# 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*](https://chapel-lang.org/users.html)