

CS 536 — Fall 2018

CSX Code Generation Routines

Part III

Indexing and Assigning Arrays

The JVM includes special instructions for loading from and storing into arrays. Integer arrays use `iaload` and `iastore`. Boolean arrays use `baload` and `bastore`. Character arrays use `caload` and `castore`.

To assign arrays we'll use the `CSXLib` methods:

```
int [] cloneIntArray(int[]),
boolean[] cloneBoolArray(boolean[]),
char[] cloneCharArray(char[]),
char[] convertString(String),
int [] checkIntArrayLength(int[], int[]),
boolean[] checkBoolArrayLength(boolean[], boolean[]),
char[] checkCharArrayLength(char[], char[]).
```

These routines make a copy (clone) of the source array and check the length of the source and target arrays (in case an array parameter is involved). If the array lengths are not compatible, an `ArraySizeException` is raised.

We'll extend `computeAdr`, `storeName` and the visit methods for `nameNodes` and `asgNodes` to include array indexing and assignment.

```

void visit(nameNode n) { // Final version
    n.adr = stack;
    if (n.subscriptVal.isNull()) {
        // Simple (unsubscripted) identifier
        if (n.varName.idinfo.kind == Var ||
            n.varName.idinfo.kind == Value ||
            n.varName.idinfo.kind == ScalarParm) {
            // id is a scalar variable, parameter or const
            if (n.varName.idinfo.adr == Global){
                // id is a global
                String label = n.varName.idinfo.label;
                loadGlobalInt(label);
            } else { // (n.varName.idinfo.adr == Local)
                n.varIndex = n.varName.idinfo.varIndex;
                loadLocalInt(n.varIndex);
            } } else { // varName is an array var or array parm
            if (n.varName.idinfo.adr == Global){
                n.label = n.varName.idinfo.label;
                loadGlobalReference(n.label,
                    arrayTypeCode(n.varName.idinfo.type));
            } else { // (n.varName.idinfo.adr == local)
                n.varIndex = n.varName.idinfo.varIndex;
                loadLocalReference(n.varIndex);
            } }
        } }

    } else { // This is a subscripted variable
        // Push array reference first
        if (n.varName.idinfo.adr == Global){
            n.label = n.varName.idinfo.label;
            loadGlobalReference(n.label,
                arrayTypeCode(n.varName.idinfo.type));
        } else { // (n.varName.idinfo.adr == local)
            n.varIndex = n.varName.idinfo.varIndex;
            loadLocalReference(n.varIndex);
        } // Next compute subscript expression
        this.visit(n.subscriptVal);
        // Now load the array element onto the stack
        switch(n.type){
            case Integer:
                // Generate: iaload
                break;
            case Boolean:
                // Generate: baload
                break;
            case Character:
                // Generate: caload
                break;
        }
    } }
}

```

```

// Compute address associated w/ name node
// DON'T load the value addressed onto the stack
void computeAdr(nameNode name) { // Final version
    if (name.subscriptVal.isNull()) {
        // Simple (unsubscripted) identifier
        if (name.varName.idinfo.kind == Var ||
            name.varName.idinfo.kind == ScalarParm) {
            // id is a scalar variable
            if (name.varName.idinfo.adr == Global) {
                name.adr = Global;
                name.label = name.varName.idinfo.label;
            } else { // varName.idinfo.adr == Local
                name.adr = Local;
                name.varIndex =
                    name.varName.idinfo.varIndex;
            }
        } else { // Must be an array
            // Push ref to target array to check length
            if (name.varName.idinfo.adr == Global){
                name.label = name.varName.idinfo.label;
                loadGlobalReference(name.label,
                    arrayTypeCode(name.varName.idinfo.type));
            } else { // (name.varName.idinfo.adr == local)
                name.varIndex =
                    name.varName.idinfo.varIndex;
                loadLocalReference(name.varIndex);
            }
        }
    } else { // This is subscripted variable
        // Push array reference first
        if (name.varName.idinfo.adr == Global){
            name.label = name.varName.idinfo.label;
            loadGlobalReference(name.label,
                arrayTypeCode(name.varName.idinfo.type));
        } else { // (name.varName.idinfo.adr == local)
            name.varIndex = name.varName.idinfo.varIndex;
            loadLocalReference(name.varIndex);
        }
        // Next compute subscript expression
        this.visit(name.subscriptVal);
    }
}
}

