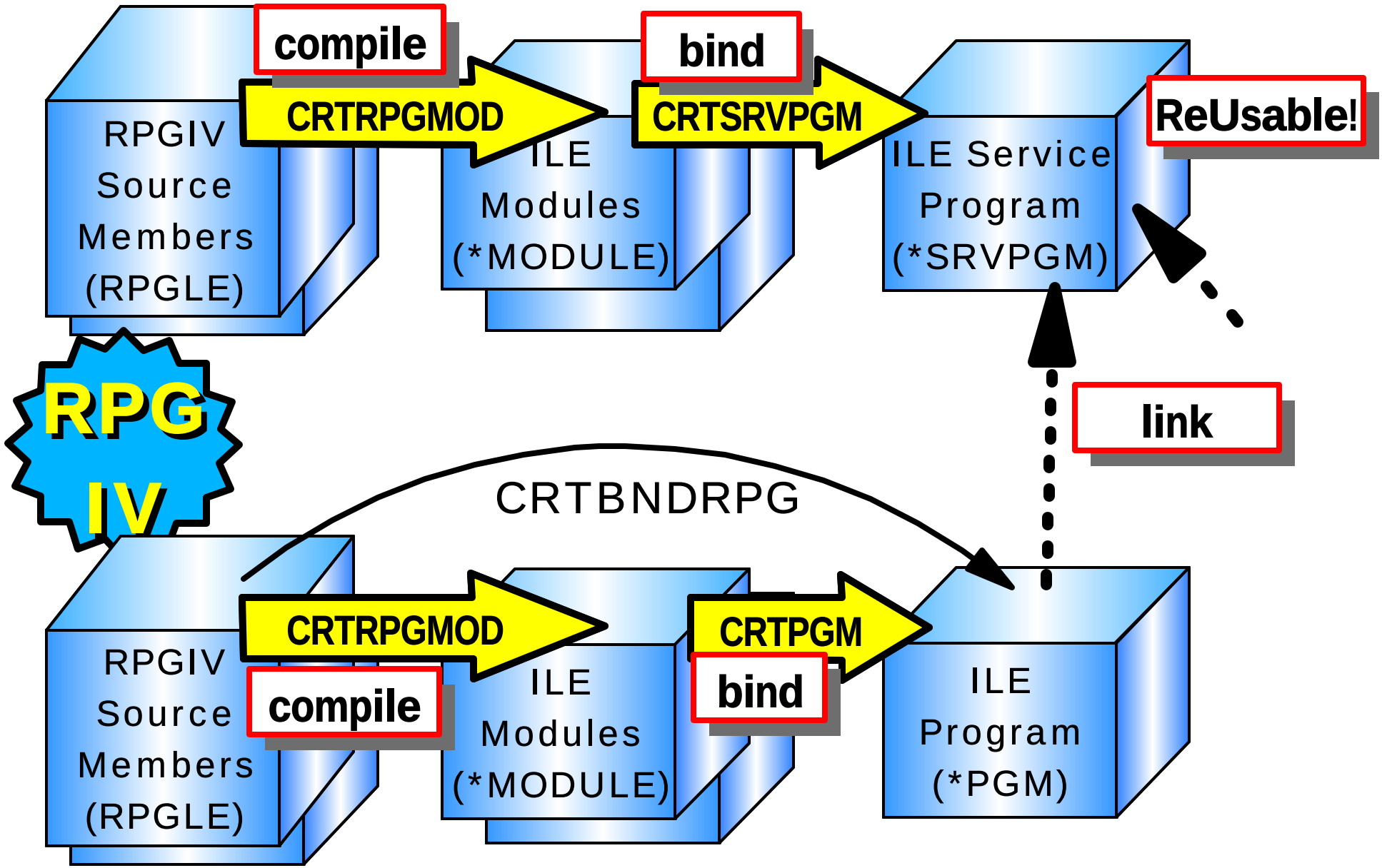
- We compare Java to RPG IV
  - closer match to Java than III
  - more modern constructs
  - easier skills transfer to Java!

Continue your RPG IV journey!

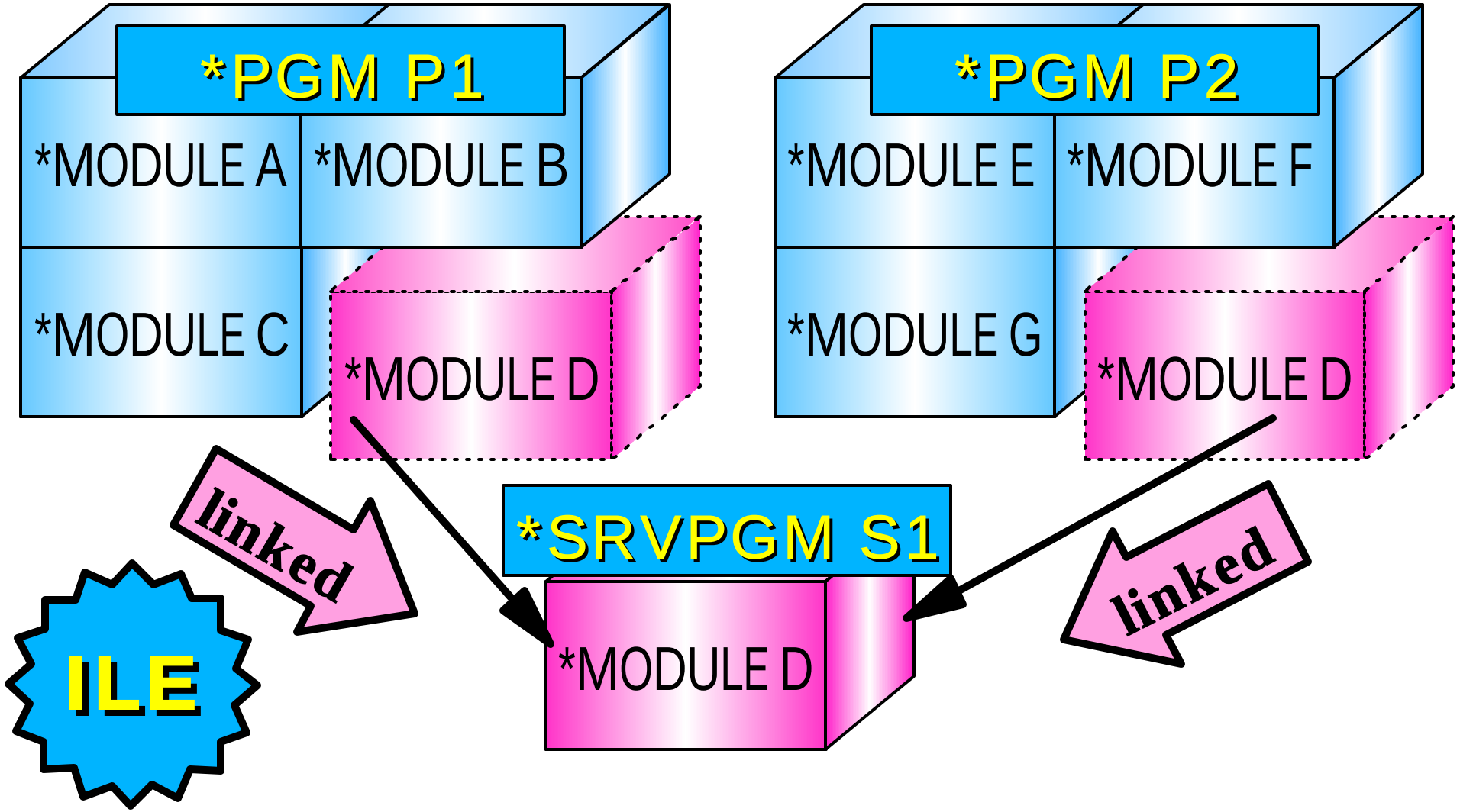
RPG IV Review

- ✓ **Longer names (10, but 4096 in V3R7)**
- ✓ **Mixed case (folded to upper by compiler)**
- ✓ **New D spec (Definition) for declares**
- ✓ **Free form expressions in factor 2 of some op-codes: EVAL, IF, DOW, DOU, WHEN**
- ✓ **New data types**
  - Date, Time, Timestamp, Integer, Float, Null, Variable-Length (V4R2), Indicator (V4R2) fields
- ✓ **Built-in functions (like %TRIML / R)**
- ✓ **Procedures ("grown up subroutines")**
  - fast intra/inter-module calls. New CALLP op-code

ILE Compiling, Binding



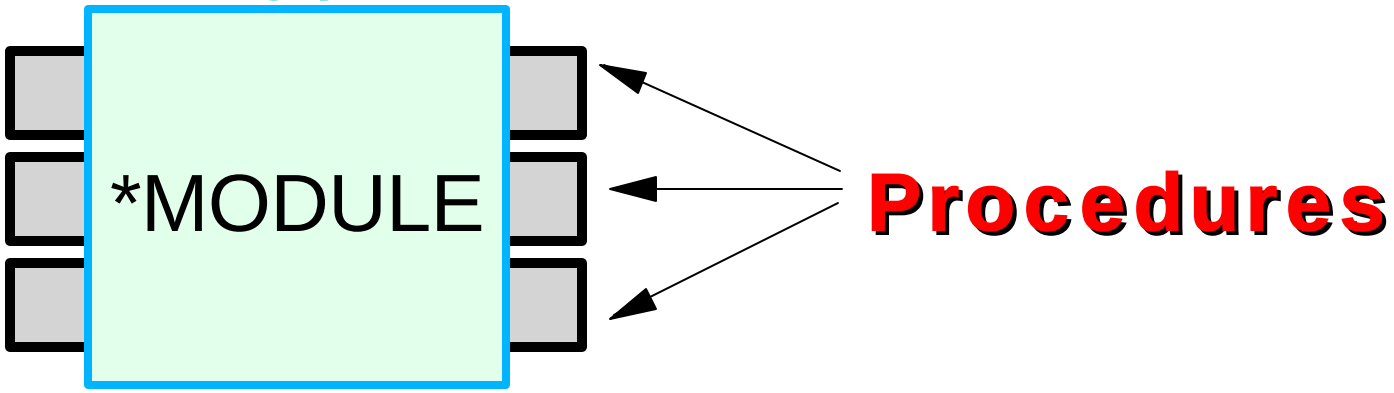
ILE Service Programs



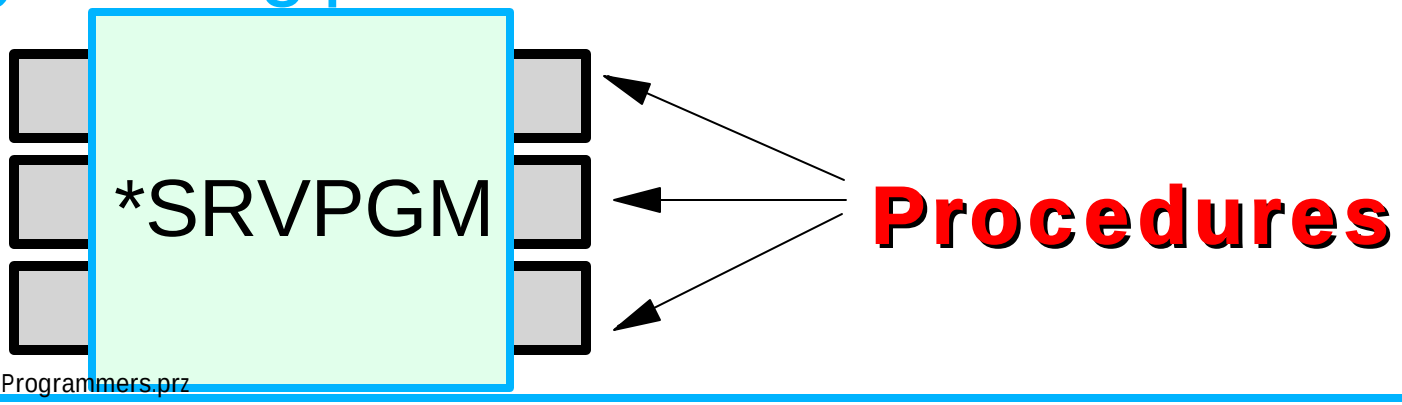
- allow you to extract out common code
- are linked, not bound, to *PGMs

Inter-Module Calls

- Modules ***call*** each other...
  - by calling procedures



- *PGMs ***call*** *SRVPGMs...
  - By calling procedures



RPG IV Procedures

- ✓ Local Variables
- ✓ Return Values
- ✓ PARMS: Value & Reference
- ✓ Recursion
- ✓ Exporting
- ✓ Prototyping

"grown up subroutines"

Modularity

Re-Use

Skills transfer to Java (methods)

Anatomy of Procedures


```
Pmax                B                   EXPORT
 * return value
D max                PI            5P 0
 * parameters
D parm1                            5P 0 VALUE
D parm2                            5P 0 VALUE
 * local variables
D temp               S             5P 0
 * local code
C                    IF            parm1 > parm2
C                    EVAL          temp = parm1
C                    ELSE
C                    EVAL          temp = parm2
C                    ENDIF
C                    RETURN        temp
 * end of procedure
Pmax                 E
```

P-spec

Procedure Beg

return type

parameters

local field

executable code

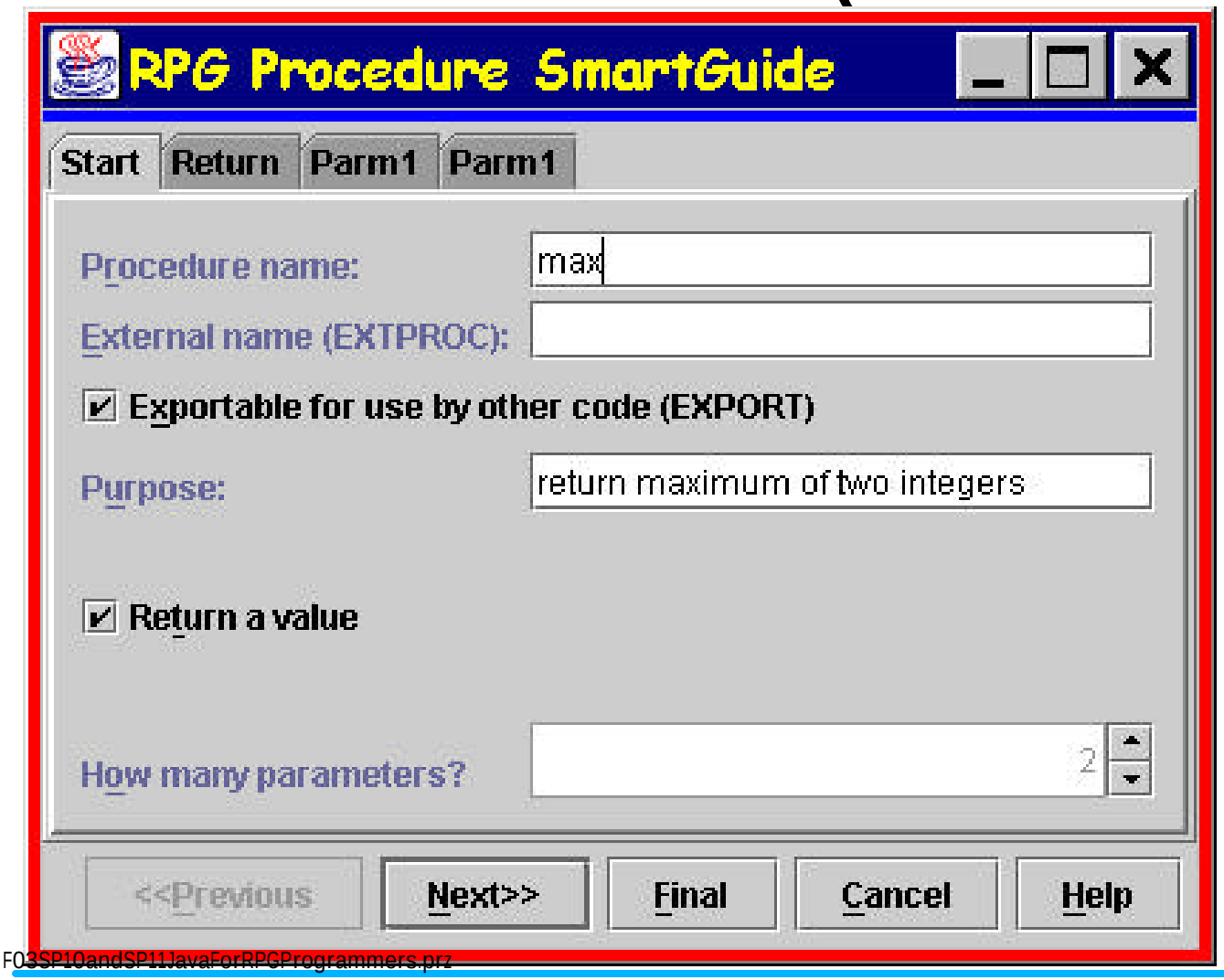
return value

P-spec

Procedure End

Advertisement!

