Handling Complex Numbers

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Matrix objects

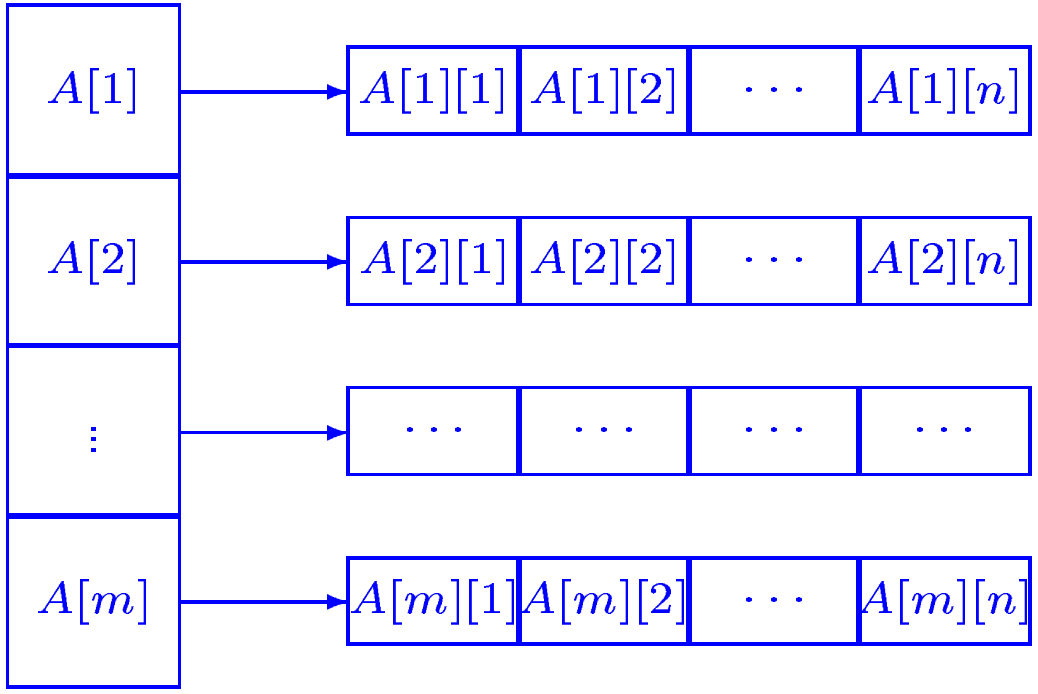
Matrix

$A(1:m, 1:n)$

$A(1,1)$	$A(1,2)$	$\cdots$	$A(1,n)$
$A(2,1)$	$A(2,2)$	$\cdots$	$A(2,n)$
$\cdots$	$\cdots$	$\cdots$	$\cdots$
$A(m,1)$	$A(m,2)$	$\cdots$	$A(m,n)$

Array of arrays

$A[1:m][1:n]$



Matrices vs. arrays of arrays

1. The location of an element $A(i, j)$ can be computed using simple arithmetic. Finding $A[i][j]$ involves, in general, pointer chasing.

2. There is no guarantee that $A[1 : m][1 : n]$ is rectangular. Even if it was rectangular when created it may have been modified.

3. Aliasing disambiguation. Given two matrix objects A and B it is sufficient to show that $A \neq B$ to prove there is no aliasing between them. In the case of two arrays of arrays $A[][]$ and $B[][]$ one has to show that $A[i] \neq B[j]\ \forall i, j$.

4. Regular array sections for matrices can be represented compactly.

5. Disambiguation between two array sections reduces to proving that the source arrays are different or that the sections do not intersect.

6. Privatizing matrix $A(1 : m, 1 : n)$, for thread safety, requires copying only one reference.

Language support for rectangular arrays (matrices)

- Fortran-like syntax for rectangular arrays:

```
float[,] dup(float[,] b, int n, int m) {
  float[,] a = new float[n,m]
  for (int i=0; i<n; i++)
    for (int j=0; j<m; j++)
      a[i,j] = b[i,j];
  return a;
}
```

- Equivalent (compiler-generated) code using proposed Java standard classes:

```
FloatMatrix2D dup(FloatMatrix2D b, int n, int m) {
  FloatMatrix2D a = new FloatMatrix2D(n,m);
  for (int i=0; i<n; i++)
    for (int j=0; j<m; j++)
      a.setElement(i,j,b.getElement(i,j));
  return a;
}
```

Complex numbers

MICROSTRIP benchmark description:

- **do** $i = 1, w - 1$
  do $j = 1, h - 1$
  $B[i][j] = 0.25 * (A[i + 1][j] + A[i - 1][j] + A[i][j + 1] + A[i][j - 1])$
  end do
  end do
  do $i = 0, w$
  do $j = 0, h$
  $r = r + |B[i][j] - A[i][j]|$
  end do
  end do

- $w = h = 99$.

Complex MICROSTRIP results on the RS/6000 990