

## Quick Start

*How to write a one-line “hello, world” program*

1. Create the file hello.chpl:  

```
writeln("hello, world");
```
2. Compile and run it:  

```
> chpl hello.chpl
> ./a.out
hello, world
>
```

## Comments

```
// single-line comment
/* multi-line
   comment */
```

## Primitive Types

Type	Default size	Other sizes	Default init
bool	impl. dep.	8, 16, 32, 64	false
int	64	8, 16, 32	0
uint	64	8, 16, 32	0
real	64	32	0.0
imag	64	32	0.0i
complex	128	64	0.0+0.0i
string	variable		""

## Variables, Constants and Configuration

```
var x: real = 3.14; variable of type real set to 3.14
var isSet: bool; variable of type bool set to false
var z = -2.0i; variable of type imag set to -2.0i
const epsilon: real = 0.01; runtime constant
param debug: bool = false; compile-time constant
config const n: int = 100; > ./a.out --n=4
config param d: int = 4; > chpl -sd=3 x.chpl
```

## Modules

```
module M1 { var x = 10; } module definition
module M2 {
  use M1; module use
  proc main() { ...x... } main definition
}
```

## Expression Precedence and Associativity\*

Operators	Uses
. () []	member access, call and index
new (right)	constructor call
:	cast
** (right)	exponentiation
reduce scan dmapped	reduction, scan, apply domain map
! ~ (right)	logical and bitwise negation
* / %	multiplication, division, modulus
unary + - (right)	positive identity, negation
+ -	addition, subtraction
<< >>	shift left, shift right
<= >= < >	ordered comparison
== !=	equality comparison
&	bitwise/logical and
^	bitwise/logical xor
	bitwise/logical or
&&	short-circuiting logical and
	short-circuiting logical or
..	range construction
in	loop expression
by #	range/domain stride and count
if forall [ for	conditional expression, parallel iterator expression, serial iterator expression
,	comma separated expression

\*Left-associative except where indicated

## Casts and coercions

```
var i = 2.0:int; cast real to int
var x: real = 2; coerce int to real
```

## Conditional and Loop Expressions

```
var half = if i%2 then i/2+1 else i/2;
writeln(for i in 1..n do i**2);
```

## Assignments

Simple Assignment: =  
Compound Assignments: += -= \*= /= %= \*\*=  
&= |= ^= &&= ||= <<= >>=  
Swap Assignment: <=>

## Statements

```
if cond then stmt1(); else stmt2();
if cond { stmt1(); } else { stmt2(); }
```

```
select expr {
  when equiv1 do stmt1();
  when equiv2 { stmt2(); }
  otherwise stmt3();
}
```

```
while condition do ...;
while condition { ... }
do { ... } while condition;
for index in aggregate do ...;
for index in aggregate { ... }
label outer for ...
break; or break outer;
continue; or continue outer;
```

## Procedures

```
proc bar(r: real, i: imag): complex {
  var c: complex = r + i;
  return c;
}
proc foo(i) return i**2 + i + 1;
```

## Formal Argument Intents

Intent	Semantics
in	copied in
out	copied out
inout	copied in and out
ref	passed by reference
const	passed by value or reference, but with local modifications disabled
blank	like ref for arrays, domains, syncs, singles; otherwise like const

## Named Formal Arguments

```
proc foo(arg1: int, arg2: real) { ... }
foo(arg2=3.14, arg1=2);
```

## Default Values for Formal Arguments

```
proc foo(arg1: int, arg2: real = 3.14);
foo(2);
```

## Records

```
record Point { record definition
    var x, y: real; declaring fields
}
var p: Point; record instance
writeln(sqrt(p.x**2+p.y**2)); field accesses
p = new Point(1.0, 1.0); assignment
```

## Classes

```
class Circle { class definition
    var p: Point; declaring fields
    var r: real;
}
var c = new Circle(r=2.0); class construction
proc Circle.area() method definition
    return 3.14159*r**2;
writeln(c.area()); method call
class Oval: Circle { inheritance
    var r2: real;
}
proc Oval.area() method override
    return 3.14159*r*r2;
delete c; free memory
c = nil; store nil reference
c = new Oval(r=1.0,r2=2.0); polymorphism
writeln(c.area()); dynamic dispatch
```

## Unions

```
union U { union definition
    var i: int; alternatives
    var r: real;
}
```

## Tuples

```
var pair: (string, real); heterogeneous tuple
var coord: 2*int; homogeneous tuple
pair = ("one", 2.0); tuple assignment
(s, r) = pair; destructuring
coord(2) = 1; tuple indexing
```

## Enumerated Types

```
enum day {sun,mon,tue,wed,thu,fri,sat};
var today: day = day.fri;
```

## Ranges

```
var every: range = 0..n; range definition
var evens = every by 2; strided range
var R = evens # 5; counted range
var odds = evens align 1; aligned range
```

## Domains and Arrays

```
var D: domain(1) = {1..n}; domain (index set)
var A: [D] real; array
var Set: domain(int); associative domain
Set += 3; add index to domain
var SD: sparse subdomain(D); sparse domain
```

## Domain Maps

```
var B = new dmap(
    new Block({1..n})); block distribution
var D: domain(1) dmapped B; distributed domain
var A: [D] real; distributed array
var D2: domain(1) dmapped
    Block({1..n}); domain map sugar
```

## Data Parallelism

```
forall i in D do A[i] = 1.0; domain iteration
[i in D] A[i] = 1.0; "
forall a in A do a = 1.0; array iteration
[a in A] a = 1.0; "
A = 1.0; array assignment
```

## Reductions and Scans

Pre-defined: + \* & | ^ && || min max  
minloc maxloc

```
var sum = + reduce A; 1 2 3 => 6
var pre = + scan A; 1 2 3 => 1 3 6
var ml = minloc reduce (A, A.domain);
```

## Iterators

```
iter squares(n: int) { serial iterator
    for i in 1..n do
        yield i**2; yield statement
}
for s in squares(n) do ...; iterate over iterator
```

## Zipper Iteration

```
for (i,s) in zip(1..n, squares(n) do ...
```

## Task Parallelism

```
begin task();
cobegin { task1(); task2(); }
coforall i in aggregate do task(i);
sync { begin task1(); begin task2(); }
serial condition do stmt();
```

## Atomic Example

```
var count: atomic int;
if count.fetchAdd(1)==n-1 then
    done = true; nth task to arrive
```

## Synchronization Examples

```
1) var data$: sync int;
data$ = produce1(); consume(data$);
data$ = produce2(); consume(data$);

2) var go$: single real;
go$=set(); use1(go$); use2(go$);
```

## Locality

### Built-in Constants:

```
config const numLocales: int; set via -nl
const LocaleSpace = {0..numLocales-1};
const Locales: [LocaleSpace] locale;
```

```
var c: Circle;
on Locales[i] { migrate task to new locale
    writeln(here.id);
    c = new Circle(); allocate class on locale
}
writeln(c.locale); query locale of class instance
on c do { ... } data-driven task migration
```

## More Information

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