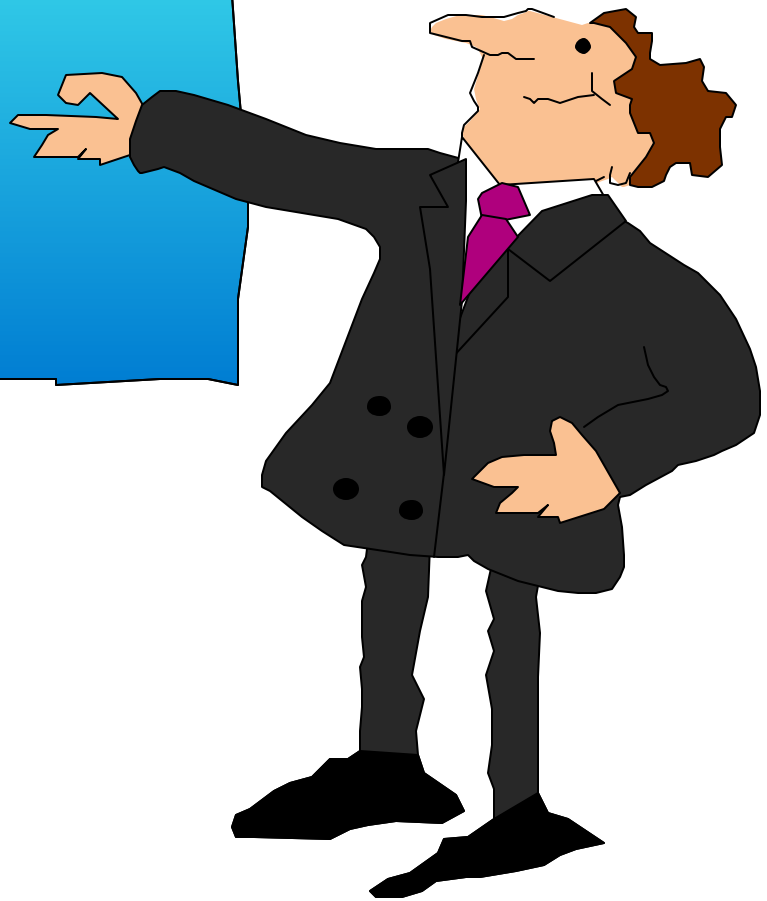
- CODE/400 has a Procedure SmartGuide ("wizard")



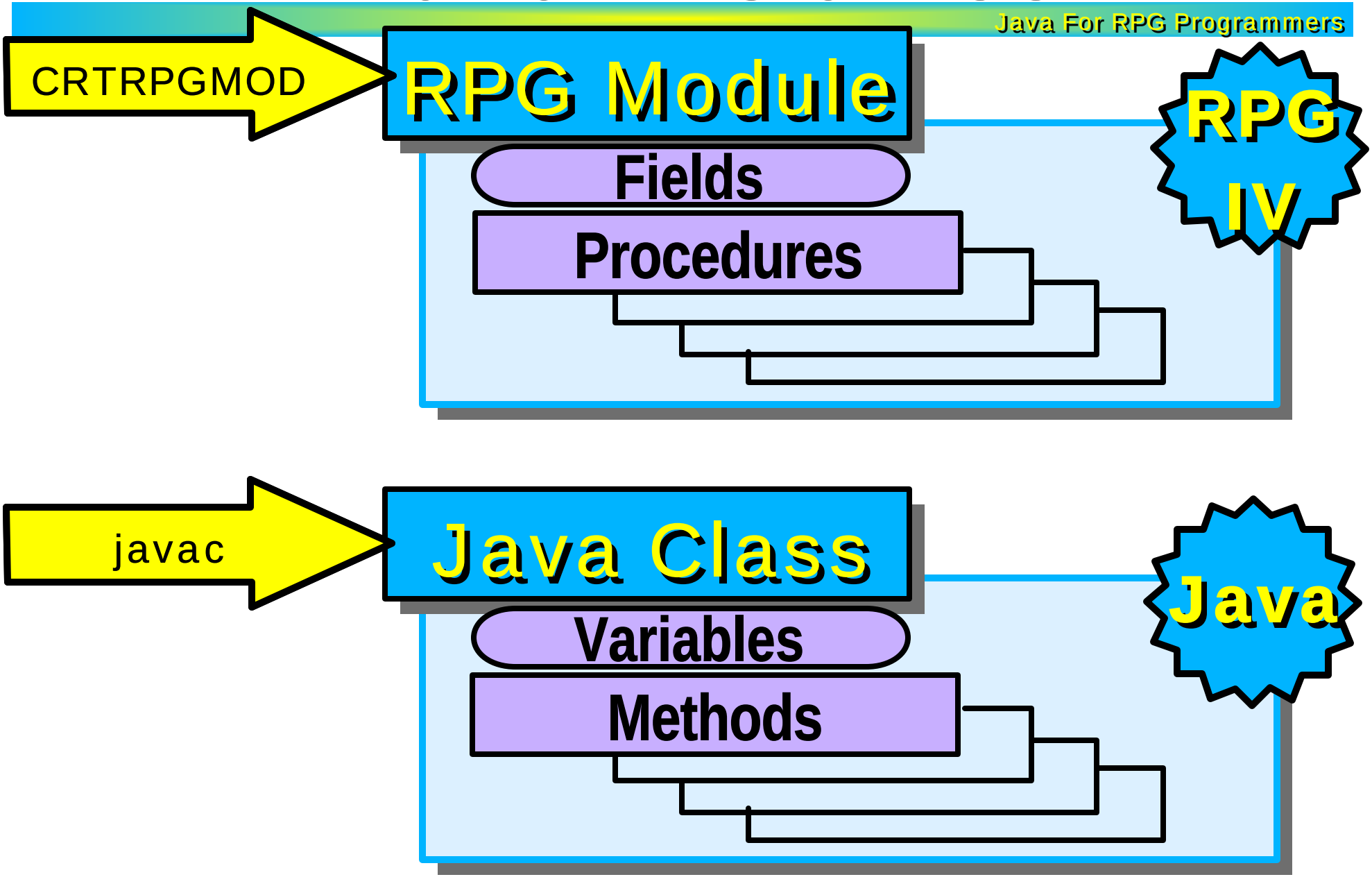
- generates skeleton code for you
- saves you from memorizing procedure syntax

Agenda

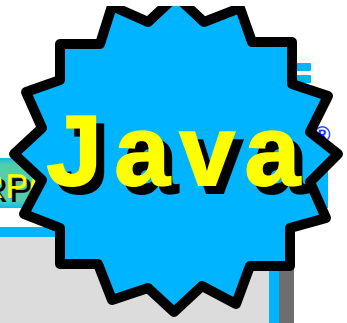
Java vs RPG



MODULE vs CLASS



Java Class Syntax



class **keyword: what we're defining**

public **modifier: anyone can use**

private **modifier: only code in this class can access**

braces { } delimit start and end of class

```
public class Customer
{
   private int custId;
   private char custCode;

   public static void main(String args[])
   {
      . . .
   }

   public int setMyVariable(int newValue)
   {
      . . .
   }
}
```

class name

Global variables

field name

"main" method (described later)

Methods (described next)

Java Methods

public modifier: anyone can call

method name

parameter type + name

void keyword: nothing returned

Code goes here

Comments

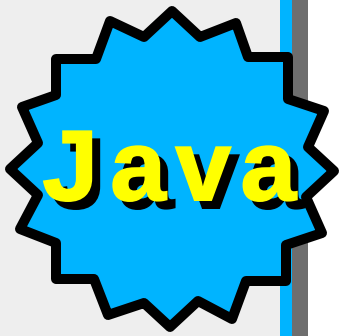
private modifier: only code in this class can call

integer value returned

```
public void setId(int idParm)
{

} // end of the method

private int read()
{

} // end of the method
```

Code goes here

braces { } delimit start and end of methods



Java Method Example

```
int max(int parm1, int parm2)
{
   int retval;

   if (parm1 > parm2)
     retval = parm1;
   else
     retval = parm2;

   return retval;
}
```

no public modifier specified so only classes in this package can call this method

Local Variables

Parm type/name pairs

Java

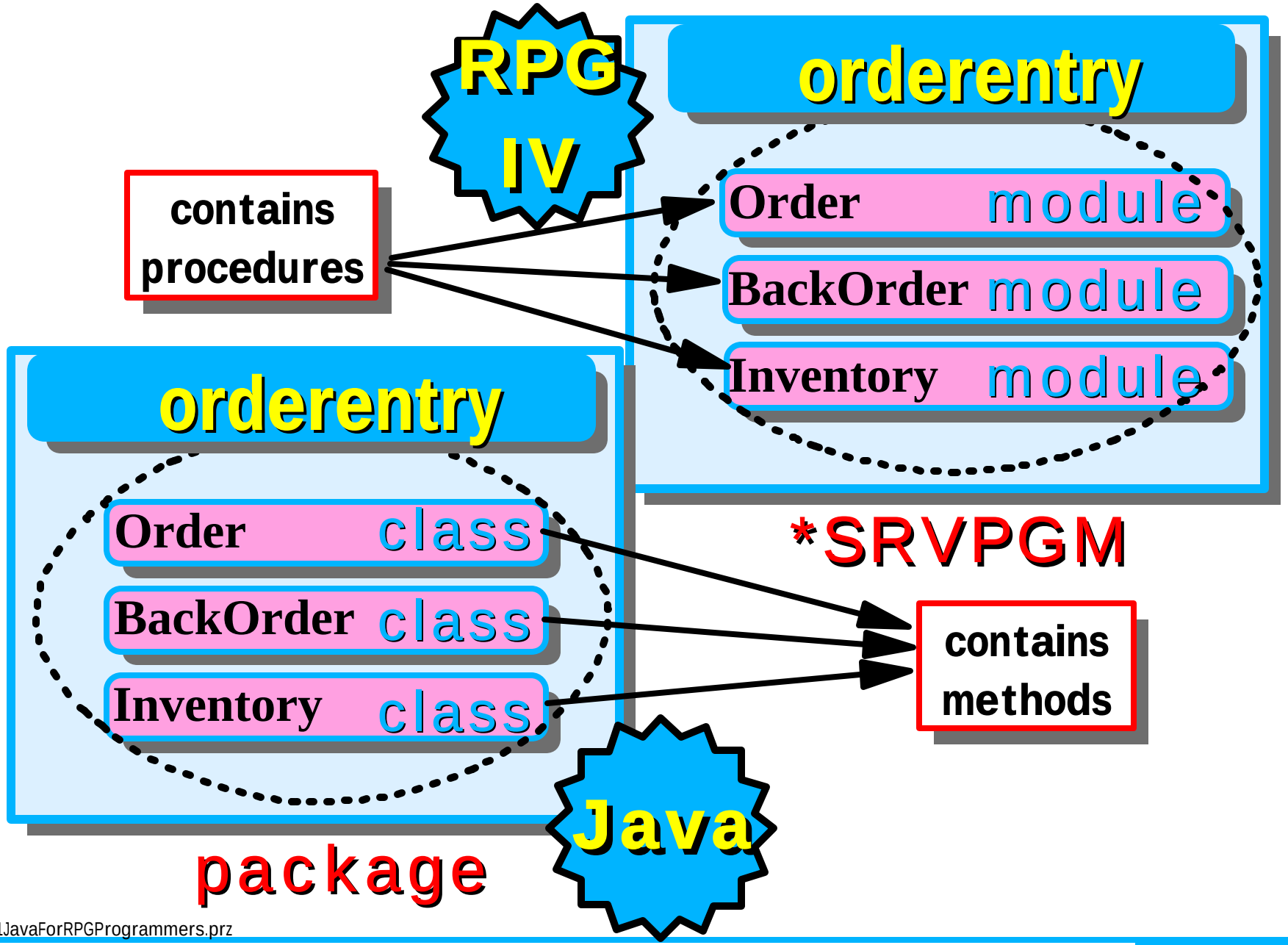
Return Value

int is the integer data type in Java

Naming Conventions

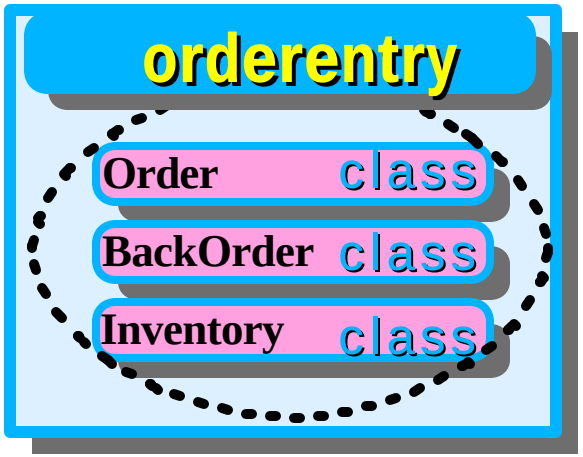
- Class names should
  - ►be all lowercase except
    - ***first letter of each word***
    - ***eg:* OrderEntry**
- Method / field names should
  - ►be all lowercase except
    - ***first letter of each word other than first***
    - ***eg:* processOrder**
- Constants should
  - ►be all uppercase
    - ***eg* SUNDAY**

Packages



Defining Packages

"package" must be first statement in source file



"package" is like compiler directive

Order.java

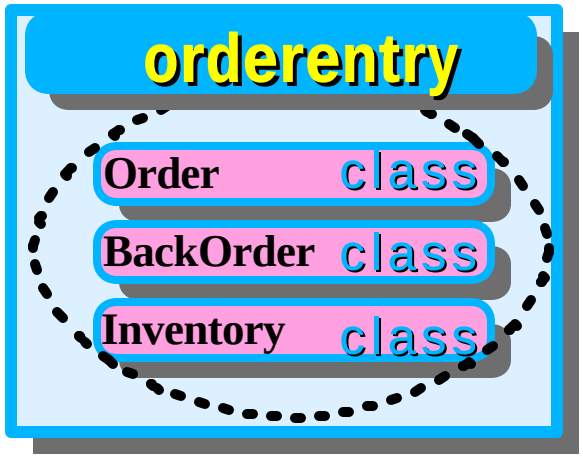
```
package orderentry
public class Order
{
    ...
}
```

BackOrder.java

```
package orderentry
public class BackOrder
{
    ...
}
```

Using Packages

"import" enables access to classes in package



can import one class or all (*)

"import" is like ADDLIBLE. It is NOT like /COPY!