```

```

void storeName(nameNode name) { // Final version
    if (name.subscriptVal.isNull()) {
        // Simple (unsubscripted) identifier
        if (name.varName.idinfo.kind == Var ||
            name.varName.idinfo.kind == ScalarParm) {
            if (name.adr == Global)
                storeGlobalInt(name.label);
            else // (name.adr == Local)
                storeLocalInt(name.varIndex);
        } else { // Must be an array
            // Check the lengths of source & target arrays
            switch(name.type){
                case Integer:
                    genCall("CSXLib/checkIntArrayLength([I[I][I]");
                    break;
                case Boolean:
                    genCall(
                        "CSXLib/checkBoolArrayLength([Z[Z][Z]");
                    break;
                case Character:
                    genCall(
                        "CSXLib/checkCharArrayLength([C[C][C]");
                    break;
            } // Now store source array in target variable
            if (name.varName.idinfo.adr == Global){
                name.label = name.varName.idinfo.label;
                storeGlobalReference(name.label,
                    arrayTypeCode(name.varName.idinfo.type));
            } else { // (name.varName.idinfo.adr == local)
                name.varIndex =
                    name.varName.idinfo.varIndex;
                storeLocalReference(name.varIndex);
            }
        }
    } else // This is a subscripted variable
        // A reference to the target array, the
        // subscript expression and the source expression
        // have already been pushed.
        // Now store the source value into the array
        switch(name.type){
            case Integer:
                //Generate: iastore
                break;
            case Boolean:
                //Generate: bastore
                break;
            case Character:
                //Generate: castore
                break;
        }
    }
}

```

```

void visit(asgNode n) { // Final version
    // Compute address associated with LHS
    computeAdr(n.target);

    // Translate RHS (an expression)
    this.visit(n.source);

    // Check to see if source needs to be cloned or converted
    if (n.source.kind == Array ||
        n.source.kind == ArrayParm)
        switch(n.source.type){
            case Integer:
                genCall("CSXLib/cloneIntArray([I][I]");
                break;
            case Boolean:
                genCall("CSXLib/cloneBoolArray([Z][Z]");
                break;
            case Character:
                genCall("CSXLib/cloneCharArray([C][C]");
                break;
        }
    else if (n.source.kind == String)
        genCall("CSXLib/convertString(Ljava/lang/String;)[C]");

    // Value to be stored is now on the stack
    // Store it into LHS
    storeName(n.target);
}

```

The increment operation is essentially a load, add and store. Incremented array elements require special care since the index expression must be evaluated only once (in case of side-effects). In the case of indexed arrays, an array reference and index expression are pushed onto the stack and then duplicated. One pair is used to load the array element and the other pair is used to store the incremented value.

```

void visit(incrementNode n) {
    if (n.target.subscriptVal.isNull()){
        // Simple (unsubscripted) identifier
        this.visit(n.target); //Evaluate ident onto stack
        loadI(1);
        gen("iadd"); //incremented ident now on stack
        computeAdr(n.target);
        storeName(n.target);
    } else { // Subscripted array element
        computeAdr(n.target); //Push array ref and index
        gen("dup2"); // Duplicate array ref and index
        // (one pair for load, 2nd pair for store)
        // Now load the array element onto the stack
        switch(n.target.type){
            case Integer:
                gen("iaload");
                break;

```

```
        case Boolean:
            gen("baload");
            break;
        case Character:
            gen("caload");
            break;
    }
    loadI(1);
    gen("iadd"); // incremented identifier now on stack
    storeName(n.target);
}
}
```