Quick Start: one-line "hello, world"

1. Create the file `hello.chpl`:
```
writeln("hello, world ");
```
2. Compile and run it:
```
$ chpl hello.chpl
$ ./hello
hello, world
$
```

Comments

```
// single-line comment
/* multi-line
   comment /*can be nested*/ */
```

Primitive Types

Type	Default size	Other sizes	Default init
`bool`	n/a		`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`	n/a		`""`

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;   // $ ./prog --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(){ writeln(x); }   // main function
}
```

Expression Precedence and Associativity*

Operators	Uses
`. () []`	member access; call or index
`new` *(right)*	creation of a new instance
`:`	cast
`**` *(right)*	exponentiation
`reduce scan dmapped`	reduction, scan, apply domain map
`! ~` *(right)*	logical and bitwise negation
`* / %`	multiplication, division, modulus
unary `+ -` *(right)*	positive identity, negation
`<< >>`	shift left, shift right
`&`	bitwise/logical and
`^`	bitwise/logical xor
`|`	bitwise/logical or
`+ -`	addition, subtraction
`.. ..<`	range and open range construction
`<= >= < >`	ordered comparison
`== !=`	equality comparison
`&&`	short-circuiting logical and
`||`	short-circuiting logical or
`by # align`	range stride, count, alignment
`in`	used in loop headers
`if` / `for` *and* `foreach` / `forall` *and* `[]`	conditional expression, serial and order-indep. loop expr., parallel loop expressions
`,`	expression list

* left-associative except where indicated

Casts and coercions

```
var i = 2.0:int;   // explicit conversion  real to int
var x: real = 2;   // implicit conversion  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();
}

do { … } while condition;
while condition { … }        // single-statement forms:
for index in iterable { … }  //   … do stmt();
foreach index in iterable { … }
try { … } catch error { … }
label outer for …
break; or break outer;
continue; or continue outer;
```

Procedures

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

Formal Argument Intents

Intent	Semantics
`in`	copy-initialized in
`out`	copied out
`inout`	copied in and out
`ref`	passed by reference
`const in`	copied in; local modifications are disallowed
`const ref`	passed by reference; local modifications are disallowed
`const`	passed by value or by reference; local and caller modifications are disallowed
default	like `const` for most types; like `ref` for syncs and atomics

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 variable
writeln(sqrt(p.x**2+p.y**2));     field accesses
p = new Point(1.0, 1.0);          assignment
                                  of a new instance
```

Classes

```
class Circle {                    class definition
  var p: Point;                   declaring fields
  var r: real;
}
var c = new Circle(r=2.0);        initialization
proc Circle.area()                method definition
  do return 3.14159*r**2;
writeln(c.area());                method call
class Oval: Circle {              inheritance
  var r2: real;
}
override proc Oval.area()         method override
  do return 3.14159*r*r2;
c = new Oval(r=1,r2=2);           polymorphism
writeln(c.area());                dynamic dispatch
var nc: owned Circle? = nil;      nilable type required
                                  to store nil references
```

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
var (s, r) = pair;                destructuring
coord(0) = 1;                     tuple indexing, 0-based
```

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
var open = 0..<n;                 open range
```

Domains and Arrays

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

Domain Maps

```
use BlockDist;
const D = {1..n} dmapped          distrib. domain w/ block
  blockDist(boundingBox={1..n});  distribution
var A: [D] real;                  distributed array
```

Data Parallelism and Task Intents

```
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 + B;      promoted addition and array assignment
var sum = 0.0, factor = 3;
forall a in A     task intents: [const] in, [const] ref, reduce
  with (const in factor, + reduce sum)
  do sum reduce= a * factor;
```

Reductions and Scans

Pre-defined: `+ * & | ^ && || min max minmax 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;                   generate a value
}
for s in squares(n) do …;         loop over iterator
```

Zipper Iteration

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

Extern Declarations

```
extern proc C_function(x: int);
extern "C_name" var C_variable: real;
extern { /* C code here */ }
```

Task Parallelism

```
begin task();
cobegin { task1(); task2(); }
coforall i in iterable 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

```
var data: sync int;
data.writeEF(produce1());
consume(data.readFE());
data.writeEF(produce2());
consume(data.readFE());
```

Locality

Built-in Constants

```
config const numLocales: int; $./prog -nl 4
const LocaleSpace = {0..numLocales-1};
const Locales: [LocaleSpace] locale;
```

Example

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

User Resources

https://chapel-lang.org/users.html