Order.java

```
import orderentry.* ;
public class Order
{
    ...
}
```

Java

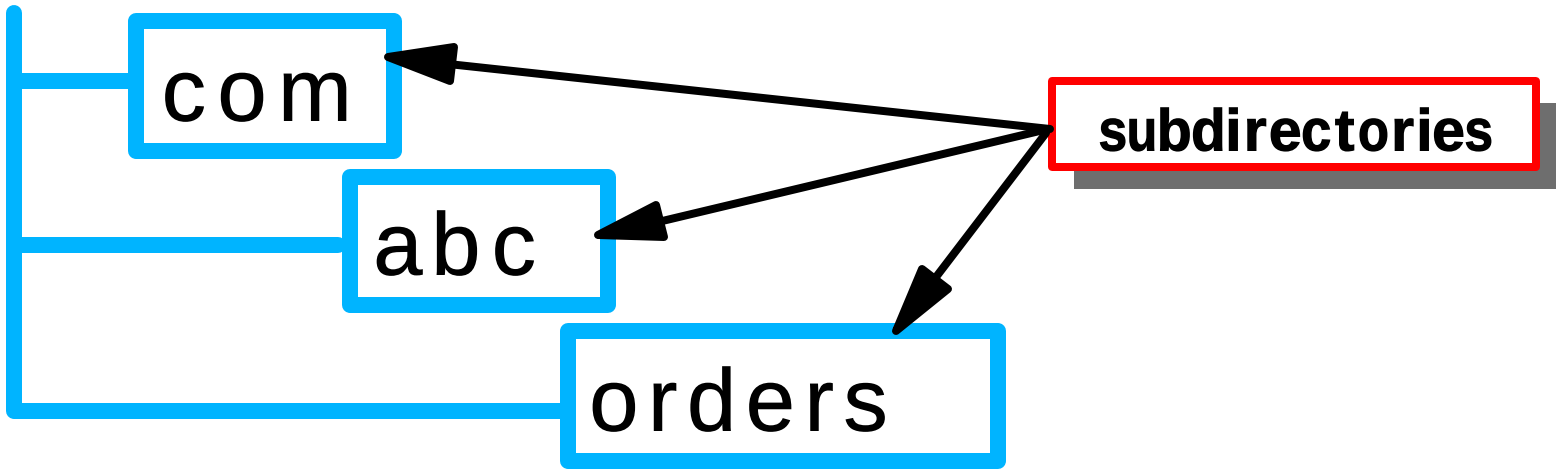
Naming Packages

- Package names are
  - usually all lowercase
  - usually multi-part, dot separated
- Java-supplied packages
  - all named java.xxx
  - for example: java.awt or java.awt.event
- Your packages
  - will start with com.xxx, where xxx.com is your company's domain name
  - eg. IBM's start with com.ibm.xxx

java.lang always imported for you

Packages vs File System

- Packages
  - have no file system objects!
  - map to directories
    - ***One per dot-separated name part***
- For example
  - Consider package name com.abc.orders



Comparing Anatomies

RPG	JAVA	COMMENTS
*PGM	Application	*Program object == Application*
*SRVPGM	Package	
Module	Class	*Compilation unit*
Fields	Variables	*Global variables*
Procedures	Methods	*Functions*
Variables	Variables	*Local Variable*
Code	Code	*Executable code*

CLASSPATH

- How are classes found?
  - when referred to by code in other classes
  - by the compiler (javac) and runtime (java)
- Answer!
  - by searching the CLASSPATH env variable
- CLASSPATH
  - is a list of semi-colon separated directories
    - ***colon separated on OS/400***
  - much like library list on OS/400!
    - ***system searches it for first match***

CLASSPATH

- CLASSPATH entries are
  - directories to search for classes

c:\autoexec.bat on:
Windows95 / 98

```
SET CLASSPATH = .;c:\myJava
```

search current directory

search c:\myJava directory

CLASSPATH and Packages

- For classes in packages
  - name parent directory containing subdirs
- Consider package com.abc.orders:
  - if com\abc\orders is off of c:\myJava . . .

```
SET CLASSPATH = .;c:\myJava
```

searches inside .\com\abc\orders

searches inside c:\myJava\com\abc\orders

ZIP and JAR Files

- Two options for distribution:
  - ZIP files
    - ***Industry standard compression technology***
  - JAR files (Java ARchive)
    - ***Same as ZIP by written in Java, part of JDK***
- To compress multiple files together
  - Use WINZIP or PKZIP utilities on Windows or…
  - Use jar command that comes with JDK

```
jar -cvf myClasses.jar *.class
```

create myClasses.jar file

put all class files in it

CLASSPATH and ZIP, JAR Files

- You don't have to uncompress!
  - ►JVM can find and read classes directly from ZIP files and JAR files!!
    - ***That's cool!***
- However, the .zip or .jar file must be on the CLASSPATH environment var
  - ►place actual file name on path, not just dir!

```
SET CLASSPATH =
.;c:\myJava;c:\myJava\myClasses.jar
```

JAR files and Applets

- For APPLETS, use archive parm
  - Versus CLASSPATH environment variable
  - On <APPLET> tag in HTML source
  - Identify one or more .jar files
    - *plus-sign separated*

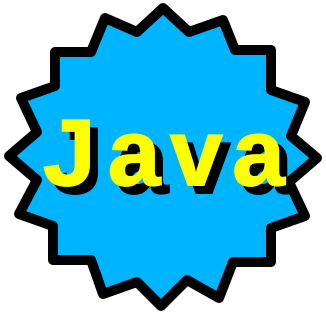
```
<APPLET code=CoolApplet.class
        codebase=
          "http://www.mycompany.com/coolstuff"
         archive="cool.jar + cooler.jar"
        height=500
        width=300>
</APPLET>
```

Browser JVM will search these for referenced classes

Java Syntax

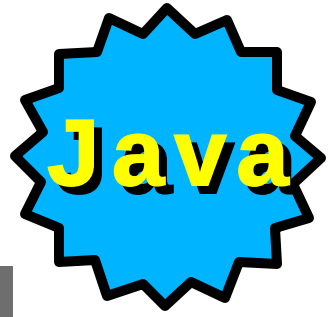
- Statements are free-format
  - extra blanks and lines are ignored
  - statements end with semi-colon ;
- Blocks use braces { }
  - start and end of classes
  - start and end of methods
  - start and end of conditional / loop blocks
- All names are case-sensitive
  - abc NOT= ABC
  - even source file names are case sensitive

C-like syntax



I Want To Be Free

- **Java is totally free form**
  - extra blanks and lines ignored




```
void myMethod(int param1)
{
    return;
}
```

=

```
void myMethod(int param1) {
    return;
}
```

```
return;
```

=

```
return
;
```

Java Comments

- Multi-line comment:

```
/* this is a
multi
   line comment */
```

```
/*-------------------------*
 * Please read these comments  *
 * as they are very important! *
 *-------------------------*/
```

- Single line comment:

```
// This whole line is a comment
int myVariable = 10; // Only this part is a
comment
```

- JavaDoc comment:

note double asterisk

```
/** This is the <U>scan package</U>
 *  this is the second line.
 *  @author  George & Phil
 *  @version Feb 26,2000
 */
```

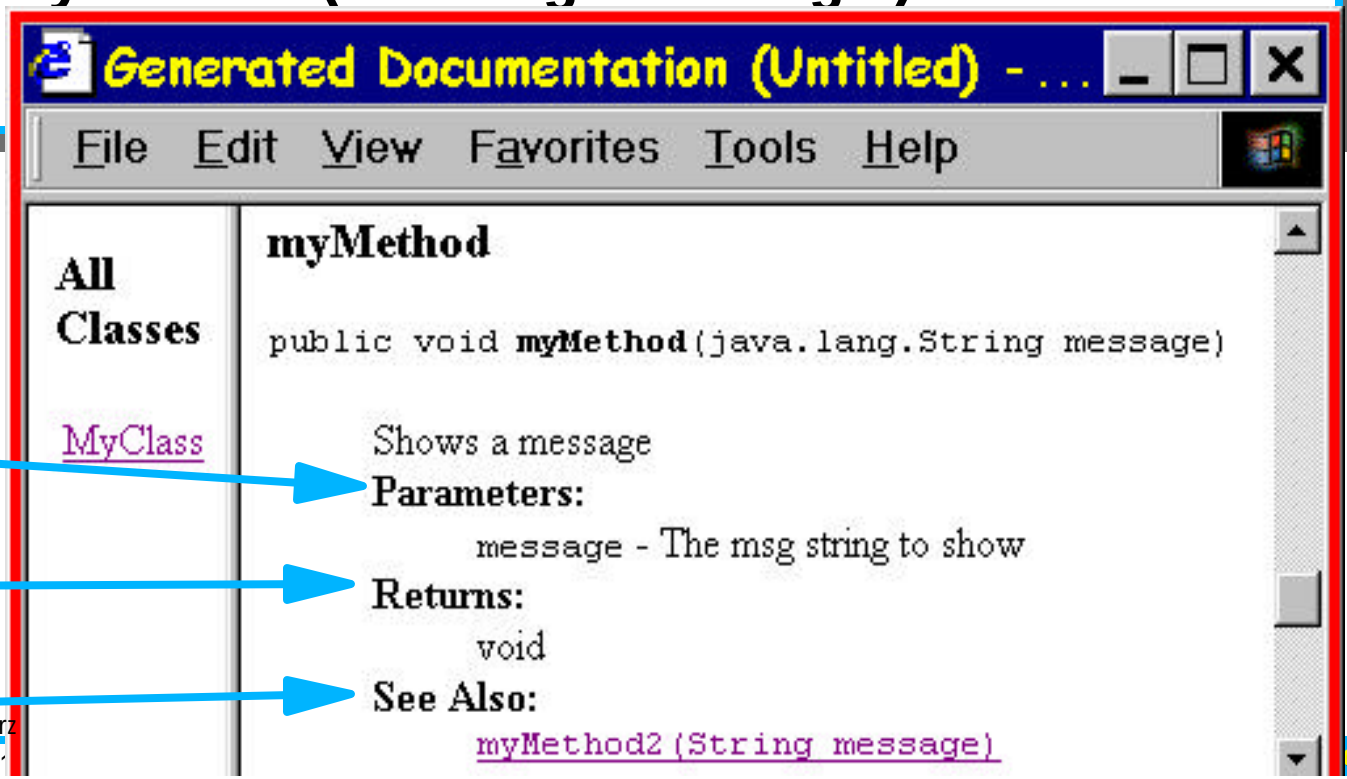
JavaDoc Comments

- Can use special tags
  - special meaning to javadoc formatter
  - can also use any HTML tags like **bold**

Tag	Description
@author	Author of this class or method
@see	References another class or method. Generates a link
@version	Version number of this class or method
@since	Release or version this class or method has existed since
@deprecated	This is an obsolete method
@return	Describes what this method returns
@param	Describes a parameter to this method

JavaDoc Example


```
/**
 * Shows a message
 * @param  message The msg string to show
 * @return void
 * @see    MyClass#myMethod2(String message)
 */
public void myMethod(String message)
{
```

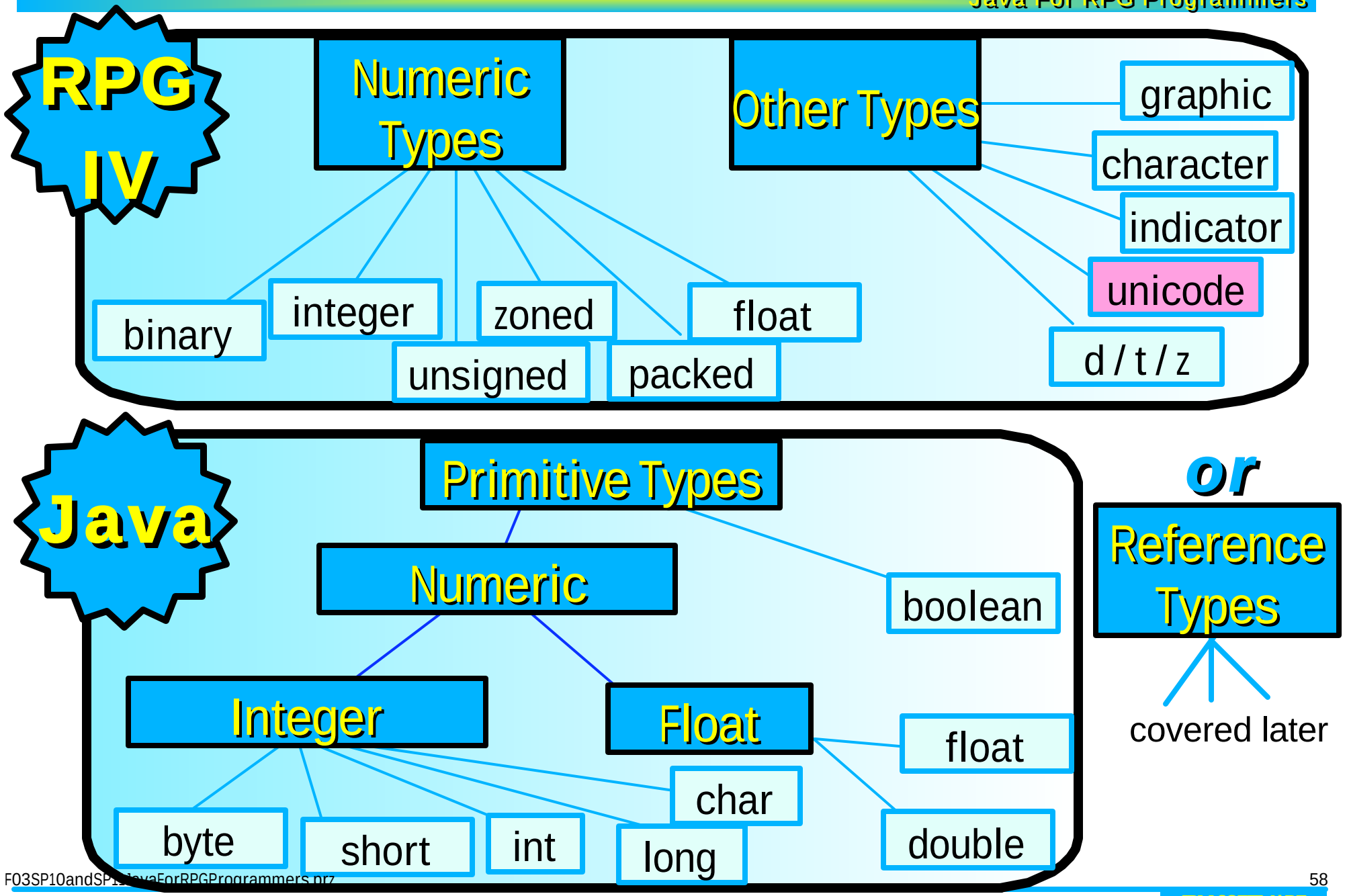


@param

@return

@see

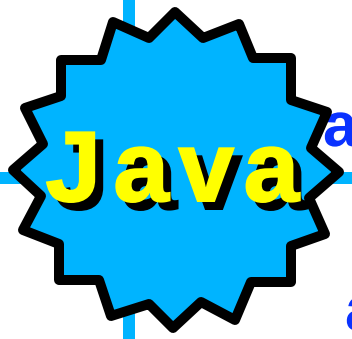
Data Types Overview



Java Primitive Types

IBM®

Type	In Use	Description
Integer	int i;	4 byte signed: about +- 2 billion
Long	long l;	8 byte signed: about +- huge #
Byte	byte b;	1 byte signed: -128 to + 127
Short	short s;	2 byte signed: -32768 to 32767
Character	char c;	2 byte unicode. 1 char only!
Boolean	boolean flag;	true or false
Float Single	float f;	32 bit
Float Double	double d;	64 bit



Data Types...

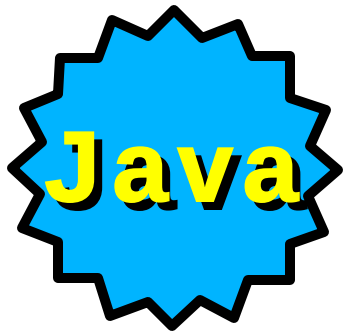
RPG	Java	Comments
numeric (no decimals)	**short** or **int**	**depends on length**
numeric (with decimals)	**float** or **double**, or **BigDecimal** class	**depends on length. BigDecimal is a Java supplied class**
float (length 4)	**float**	**Both are IEEE standard**
float (length 8)	**double**	**Both are IEEE standard**
character (length one)	**char**	**single character only**
character (length n)	**String** class	**A class, not a primitive type**
graphic	**String** class	**A class, not a primitive type**
unicode	**String** class	**A class, not a primitive type**
indicator	**boolean**	**'1' =** true, **'0' =** false
date, time, timestamp	**GregorianCalendar** class	**A class, not a primitive type**

More on Boolean

- Can be assigned true or false:
  - `boolean myFlag = true;`

language keywords

- Can be assigned an expression:
  - `boolean myFlag = (rate > 10);`
- Can be in an expression:
  - `if (rate > 10) ...` *** or ***
  - `if (myFlag)`
- Can be negated:
  - `myFlag = !myFlag;`
  - `while (!myFlag) ...`



What about Packed?

- **No** packed decimal data type in Java
  - Could use float / double, but precision is a problem for "fixed decimal" numbers

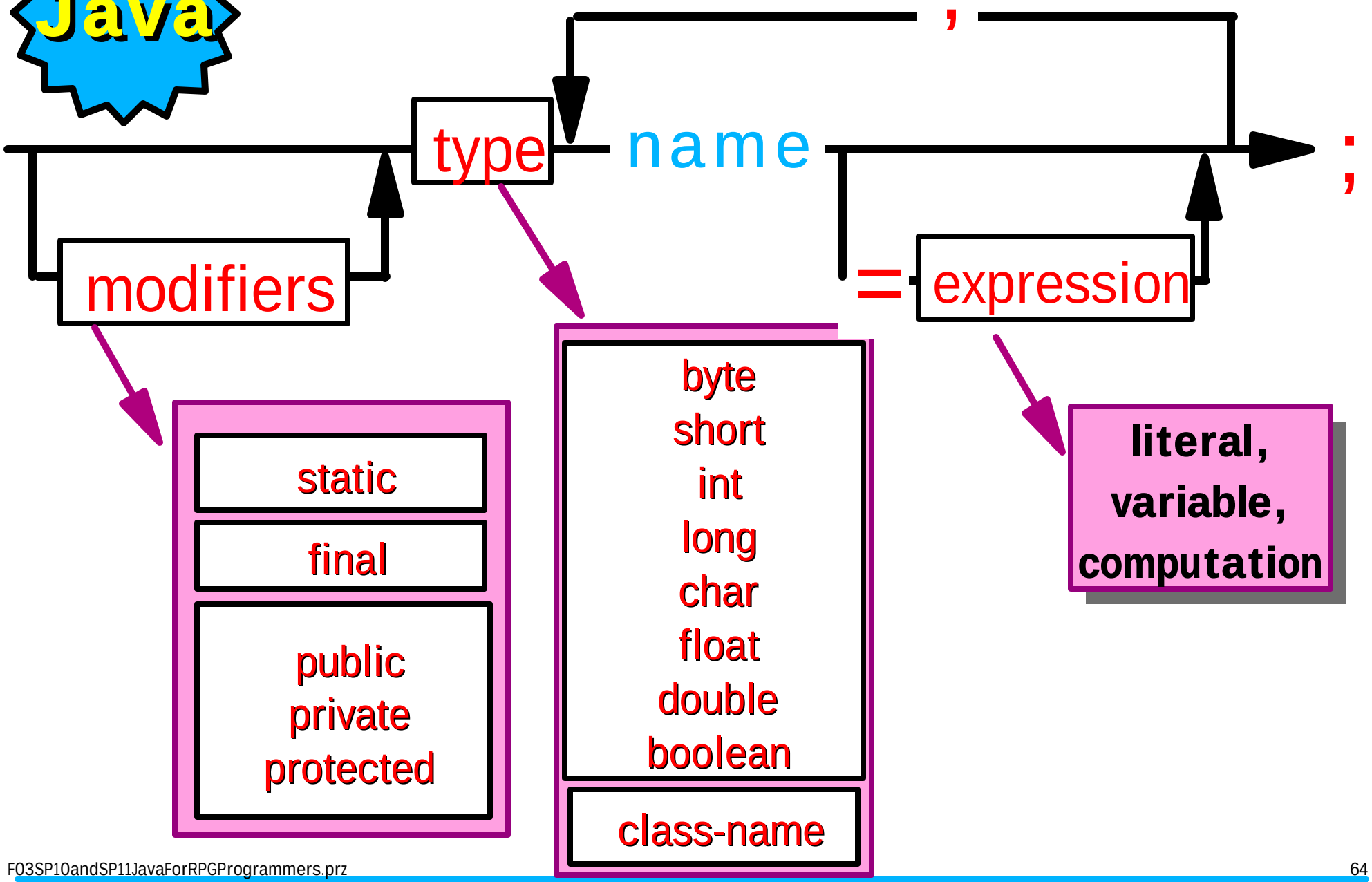
- Answer: **BigDecimal** class
  - Part of **java.math** package
  - A class, not a built-in "primitive" data type
  - *Software simulation* of fixed decimal numbers
  - Unlimited **precision** (total number of digits)
  - Program control over **scale** (number of decimal digits)
  - Methods include: **add**, **subtract**, **divide**, **multiply**, **setScale**
- See also: **BigInteger** class

Declaring Fields in RPG


```
+*.. 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+... 6 ...+...
************ Beginning of data ********************************
FQSYSPRT   O    F   80        PRINTER OFLIND(*INOV)
D FIRST          S                7A   INZ('George ')
D AGE            S                2B 0 INZ(25)
D*-------------------------------------------------------------
C     *LIKE      DEFINE    FIRST          LAST                -3
C                EVAL      LAST='FARR'
C                MOVE      ' AGE WAS--->'AGETEXT              12
C                EXCEPT    RESULT
C                MOVE      *ON            *INLR
C*-------------------------------------------------------------
OQSYSPRT   E                RESULT
O                           FIRST           5
O                           LAST           10
O                           AGETEXT        22
O                           AGE            26
```

- On the C specification
- Using the Define operation code
- ✓ On the new Definition specification

Declaring Variables



Declaring

RPG IV

```
D*..1....+....2....+....3....+....4..
DEmpRcd           DS
D number                         5I 0
D type                           1A
D name                          20A
D address                       50A
D hired                          D
D salary                         9P 2
```

Java

```
public class EmployeeRecord
{
  private int    number;
  private char   type;
  private String name;
  private String address;
  private Date   hired;
  private BigDecimal salary;
}
```

DS = "Data Structure"
S = "Standalone"

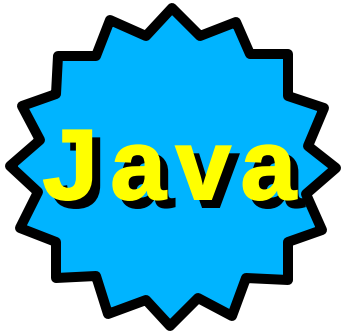
access *modifiers*

data types

actual variable names

Where's the Length?

- You do not specify #digits!
  - Data Type determines # of bytes
    - ***which determines how much var can hold***
    - ***eg: short holds -32768 to 32767***



- Usually you will use:
  - integer ("int") when no decimals (unless numbers > 2 billion)
  - BigDecimal class when decimals needed
  - String class when dealing with characters

Declaring and Init'g


```
public class EmployeeRecord
{
    private int     number  = 0;
    private char    type    = 'R';
    private String  name    = "Joe Public";
    private String  address = "1 Young St";
    private Date    hired   = new Date();
    private BigDecimal salary = new BigDecimal("30000.00");
}
```

Java

Note: new operator described later

```
D*..1....+....2....+....3....+....4....+....5
DEmpRcd           DS
D number                         5I 0 INZ(0)
D type                           1A   INZ('R')
D name                          20A   INZ('Joe Public')
D address                       50A   INZ('1 Young St')
D hired                           D
INZ(D'1999-12-31')
D salary                         9P 2 INZ(30000)
```

RPG IV

Declaring Constants

"static" and "final" keywords define a constant

Java

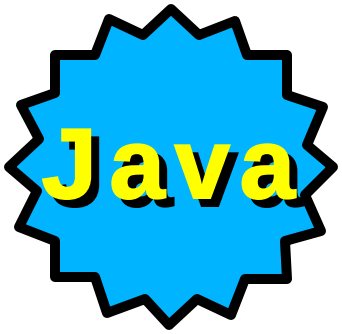
```
public class EmployeeRecordDefaults
{
    static final int     NUMBER = 0;
    static final char    TYPE   = 'R';
    static final String  NAME   = "Joe Public";
    static final String  ADDRESS = "1 Young St";
    static final Date    HIRED  = new Date();
    static final BigDecimal SALARY  =
                    new BigDecimal("30000.00");
}
```

RPG IV

```
D*..1....+....2....+....3....+....4....+....5
D*EmpRcdDFT       DS
D numberDFT       C                   CONST(0)
D typeDFT         C                   CONST('R')
D nameDFT         C                   CONST('Joe Public')
D addressDFT      C                   CONST('1 Young St')
D hiredDFT        C                   CONST(D'1999-12-31')
D salaryDFT       C                   CONST(30000)
```

Wrapper Classes

- Primitive types have wrappers
  - classes in java.lang package
    - ***always imported for you!***
  - sometimes you will need them
    - ***such as for Vectors as we'll see***
    - ***they also have handy methods and constants***



Primitive	Wrapper
byte	**Byte**
short	**Short**
int	**Integer**
long	**Long**

Primitive	Wrapper
char	**Character**
boolean	**Boolean**
float	**Float**
double	**Double**

Casting in RPG

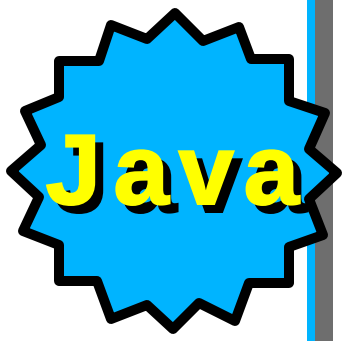
casting is always implicit in RPG

```
...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+...
****************** Beginning of data ************************
     FQSYSPRT   O    F   80        PRINTER OFLIND(*INOV)
     D DS1                DS
     D  int5                                5I 0 INZ(25)
     D  BIN9                                9B 0 INZ(22)
     D  ZONE9                               9S 0 INZ(30)
     D  PACK9                               9P 0 INZ(40)
     D*-------------------------------------------------------
     C                    MOVE      BIN9           INT5
     C                    EXCEPT    RESULT
     C                    MOVE      PACK9          INT5
     C                    EXCEPT    RESULT
     C                    MOVE      ZONE9          INT5
     C                    EXCEPT    RESULT
     C                    MOVE      *ON            *INLR
     OQSYSPRT   E              RESULT
     O                         INT5                15
******************** End of data ****************************
```

RPG IV

Casting in Java

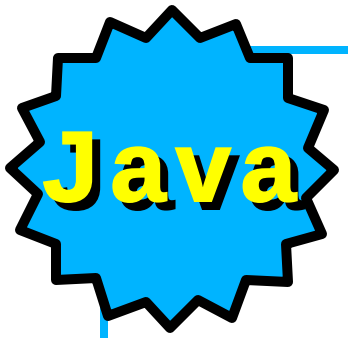
```
public class TestCast
{
    public static void main(String args[])
    {
        short sValue = 10; // 2 bytes
        long  lValue = 30; // 8 bytes
        lValue = sValue; // implicit
        sValue = (short)lValue;// explicit
    }
}
```



- Casting in Java
  - only implicit if target *type* larger than source
  - else must explicitly cast: (target-type)source

What About OverFlow?

- Source won't fit in target?
  - Nothing happens!!
    - ***No overflow indicators in Java!!***
  - You're job to check first before casting:
    - ***Use* MIN_VALUE *and* MAX_VALUE *constants in wrapper classes***




```
if ((lValue <= Short.MAX_VALUE) &&
    (lValue >= Short.MIN_VALUE))
  sValue = (short)lValue; // cast
else
  // overflow/underflow error...
```

Casting Summary Table

	byte	char	short	int	long	float	double
byte	No	Cast[1]	No	No	No	No	No
char	Cast	No	Cast[1]	No	No	No	No
short	Cast	Cast	No	No	No	No	No
int	Cast	Cast	Cast	No	No	No	No
long	Cast	Cast	Cast	Cast	No	No	No
float	Cast	Cast	Cast	Cast	Cast	No	No
double	Cast	Cast	Cast	Cast	Cast	Cast	No

Java

read left to right

[1] Potential loss of sign

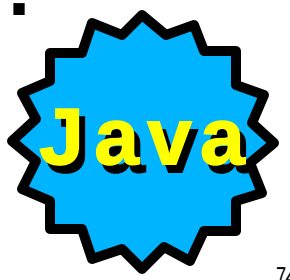
Assignment

- RPG IV:
  - free-format EVAL op-code & equal operator '='
- Java:
  - no op-code, just equal operator "="

RPG III	RPG IV	Java
`C  MOVE  0  X`	`C  EVAL  X = 0`	`X = 0;`

- Java also allows stringing:

```
A = B = C = 25;
```



If-Else


```
C*    op-code   factor2
C     IF        expression
C*      Body
C     ELSE
C*      Body
C     ENDIF
C*      :
```

RPG

```
if (condition)
   {
      //Body;
   }
else
   {
      //Body;
   }
```

Java

- Similar in both languages
- But in Java
  - Body can be compound or single statement
    - ***Single statement bodies don't need braces***

IF Example

RPG III

```
C     AGE           IFLE      2
C                   MOVE      0         PRICE
C                   ELSE
C     AGE           IFLE      10
C                   MOVE      5         PRICE
C                   ELSE
C                   MOVE      10        PRICE
C                   ENDIF
C                   ENDIF
```

Java

```
if (age <= 2)
  price = 0;
else if (age <= 10)
  price = 5;
else
  price = 10;
```

RPG IV

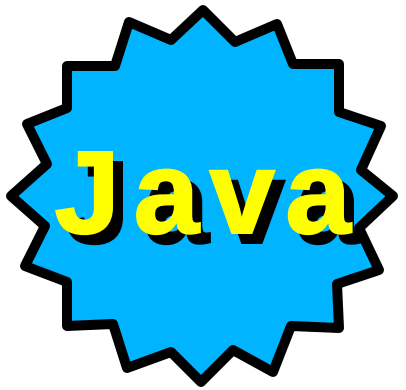
```
C                   IF        AGE <= 2
C                   EVAL      PRICE = 0
C                   ELSE
C                   IF        AGE <= 10
C                   EVAL      PRICE = 5
C                   ELSE
C                   EVAL      PRICE = 10
C                   ENDIF
C                   ENDIF
```

note single statement in body so braces not required

Conditional Operator

- Conditional operator '? :'
  - also called a *ternary* operator
- Short form for if statement
  - when only binary decision to make

```
result = (idx == 20) ? 30 : 35;

// same as...
if (idx == 20)
   result = 30;
else
   result = 35;
```



SELECT vs switch

IBM

RPG

```
C           SELECT
C           WHEN day = MON
C*             do something
C           WHEN day = TUE
C*             do something
C           WHEN day = WED
C*             do something
C           WHEN day = THU
C*             do something
C           OTHER
C*             do something
C           ENDSL
```

Java

```
switch (day)
{
    case MON:
       // do something
        break;
    case TUE:
       // do something
        break;
     ....
     default:
       // default code
} // end switch statement
```

Improved readability over nested IFs

Structures are similar in both languages!

Same But Different

RPG

- Each WHEN expr evaluated until true
- Code executed until next WHEN

Java

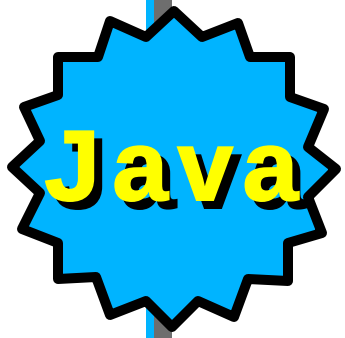
- switch expression evaluated
- Result compared to each case
- In first match, code executed until "break;" or end of switch

RPG SELECT	Java Switch
SELECT	switch
WHEN or WHENxx	case
OTHER	default
ENDSL	end brace }

Breakless Switch

```
switch (day)
{
    case 1:
    case 2:
    case 3:
       // Mon-Wed code
       break;
    case 4:
    case 5:
       // Thur-Fri code
       break;
    default:
} // end switch statement
```

Control goes to first "case" that matches the expression, then executes until "break" is encountered, or the end brace



Looping Around

- RPG and Java, like all other languages have three main loops, they are...

RPG

```
C     start         DO        limit   index
C*                    :
C                     ENDDO
```

DO

```
C                   DOW   expression
C*                    :
C                     ENDDO
```

DO-WHILE

```
C                   DOU   expression
C*                    :
C                     ENDDO
```

DO-UNTIL

JAVA

```
for (initialization;
     condition;
     increments)
{
  // body
}
```

FOR

```
while (expression)
{
  // body
}
```

WHILE

```
do
{
  // body
} while (expression);
```

DO-WHILE

for-loop

- A <declare> and initialize index variable
- B loop while true
- C increment / decrement index

```
static final int MAX = 10;
          A    B     C
for (int idx=0; idx < MAX; idx++)
{
    // body;
}
```

Java

```
C                   1               DO    10                I
C*                                  ...
C                                   ENDDO1
```

RPG III

```
 C*     initial-value DO             Limit-value
index
 C      1              DO            10                    I
 C*                                   ...
 C*                                   ENDDO      Increment-value
```

RPG IV

for-loop Parts

- All three parts are ***optional***
  - Only convention that:
    - **first part is for initing index variable,**
    - **expression is for comparing index value and**
    - **increment is for incr'tg/decr'tg index value**
- All three can even be empty!

```
for ( ; ; )
  System.out.println("looping...");
```

Never ending loop!

for-loop Parts

- **Simple bodies can be done in incrementing part versus body**
  - Comma-separated statements

```
for (idx = 0;
     idx < myCharArray.length;
     myCharArray[idx] = ' ', idx++)
  ;
```

Blank out entire array

all work done in increment part. No need for body

two statements, comma separated

New FOR-loop in RPG!

Example 1: n!

```
C*RN01Factor 1                Factor 2------Result-Field
C*
C                     EVAL      Factorial = 1
C                     FOR       i = 1 to n
C                     EVAL      Factorial = Factorial * i
C                     ENDFOR
```

RPG IV: V4R4

If n = 5,
n! = 5 * 4 * 3 * 2 * 1 = 120 ...

Example 2: Last non-blank character

```
C*RN01F                                    esult-Field
C*
C                     FOR       i = %len(SayWhat) DOWNTO 1
C                     IF        %SUBST(SayWhat:i:1) <> ' '
C                     LEAVE
C                     ENDIF
C                     ENDFOR
```

if SayWhat =
'New For RPG4 ',
Last non-blank = 12

Java Skills Transfer!

while-loop

Java

A

- loop while true

B

- set variable to force end of loop
- loop iterations >= 0

```
boolean in30 = false;
while (!in30)                    A
{
   if (endOfFile())
     in30 = true;                B
   else
     readLine();
}
```

RPG III

```
C                   *IN30     DOWNE*OFF
C*                            ...
C                             END
```

RPG IV

```
C                   DOW       *IN30 NE *OFF
C*                            ...
C                             END
```

Free Form Factor 2

do-loop

Java

- A loop *until* true
- B set variable to force end of loop
- loop iterations >= 1

```
boolean in30 = false;
do
{
   if (endOfFile())
     in30 = true;
   else
     readLine();
} while (!in30);
```

B

A

RPG III

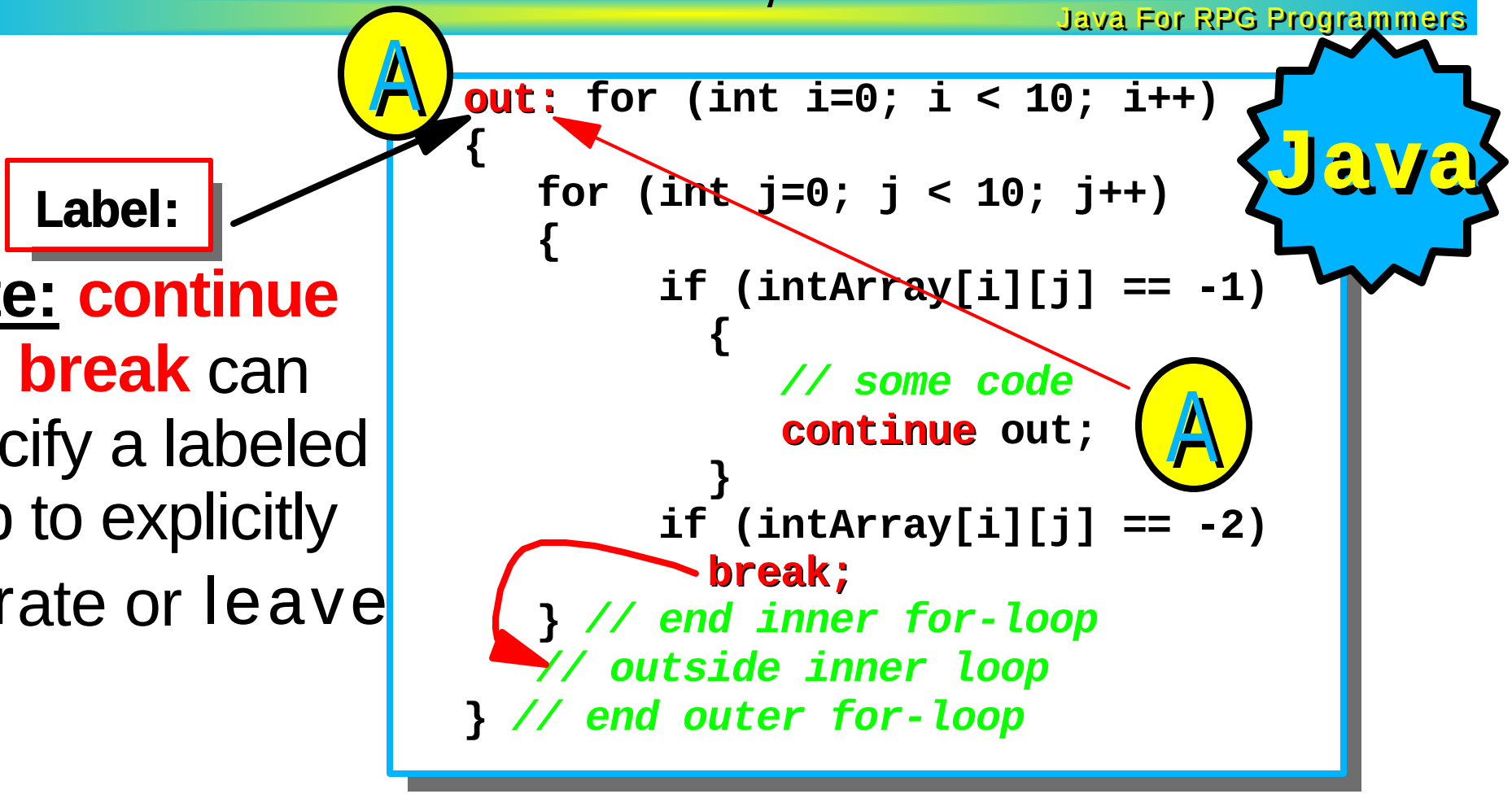
```
C                   *IN30     DOUNE*OFF
C*                            ...
C                             END
```

RPG IV

```
C                             DOU       *IN30 NE *OFF
C*                            ...
C                             END
```

Free Form Factor 2

continue, break



Label:

Note: **continue** and **break** can specify a labeled loop to explicitly iterate or leave

```
C                   DOW       RECORDN = 2938174
C                   IF        CODE='A1'
C                   ITER
C                   ENDIF
C                   LEAVE
C                   ENDDO
```

RPG IV

Operators: Relational

Operation	Java Operator	RPG Op-Codes	RPG IV Operator
Equal	==	EQ	=
Not Equal	!=	NE	<>
Greater Than	>	GT	>
Less Than	<	LT	<
GT or Equal	>=	GE	>=
Lt or Equal	<=	LE	<=
Or	||	ORxx	OR
And	&&	ANDxx	AND
Negation	!	NOT	NOT

Relational Example


```
if ( (age <= 2) ||
     ( (age >= 65) &&
       (currDay == SENIORS_DAY) ) )
  price = 0;
```

note double equals: ==

```
C    AGE         IFLE 2
C    AGE         ORGE 65
C    CURDAY      ANDEQSENDAY
C                MOVE 0          PRICE
C                ENDIF
```


```
C                IF          (age <= 2) OR
C                            ((age >= 65) AND
C                             (currday = SENIORS-DAY)
)
C                EVAL        price = 0
C                ENDIF
```

Operators: Math

Operation	Java Operator	RPG Op-Codes	RPG Operator
Add	+	ADD, Z-ADD	+
Subtract	-	SUB, Z-SUB	-
Multiply	*	MULT	*
Divide	/	DIV	/
Modulus	%	DIV and MVR	n / a
Power	Use exp or pow in Math class	n / a	**

Math Examples

RPG III

```
C* A = B+C
C                   B         ADD   C             A             50
C* A = (B+C)/12
C                   B         ADD   C             A             50
C                   A         DIV   12            A
```

RPG IV

```
C     EVAL      a = b + c
C     EVAL      a = (b+c)/12
```

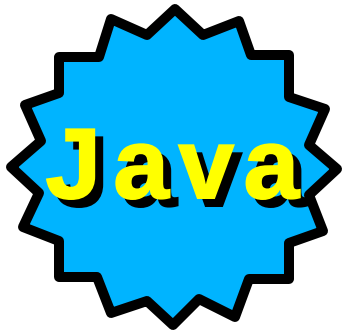
Java

```
a = b + c;
a = (b+c)/12;
```

Contracted Assignment

- What does this mean?

```
X += 10;
```



- Answer: short form for...

```
X = X + 10;
```

- All binary operators supported:

```
X *= 10; X /= 2; Y -= 1;
```

Same as using ADD **op-code in RPG and *not* specifying factor 1 value**

Increment, Decrement

- What does this mean?

```
X++;
```

same as C and C++

- Answer: short form for

```
X = X + 1;
```

- Also supports decrementing:

```
X--;
```

- **Can be before or after variable:**

more...

Increment++

- Always changes variable

```
if (X++ > 10)
```

X is incremented

X==10? result == false

- Prefix:
  - Increment variable, use value

```
X = 10;
Y = ++X + 2;
```

x=x+1;
y=x+2;

Y == 13
X == 11

- Suffix:
  - Use value, increment variable

```
X = 10;
Y = X++ + 2;
```

y=x+2;
x=x+1;

Y == 12
X == 11

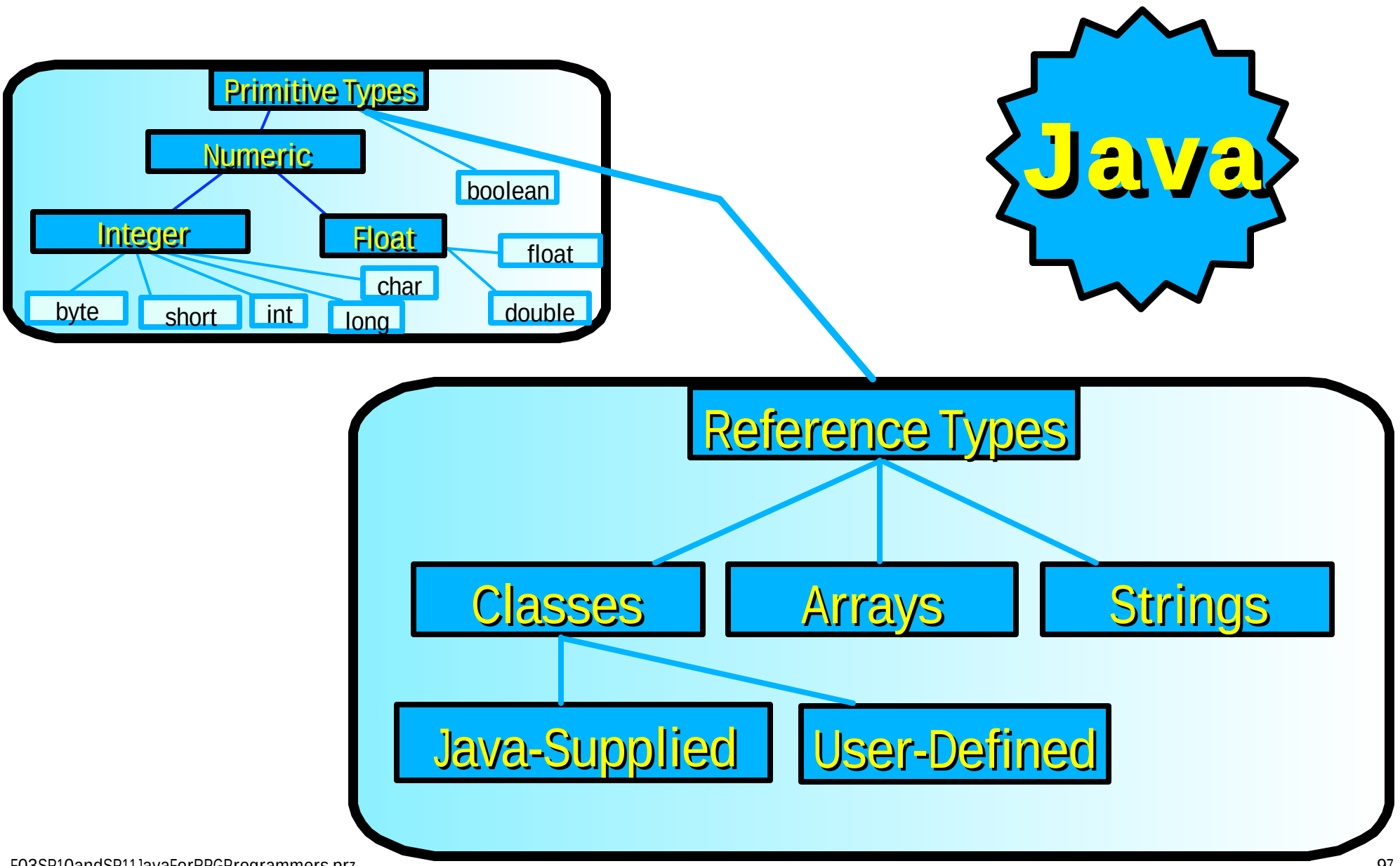
Bitwise Operators

- RPG has op-codes
  - TESTB, BITON, BITOFF
- Java has operators...

Operator	Meaning
&	Bitwise AND
|	Bitwise OR
^	Bitwise Exclusive OR
~	Bitwise negation
< <	Left Shift
> >	Right Shift
> > >	Zero fill right shift

They work only on integer types!

Reference Data Types



Disclaimer

- The following information will take some time (and more reading) to absorb
  - ► RELAX!
    - ★ Focus on the "how" ...
    - ★ ..the "why" will follow with time

Using Classes

- To use a class, you must do ***two*** things:

"how"

1. Declare an *object reference* variable:
   - Declare a variable using class as the type:

```
MyClass myVariable;
```

2. *Instantiate* an object using "new"

```
myVariable = new MyClass();
```

Objects

- Object reference variables are
  - merely pointers, or *references* , to objects
  - initially point to "null"
    - a keyword in Java
- The ***new*** operator:
  - allocates memory for the class ("*instantiates*")
    - Total memory needed by all global variables in class
- Allocated memory known as
  - *object* or
  - *instance* of class

Object Example

```
public class Customer
{
    private int          id;
    private String       name;
    private String       address;
    private int          phone;
    private BigDecimal accountBalance;

    public void setId(int custId)
    {
        id = custId;
    }

    public boolean readInfo()
    {
        boolean readok = false;
        // read customer info from database
        return readok;
    }
    // more methods. . .
}
```

```
Customer aCust =
      new Customer();
```

you can declare & instantiate in one step!

how to call the methods?

Dot Operator

- To call a method
  - use *dot operator* on object reference variable

```
public class ProcessCustomer
{
    public static void main(string args[])
    {
       Customer aCust = new Customer();
       aCust.setId(100012);
       aCust.readInfo();
    }
}
```

Must use object reference variable, not Class name

Can also access non-private variables with dot operator

Why Objects?

- Why must we instantiate?
  - Because you can instantiate more than one!

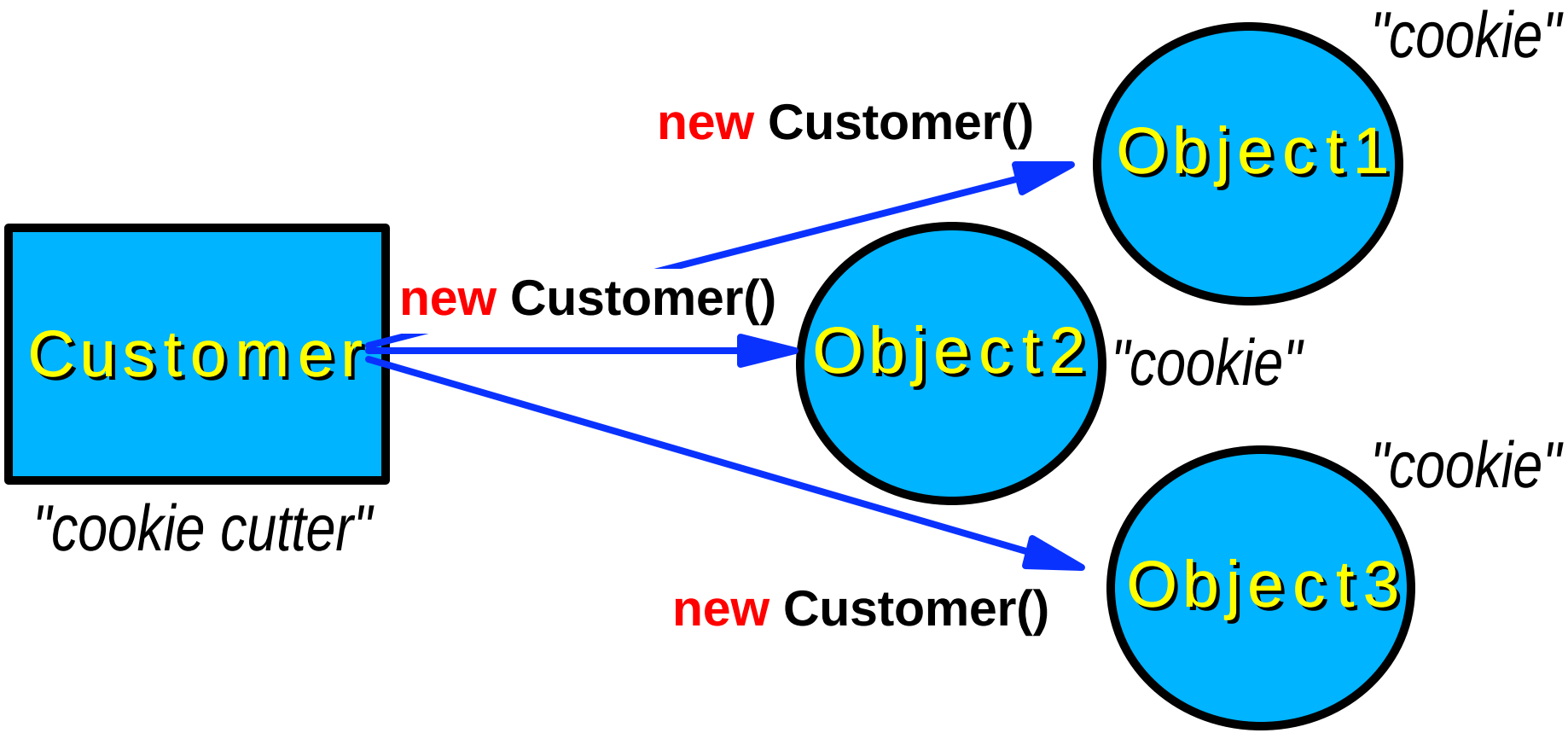
```
Customer cust1 = new Customer();
cust1.setId(100011);

Customer cust2 = new Customer();
cust2.setId(100012);
. . .
```

- Each gets their own memory
  - Each hold unique values for their variables
    - Hence we call global variables "***instance variables***"

Notes on Objects

- Classes are like templates
  - ► or "cookie cutters"
- Classes have no memory allocated
  - ► Objects have the actual memory
    - object == "instance of class"
    - object == actual "cookies"

Class vs Objects

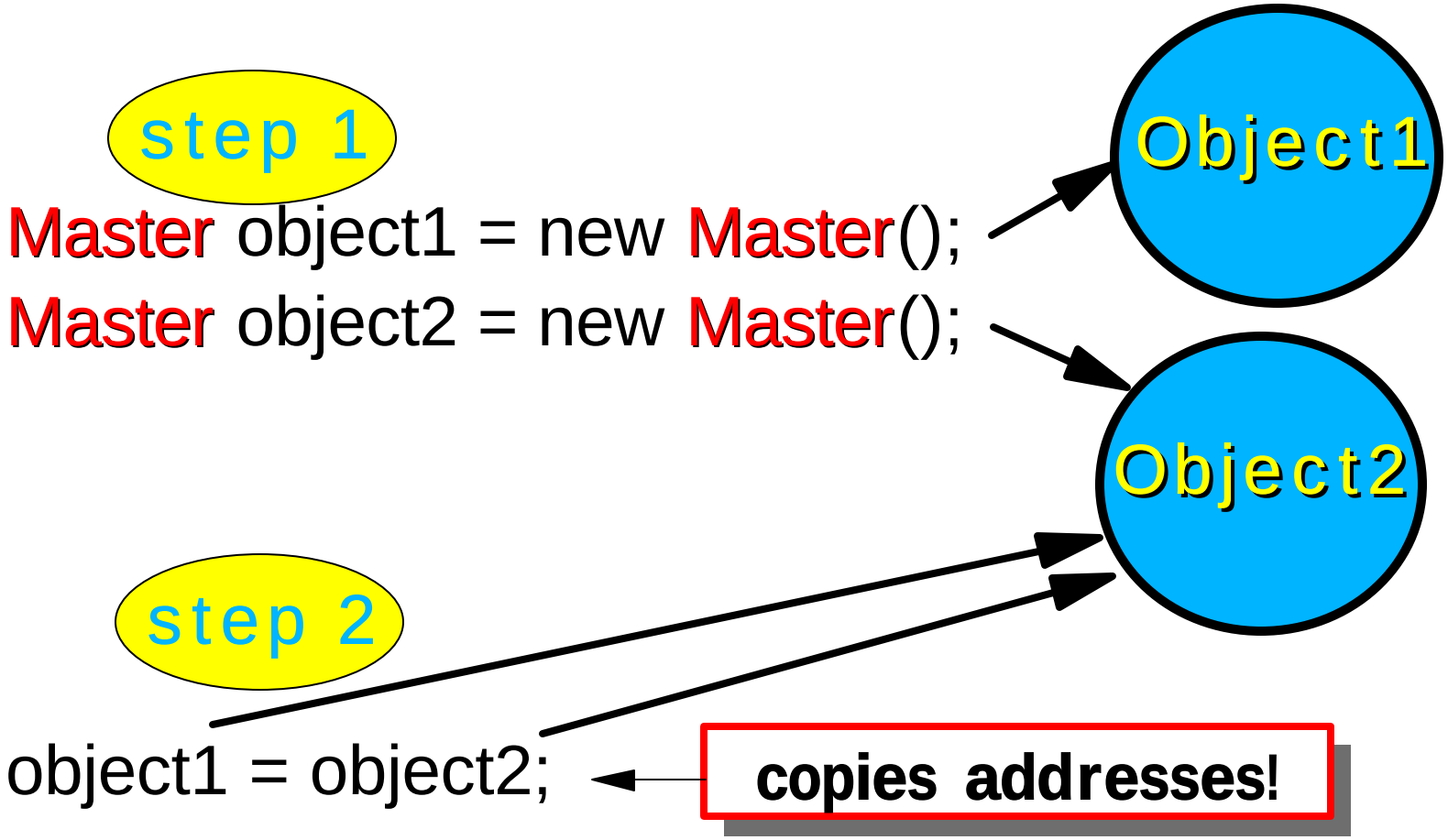


- Classes like DDS source members?
- Objects like compiled *FILE objects?
- "new" operator like DDS compiler?

Class/Object Examples

- Possible classes
  - Customer
  - Employee
  - StateTax
  - CustomerId
  - EmployeeId
  - Payroll
  - Order
  - PushButton
    - Eg, in a GUI application
    - Each instance might want different label text

Equating References



*Nobody points to object1 now so it is swept up by **Garbage Collector***

Object Example 2

- Consider a Stack class
  - for managing LIFO list of integers

```
public class Stack
{
    private int list[] = new int[100];
    private int topIndex = 0;

    public void push(int topValue)
    {
        list[topIndex++] = topValue;
    }
    public int pop()
    {
        return list[--topIndex];
    }
}
```

instance variables

Warning: no error checking!

Using Stacks

- Objects allow us multiple stacks
  - simultaneously

```
Stack myList  = new Stack();// allocate instance of stack
Stack myList2 = new Stack();// allocate another instance

myList.push(100);              // stack contents: 100
myList.push(200);              // stack contents: 100, 200

myList2.push(1000);            // stack2 contents: 1000
myList2.push(2000);            // stack2 contents: 1000, 2000

int topValue;                  // declare an integer variable
topValue = myList.pop();       // topValue:200
topValue = myList2.pop();      // topValue: 2000
```

Calling Java Methods

- Three ways to call methods:
  - **Assignment statement**
    - returned result is saved in a variable
  - **Expression**
    - returned result used in expression but not saved
  - **Expression**
    - Runs the method and disregards return value

RPG	Java
`EVAL  myVar = myProc(p1 : p2)`	`myVar = myObject.myProc(p1,p2);`
`IF  myProc(p1 : p2) = 10`	`if (myObject.myProc(p1,p2) == 10)`
`CALLP  myProc(p1 : p2)`	`myObject.myProc(p1, p2);`

`EVAL  myVar = noParms`	`myVar = myObject.noParms();`
`IF  noParms = 10`	`if (myObject.noParms() == 10)`
`CALLP  noParms`	`myObject.noParms();`

Overloading

- Method Overloading
  - Methods in same class *with same name* ! But:
    - Number or type of parameters are different
      - method name + nbr and type of parms == "*signature*"
  - Official name 'method overloading'

```
public int max(int parm1, int parm2)
{
    // code to return max of two integers
}
public float max(float parm1, float parm2)
{
    // code to return max of two floats
}
```

Static Variables

- Java variables can be *static* :
  - Use static modifer (like RPG's STATIC keyword)
    - Cannot specify it on *local* variables in methods!
  - Static variables are called *class variables*
    - Versus instance variables
  - All objects share same value for static vars
    - Qualify *with the class name* to access them

```
class RentalCar
{
    static int totalRented = 0;
    public void rentCar()
    {
        // . . .
        ++totalRented;
    }
}
```

```
if (RentalCar.totalRented > MAX_CARS)
```

Static Methods

- Methods can be static too
  - ►called *class methods*
  - ►Equivalent to standalone procedure
    - Call by qualifying with class name, not obj ref variable
  - ►*Cannot* reference instance variables in the method

```
class MyHelperRoutines
{
     // static method...
     static int max(int p1, int
p2)
     {
          if (p1 > p2)
            return p1;
          else
            return p2;
     }
}
```

```
int maxvalue = MyHelpers● max(1000,2000);
```

If your method does not reference or use any instance variables, it should be static!

Constructors

- Classes can have *constructors*
  - Special methods identified by:
    - Same name as class
    - No return value specified (not even `void`)
  - Called by JVM when object created with new
    - Right after allocating memory for the object
  - Your opportunity to do initialization
    - like *INZSR in RPG

constructor

```
public class MyClass
{
    public MyClass()
    {
        // . . .
    }
}
```

Parameters to Ctors

- Constructors can take parms
  - Declared same as in all methods
    - On method signature
  - Passed by caller in parens after new

```
MyClass myClass = new MyClass(10);
```

  - Usually to allow caller-specified initial values
    - For the instance variables

```
public class MyClass
{
    private int myVariable;

    public MyClass(int parm1)
    {
        myVariable = parm1;
    } // end ctor
}
```

constructor with parameter

"ctor" is common shorthand for "constructor"

Ctor Overloading

- Constructors can be overloaded
  - Same as with all methods
    - Number or type of parameters must be unique
  - Compiler, Runtime determine which to call
    - By matching number, type of `new` parameters

Constructor with no parms called ***default constructor***

```
MyClass obj1 =
  new MyClass(10);
```

```
MyClass obj1 =
  new MyClass(10,20);
```

```
private int myVariable;
private int myOtherVariable = 0;

public MyClass(int parm1)
{
     myVariable = parm1;
}
public MyClass(int parm1,int parm2)
{
     myVariable = parm1;
     myOtherVariable = parm2;
}
```

Constructor Example

use "this()" to call another constructor

```
class AS400
{
    private String userId;
    private String password;

    AS400() // default constructor
    {
        this("PHIL", "GREATGUY");
    }
    AS400(String userId, String password)
    {
        this.userId = userId;
        this.password = password;
    }
} // end AS400 class
```

```
AS400 host1 = new AS400(); // Call default constructor
AS400 host2 = new AS400("GEORGE","OKGUY"); // Two parm
ctor
```


Full Example

```
/** Represents a single card in a deck */
public class Card
{
    // public constants...
    public static final int HEART = 0;
    public static final int CLUB  = 1;
    public static final int SPADE = 2;
    public static final int DIAMOND=3;
    // private instance variables...
    private int     number; // value of card
    private int     suit;   // heart, spade, club, diamond
    private boolean played=false; // card been played yet?

    public Card(int number, int suit)
    {
        this.number = number;
        this.suit   = suit;
    }
    public int getNumber()
    {
        return number;
    }
    public int getSuit()
    {
        return suit;
    }

} // end of class Card
```

Java

Constants

Instance variables

Constructor

```
public boolean isPlayed()
{
    return played;
}
```

Methods

```
public void setPlayed(boolean played)
{
    this.played = played;
}
```

Main: RPG and Java

What	RPG IV	Java
How called	**CALL** command	**java** command
What compile unit gets control	first *MODULE without NOMAIN keyword	class identified on **java** command
What code gets control	first C-specs	**main** method

- **Java's `main` method *must* look like:**

```
public static void main(String
args[])
{
  ...
}
```

- so JVM can call
- nothing returned
- Array of Strings: parameters from command line
- so JVM doesn't have to instantiate class
- JVM looks for this name

Writing To Console


```
 * Prototype of this program main entry
DMAIN                 PR                  EXTPGM('HWORLD')
D STRING                                1000A   OPTIONS(*VARSIZE)
 * Definition of this program main entry
DMAIN                 PI
D STRING                                1000A   OPTIONS(*VARSIZE)
 * Global variables
DOutString            S                 52A
 * Main logic
C                     EVAL      OutString = 'Input: ' +
C                                           %TRIMR(%SUBST(STRING:1:45))
C     OutString       DSPLY
 * End of program
C                     MOVE      *ON             *INLR
```

RPG IV

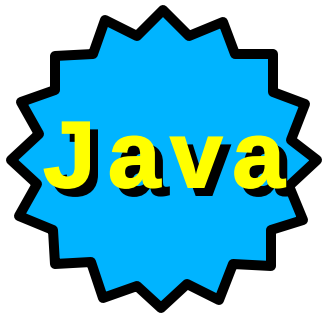
```
// main class
public class HelloWorld
{
    // main method
    public static void main(String[] args)
    {
        // print first parameter passed
        System.out.println("Input: " + args[0]);
    }
}
```

Java

Review


```
public class Time
{
    private int hour, minute, second;

    public Time(int hour, int minute, int second)
    {
        this.hour = hour;
        this.minute = minute;
        this.second = second;
    }
    public String toString()
    {
        return "Time: " + hour + ", " +
               minute + ", " + second;
    }
    public static void main(String args[])
    {
        Time torontoTime = new Time(08,30,0);
        Time sanFranTime = new Time(05,30,0);
        System.out.println(torontoTime);
        System.out.println(sanFranTime);
    }
}
```

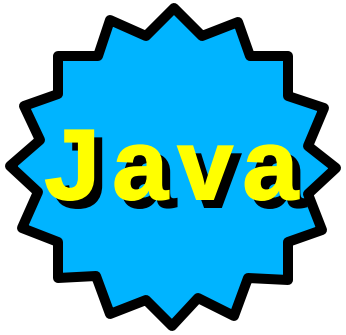
Instance variables



Object reference variables

Often, **main** is used for testing non-initial classes

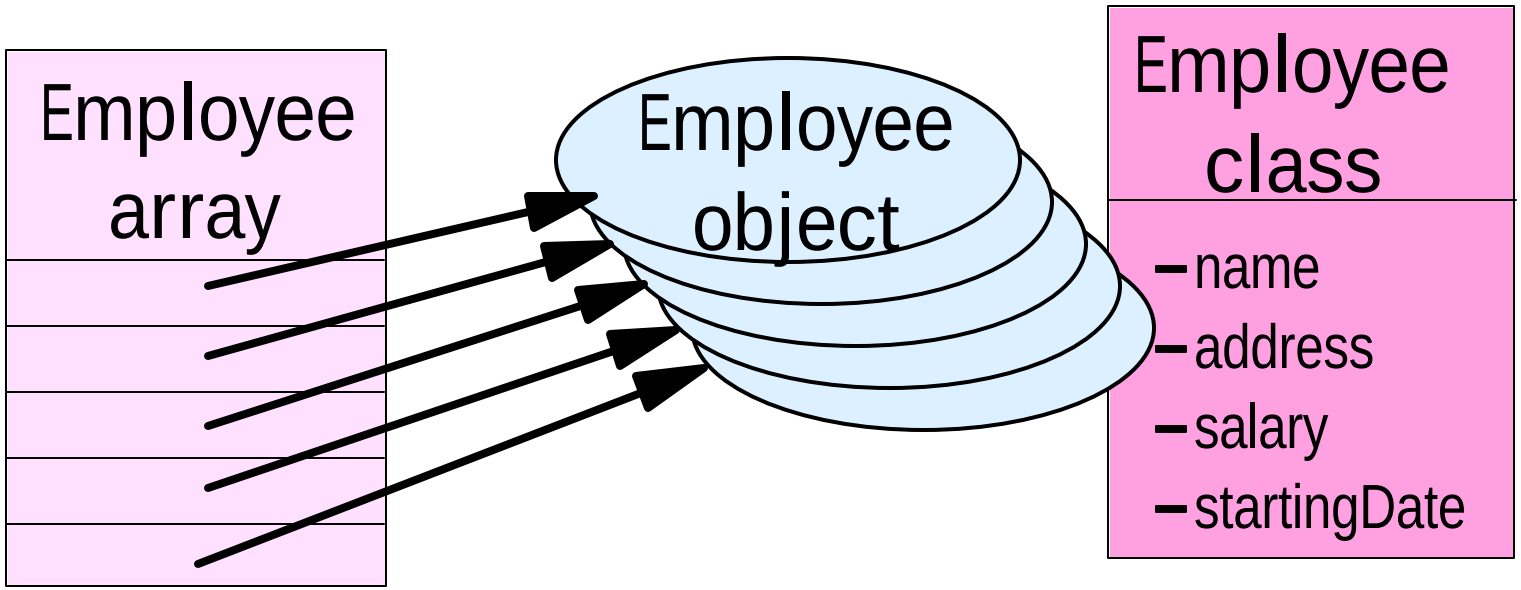
Arrays, I Need Arrays



RPG IV	Java
➤ **Array Types:**	➤ **Array Types:**
✓ One-dimension	✓ One-dimension
✘	✓ Multi-dimension
✓ Tables	✓ Hashtable class
✓ Dynamic APIs	✓ Vector class
➤ **Initializing:**	➤ **Initializing:**
✓ Compile time	✓ Compile time
✓ Pre-Runtime	✘
✓ Runtime	✓ Runtime

What About MODs?

- What about Multiple Occurring Data Structures?
  - In RPG these are arrays of structures
  - In Java these are arrays of objects
    - ✓ The object's class = the DS in RPG



Arrays in RPG


```
...+... 1 ...+... 2 ...+... 3 ...+... 4 ...+... 5 ...+...
     D  NAMES                          20A  DIM(5) CTDATA
     D                                      PERRCD(1)
     D  SALARYS                         5P0 DIM(5) FROMFILE(X)
     D                                      PERRCD(10)
     D  SSNumber                        9B0 DIM(30)
     D*
     D*-------------------------------------------------------
     C*                          :
     C*                          :
     C*                       RPG CODE
     C*                          :
     C*                          :
     O*
     O*  END OF SOURCE CODE
     **CTDATA NAMES
     George
     Phil
     Sandra
     Jennifer
     Angelica
```

RPG IV

COMPILE TIME

PRERUN TIME

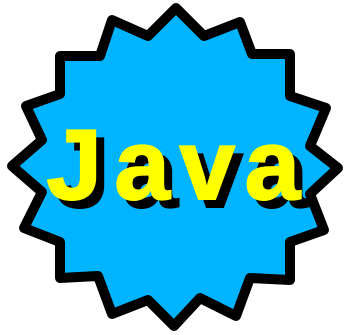
RUN TIME

COMPILE TIME ARRAY DATA

Arrays in Java

- Declaration

```
int      thisArray[ ];
long     anotherArray[ ] [ ];
char[ ] orThisOne[ ];
```



- Declaration and Definition

```
int thisArray [ ]          = new int[1000];
long anotherArray [ ][ ] = new long[10] [10];
char[ ] orThisOne[ ]       = new char [20] [20];
```

elements

[ ] versus ( )

- Spacing not important
- # bracket pairs = # dimensions
- Type is same for all elements
- Arrays are objects! Require new

Run Time Init'n

```
class TestMultiArrayRT
{
    public static void main(String args[])
    {
        int rtArray[][] = new int[3][3]; // Two dim array
        int value = 1;
        // Loop through all rows...
        for (int xIdx=0; xIdx < rtArray.length; xIdx++)
        {
            // Loop through all columns...
            for (int yIdx=0; yIdx < rtArray[xIdx].length; yIdx++)
            {
                rtArray[xIdx][yIdx] = value++; // assign and incr't
                System.out.print(rtArray[xIdx][yIdx] + " ");
            } // end inner for loop
            System.out.println();
        } // end outer for loop
    } // end main method
} // end TestMultiArrayRT class
```

length is array instance variable

arrays are zero-based in Java!

Use [var] to access elements

Compile Time Init'n

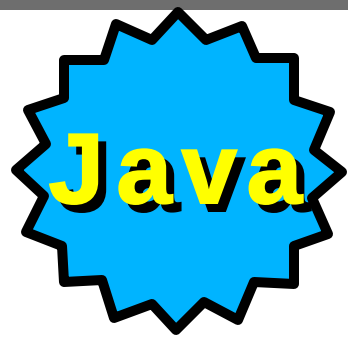
- Java allows initializing at declaration time (***compile time***):

```
String employee[] = {"ABC", "DEF", "GHI", "JKL"};
```

Note: String objects are covered shortly

```
employee[0] = "ABC"
employee[1] = "DEF"
employee[2] = "GHI"
employee[3] = "JKL"
```

- Special Java syntax:
  - Values specified between curly braces
  - Semi-colon needed after last brace
  - Values for each element separated by commas
  - No need to use **new** operator (implied)



Intro to Vectors

- In both RPG and Java, once an array is created, its size is fixed
  - it cannot be resized
  - However, Java at least allows deferring creation (using new) until after size has been determined
- However, Java also offers ***Vectors***!
  - Vector is a class in **`java.util`** package
    - To use, need "**`import java.util.*;`**"
  - Vectors are like dynamically sizable arrays
    - do not need to specify initial size
    - size grows as needed when items are added

Using Vectors

- To use Vectors:
  - Create empty Vector by instantation
  - Add items using addElement method

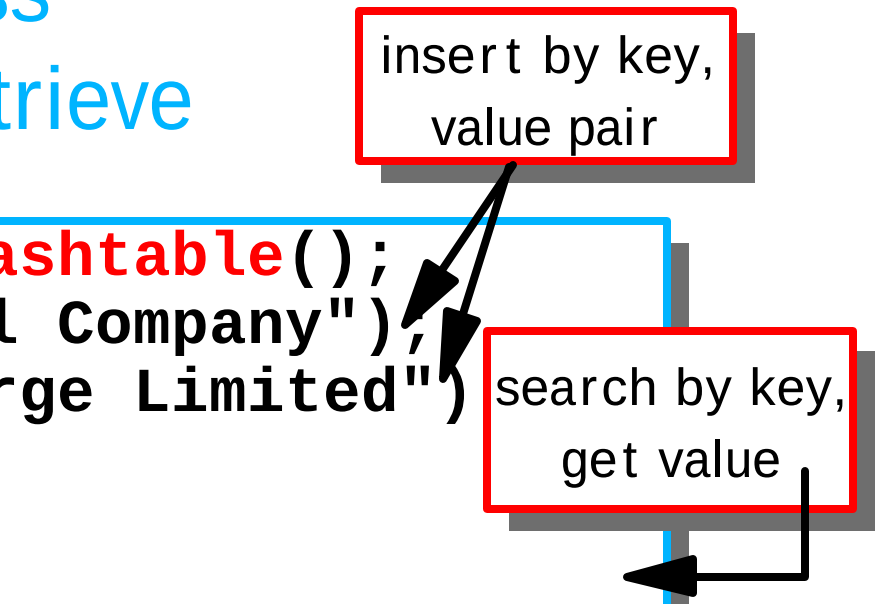
```
Vector myVector = new Vector();
String inputString = getFirstInput();
while (inputString != null)
{
     myVector.addElement(inputString);
     inputString = getNextInput();
}
```

  - Query number of elements using size method
  - Query specific element using elementAt method

```
 for (int idx = 0 ; idx < myVector.size() ;
idx++)
     System.out.println(myVector.elementAt(idx));
```

Hashtables

- Java supplies a class for simple lookup tables
  - Hashtable in package java.util
  - Contains pairs of objects
    - A **key** object and a **value** object
  - Objects can be of any class
  - Use put to insert, get to retrieve




```
Hashtable customers = new Hashtable();
customers.put("011002","Phil Company");
customers.put("110034","George Limited");
. . .
String georgeEntry =
customers.get("110034");
```

String Basics

- Strings are ***objects*** in Java
  - of the class String (in java.lang package)
- Language has special support:
  - You can concatenate with the "**+**" operator
  - You don't *have* to use the **new** operator

```
String text1 = new String("George");
String text2 = new String("Phil");
String finalText = new String(text1);
finalText = finalText.concat(" and ");
finalText = finalText.concat(text2);
```

OR

```
String text1 =  "George";
String text2 =  "Phil";
String finalText = text1 + " and " + text2;
```

String Gotchas

- Be careful of these common mistakes:

1. not assigning result of methods:

```
String textField = "Java";
textField.concat(" and RPG");
```

String is an ***immutable*** class: all methods return new objects versus changing existing

```
textField = textField.concat("and RPG");
```

2. comparing with '==' versus equals method

```
if (name == "Bob")
if (name.equals("Bob"))
```

3. copying with '=' versus clone method

```
String newName = oldName;
String newName = oldName.clone();
```

Strings: Java vs RPG

RPG o/c	RPG built-in	Description	Java Method(s)
CAT (or '+')		***Concatenate two strings***	**`concat(string)`** or '+' operator
SUBST	**%SUBST**	***Extract a substring from a string***	**`substring(int start, int end)`** or **`substring(int start)`**
SCAN	**%SCAN**	***Scan for a substring***	**`indexOf()`**
	%TRIM	***Trim begin, end blanks***	**`trim()`**
	%LEN	***Return length of string***	**`length()`**
XLATE		***Translate a string***	*Not Available*
CHECK		***Check for characters***	*Not Available*
CHECKR		***Check in reverse***	*Not Available*
	%TRIML	***Trim leading blanks***	*Not Available*
	%TRIMR	***Trim trailing blanks***	*Not Available*
	%CHAR	***V4R2. Converts to string***	**`valueOf(datatype value)`** in String class
	%REPLACE	***(V4R2) Allows replacement of substring***	*Not Available*

Some String Methods

METHOD	DESCRIPTION
compareTo	*Compares two Strings lexicographically*
endsWith, startsWith	*Test if String ends or starts with the specified string*
equals, equalsIgnoreCase	*Compares this String to another, ignoring case*
getBytes	*Convert this String into a byte array*
getChars	*Copies characters from this substring into the destination character array*
regionMatches	*Tests if two String regions are equal*
toCharArray	*Converts this String to a new character array*
toLowerCase	*Converts all characters in String to lower case*
toUpperCase	*Converts all characters in String to upper case*
valueOf	*Converts primitive data type value to a String (this is a static method)*

Java Date / Time

Class	Pack-age	Description
Date	`java.util`	Simple date/time capture. No manipulation methods
Gregorian-Calendar	`java.util`	Rich date/time functionality, including comparing, adding, subtracting, extracting
SimpleDate-Format	`java.text`	For creating "formatting objects" that will format any given Date object to the specified format pattern
TimeZone	`java.util`	For creating timezone objects representing any timezone. Apply to GregorianCalendar or SimpleDateFormat objects to get equivalent date/time in that timezone

Manipulating Dates

- **GregorianCalendar** knows all about dates

```
import java.util.*;

public class TestDate
{
  public static void main(String args[])
  {
    GregorianCalendar gc = new GregorianCalendar();
    System.out.println("Date before addition: " + gc.getTime());
    gc.add(Calendar.DATE,2);  // add two days
    System.out.println("Date after addition:  " + gc.getTime());
    gc.add(Calendar.MONTH,2); // add three months
    System.out.println("Date after addition:  " + gc.getTime());
    GregorianCalendar gc2 = new GregorianCalendar(2012,0,30);
    if (gc.before(gc2))
      System.out.println("Yes, it is");
  }
}
```

Java

Cool methods:

- `add`
- `before / after`
- `isLeapYear`
- `get` (extracting parts)

zero-based month!

```
Date before addition: Thu Sep 30 22:02:20 EDT 1999
Date after addition:  Sat Oct 02 22:02:20 EDT 1999
Date after addition:  Wed May 16 22:02:20 EDT 2001
Yes, it is
```

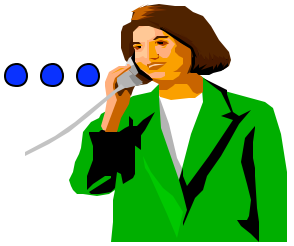
Agenda

- OO Terminology

OO Terminology

RPG IS NOT OO!!

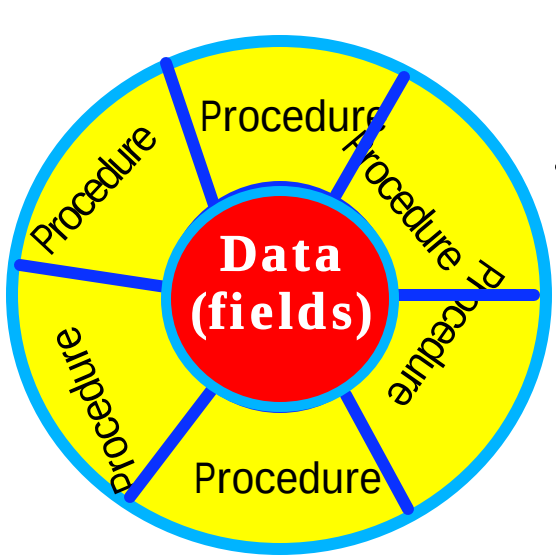
JAVA IS OO !!!



- **What does "*Object Oriented*" mean?**
  Three attributes:
  - ✓ **Encapsulation**
  - ✓ **Inheritance**
  - ✓ **Polymorphism**

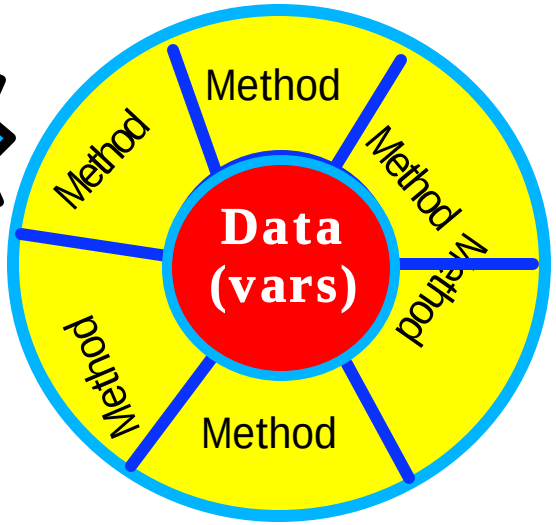
OO: Encapsulation

- Hide data from direct public programmer access
- Force access only via procedures or methods



RPG IV

Java



- ReUse with Modules and Service Programs of modules
- "Expose" certain procedures or data with EXPORT keyword

- ReUse with Classes and Packages of classes
- "Expose" certain methods or variables with `public` modifier keyword

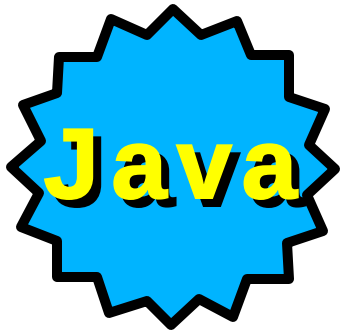
OO: Inheritance

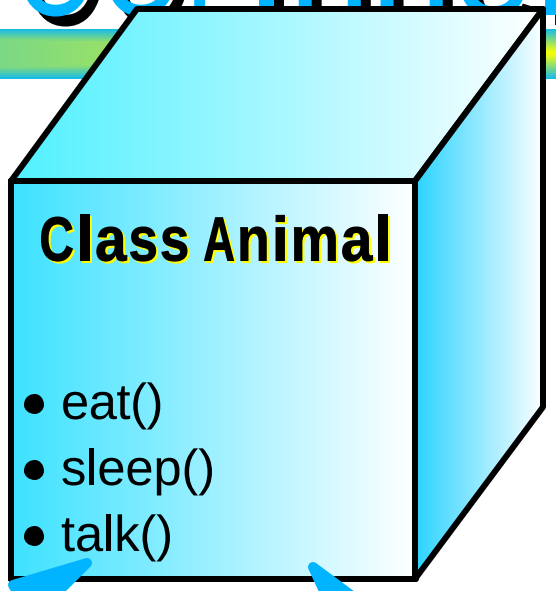
```
// class Employee
public class Employee
{
     string name;
     int salary;
     public Employee(string id, int sal)
     {
          name = id;
          salary = sal;
     }
     public void printEmployee()
     {
          System.out.print("My name is"+name);
     }
}
```

```
// class SubEmployee
public class SubEmployee extends Employee
{

}
```

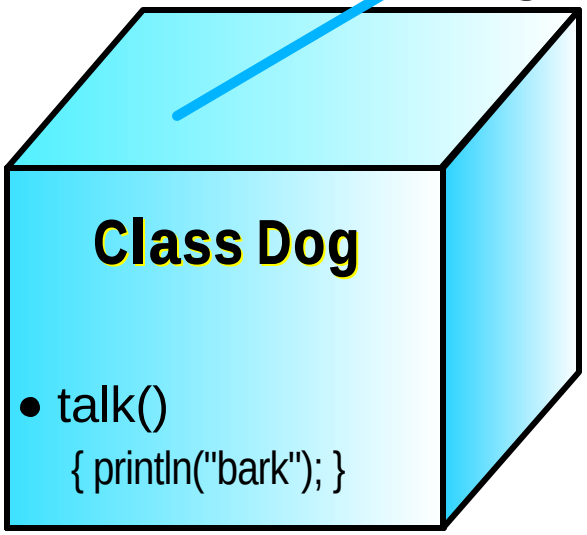
- Child class extends parent class
  - inherits methods, variables
- Child can also:
  - Add new methods, variables
  - Override methods

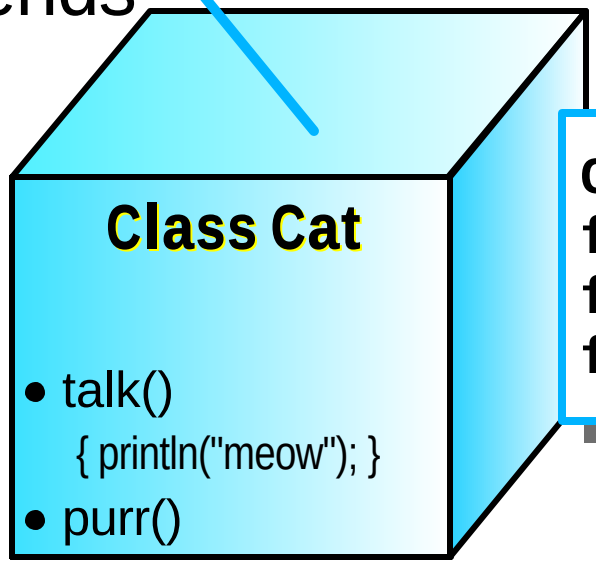
OO: Inheritance





extends





Notes:

- Can only extend *one* class
- Extended class called *parent*
- Extending class called *child*
- Signature important when overridding methods

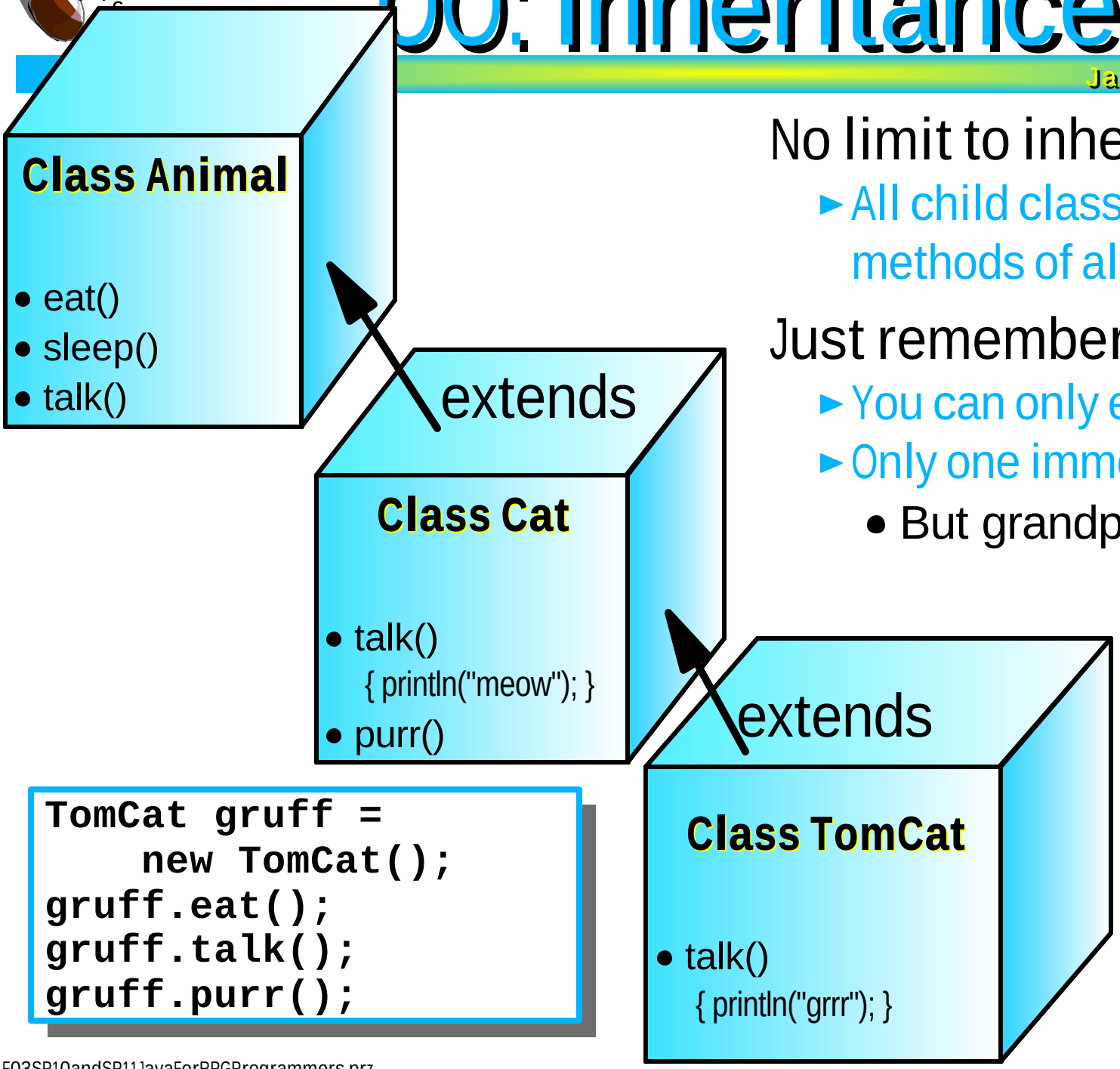
```
Cat fluff = new Cat();
fluff.eat();
fluff.talk();
fluff.purr();
```

can call inherited methods as though locally defined

- overrides "**talk**()"

- overrides "**talk**()"
- adds "**purr**()"

OO: Inheritance



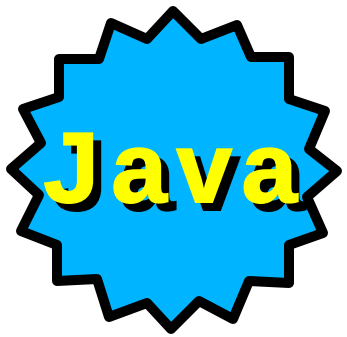
No limit to inheritance tree

- All child classes inherit methods of all parents

Just remember

- You can only extend one class
- Only one immediate parent
  - But grandparents allowed

```
TomCat gruff =
     new TomCat();
gruff.eat();
gruff.talk();
gruff.purr();
```



OO: Polymorphism

- When ClassChild *extends* ClassParent:
  - You can assign ClassChild objects to ClassParent object reference variables
    - either direct child or indirect child (eg: grandchild)

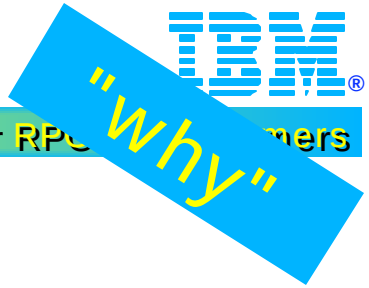
"how"

```
ClassParent obj = new ClassChild();
```

  - You can then call any method in the ClassChild object
    - as long as it is defined in the parent class too
    - if not, compile will fail (it searches declared class type)

```
obj.commonMethod();
```

OO: Polymorphism



- Why is this important?:
  - You can write generic code that calls parent's "base" methods
    - But actually calls child's methods at runtime, if they are overridden in the child class

```
Class ParentClass
{
   public void doSomething()
   {
     // ...
   }
```

```
Class ChildClass extends ParentClass
{
   public void doSomething()
   {
     // different algo
   }
}
```

```
ParentClass obj1 =
      new ParentClass();
ParentClass obj2 =
      new ChildClass();

obj1.doSomething();
obj2.doSomething();
```

no "if logic" needed!

"Poly"...."morphism"
"Many".."faces"

Polymorphism Example


```
public class Employee
{
    protected int        id;
    protected String     name;
    protected BigDecimal wage;
    protected BigDecimal hoursWorked;

    public Employee(int iD)
    {
        id = iD;
        // not shown: reading info from
database
    }
    public BigDecimal calculatePay()
    {
        return wage * hoursWorked;
    }
    // other methods: getName, setName, etc
}
```

Consider this "parent" class

"protected" modifier allows only this class and child classes access

Java

What about salaried employees?

Polymorphism Example


```
public class SalaryEmp extends Employee
{
    public SalaryEmp(int iD)
    {
        id = iD;
        // not shown: reading info from
database
    }
    public BigDecimal calculatePay()
    {
        return wage / 26;
    }
}
```

Constructors are not inherited!

Could call parent ctor with super(...);

This method overridden from parent

```
public class ContractorEmp extends
Emp
```

```
public class PartTimeEmp extends Employee
```

```
public class xxxEmp extends Employee
```

Polymorphism Example


```
public class Payroll
{
    public static void main(String args[])
    {
        Employee allEmps[] = new Employee[100];
        // populate with Employee, SalaryEmp,
        //  and PartTimeEmp objects (not shown)
        for (int idx=0; idx < allEmps.length;
idx++)
        {
           BigDecimal pay =
              allEmps[idx].calculatePay();
           // not shown: rest of code
        }
    }
}
```

Elegant!

Calls appropriate method based on object type

Change-resistant!

New child class can be added anytime

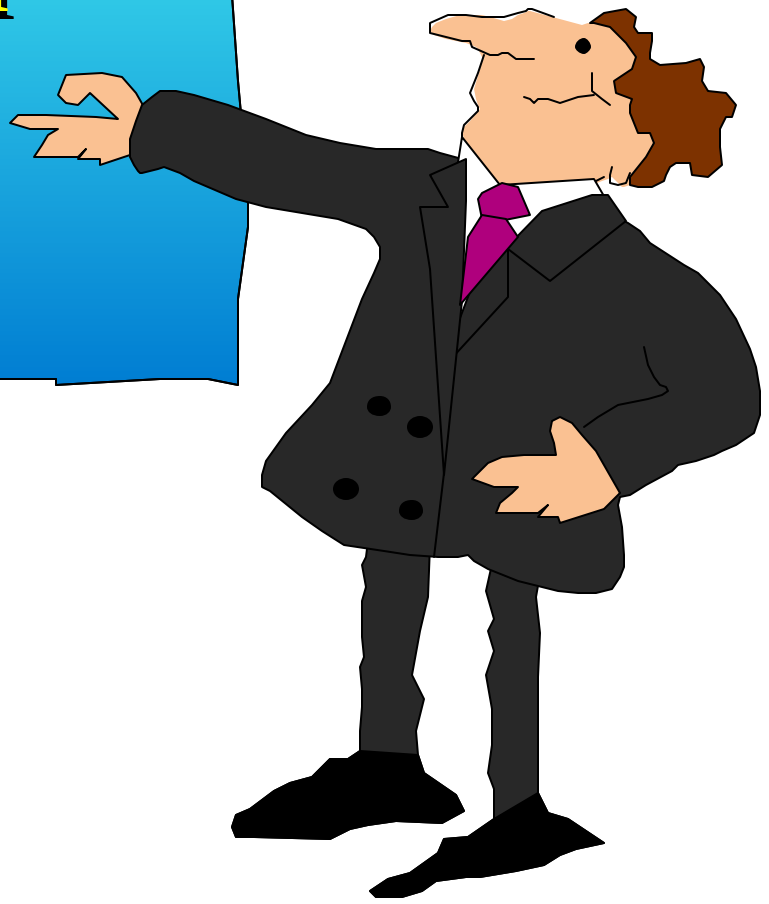
OO References

- **Recommended reading:**
  - OBJECT-ORIENTED DESIGN IN JAVA
    - **Stephen Gilbert and Bill McCarty**
    - **WAITE GROUP PRESS, 1998**
  - **Any book on UML**
  - **Any book on OOA and D**
  - **Any book on Design Patterns**

- **Look at any online bookstore**
  - **www.amazon.com**
  - **www.chapters.com**
  - **etc**

Agenda

Exception Handling



Exceptions in Java

- Java has "exceptions"
  - objects of classes that extend Exception
  - Java supplies many existing Exception classes
  - You can create your own Exception classes

```
public class MyException extends Exception
```

- Methods can *throw* exceptions
  - by using throw operator with exception object

```
if (inputParameter < 100)
   throw new IOException();
```

  - Usually done when error situation detected
    - preferred over returning special return codes

Throwing Exceptions

- If a method throws an exception:
  - It must declare which exceptions it throws using the *throws* clause on method declaration

```
public void MyMethod()
            throws MyException, OtherException
{ … }
```

  - Many Java-supplied methods throw exceptions
- To call such a method:
  - calling code must be inside a try block

```
try {
    myObj.myMethod();
}
```

Catching Exceptions

- If any method call throws an exc:
  - The appropriate catch block is executed

```
try {
   myObj.myMethod();
}
catch (MyException exc)
{
     System.out.println(
        exc.getMessage());
     exc.printStackTrace();
}
catch (OtherException exc)
{
   // do something
}
```

Comes here is exception of class MyException or its children is thrown

All exceptions support these methods

Must try to catch all exceptions listed in throws clause: else no compile!

Java vs OS/400

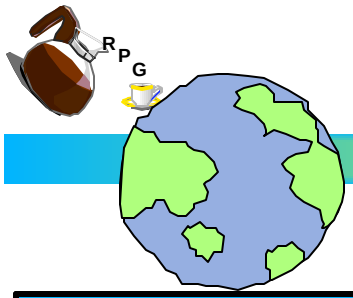
- Java exceptions similar to OS/400 exceptions!
  - exception objects like OS/400 messages
  - throw like SNDPGMMSG
  - try/catch like MONMSG
- catch with a parent class is like
  - using MONMSG with message ID ending in 00
    - Catches any exception in this family (or range)
- catch with Exception class like
  - using MONMSG with CPF9999
    - Catches any exception!

Thanks

Thanks for coming!!

Agenda

More Information



Websites

Website URL	Description
www.ibm.com/software/ad/wds400	IBM WebSphere Development Studio for iSeries
www.ibm.com/software/ad/vadd www.ibm.com/websphere/developer	VisualAge Developer Domain WebSphere Developer Domain
www.ibm.com/java www.ibm.com/iseries/java	IBM Java
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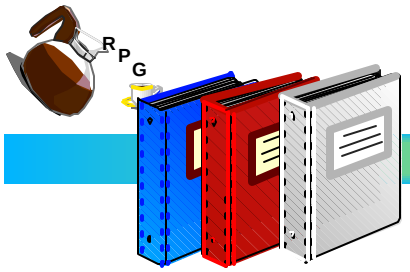

Books

Book, URL	By, ISBN
-Java for RPG Programmers -Java for COBOL Programmers -Student WorkBook for Java for RPG and COBOL Programmers www.mcpressonline.com	Phil Coulthard, George Farr. IBM Press. Also vailable at COMMON bookstore!
JAVA and the AS/400 www.29thStreetPress.com	Daniel Darnell. ISBN 1-58304-033-1
Java Application Strategies for iSeries and AS/400 2nd Edition www.mc-store.com/mc-store/	Don Denoncourt. ISBN 1-58347-025-5
Core Java series www.amazon.com	Now a series of 3 books. Horstmann, Cornell
Teach Yourself Java in 21 Days www.amazon.com	Rogers Cadenhead, Laura Lamay. ISBN 1575213907
Programming VisualAge for Java www.amazon.com	John Akerly, Antonello Parlavecchia
Understanding CODE/400 www.mcpressonline.com	Violaine Batthish. ISBN 1-58347-01606