Yellow highlighted portions are omitted from handout given to students and are filled in during lecture.

Expressions

Expression	Values	Operators
(+ 2 3 5)	2 3 5	+
(* 3.1 2.5)	3.1, 2.5	*
(+ (* 3 2.2) 7)	7, 6.6	*, +
(string-append “a” “b” “c”)	“a”, “b”, “c”	string-append
(circle 20 “solid” “red”)	20, “solid”, “red”	circle
(substring “abcd” 0 2)	“abcd”, 0, 2	substring
(beside )		beside

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Calling Versus Defining a function

CALLING a function	**DEFINING a function**

`(fn-name arg-1 arg-2)`	`(define (fn-name arg-name-1 arg-name-2)`
	`  (an expression using`
	`  arg-name-1 and arg-name-2))`

`(+ 3 3)`
 	
`(circle 20 “solid” “red”)`
	`(define (bulb c)`
	`  (circle 20 “solid” c))`

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Functions Versus Data,
Similar concept to define your own Data type

Functions		
Use them…	**Define them…**	
CALL **by name, passing the expected value(s)**	**Already defined for us** **BSL built-in/primitive functions/operators**	**Define our own** **using HtDF recipe**

`(+ 4 5)`
`(* (+ 4 3) 5)`
`(substring "Hi" 0 1)`
 	
`(bulb "red")`
 	
`(pos? -1)`
`(pos? (- 5 7))`
	+, * , /, -
	string-append
	substring
	positive?
	
	More in helpdesk…
		`(define (bulb c)`
		`(circle 20 "solid" c))`
		
		`(define (pos? n)`
		`(> n 0))`

Data Types		
Use them…	**Define them…**	
In the signature of our function	**BSL built-in/primitive types**	**Define our own** **using HtDF recipe**

`;; Natural -> Natural`
 	
`;; String Number -> String`
 	
`;; Number -> Boolean`
 	
`;; TeamName -> Boolean`
 	
`;; Age -> Boolean`
	Number
	Integer
	Natural
	
	String
	Boolean
	
	More in helpdesk…
		TeamName
		
		Age

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Information Versus Data

Information	➔ represent <- interpret	Data
Problem Domain		**Program**
Street lights Red Yellow Green		0 1 2 Natural[0, 2]
Character health 1 life 2 lives 10 lives Limit? dead		 Natural Natural[1,10] - constrained false
Team name Canucks Raptors BlueJays		 String
Person age 0 20 29 105 200		 Natural[0,110]

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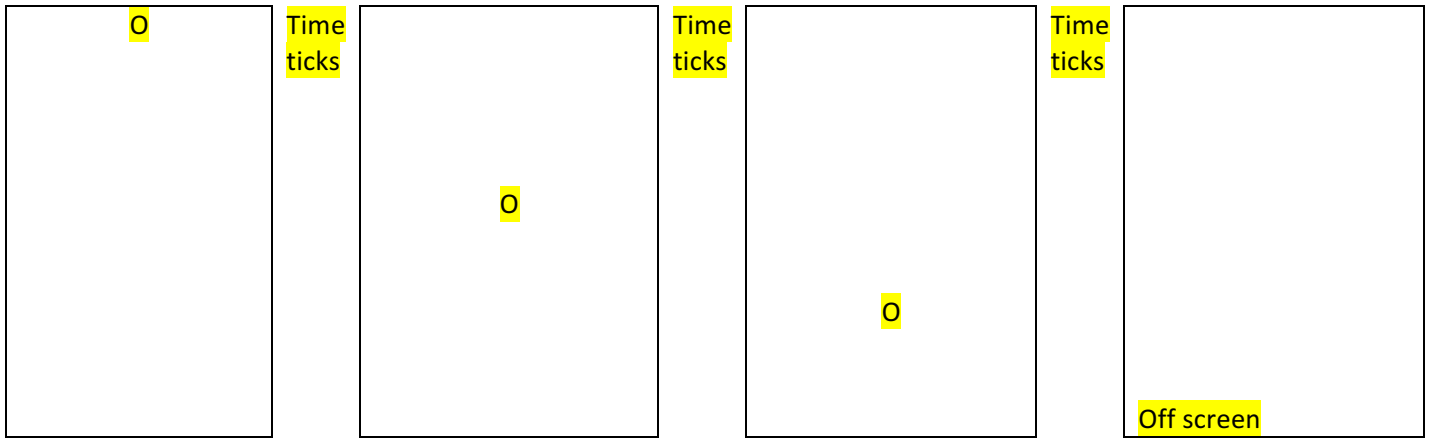
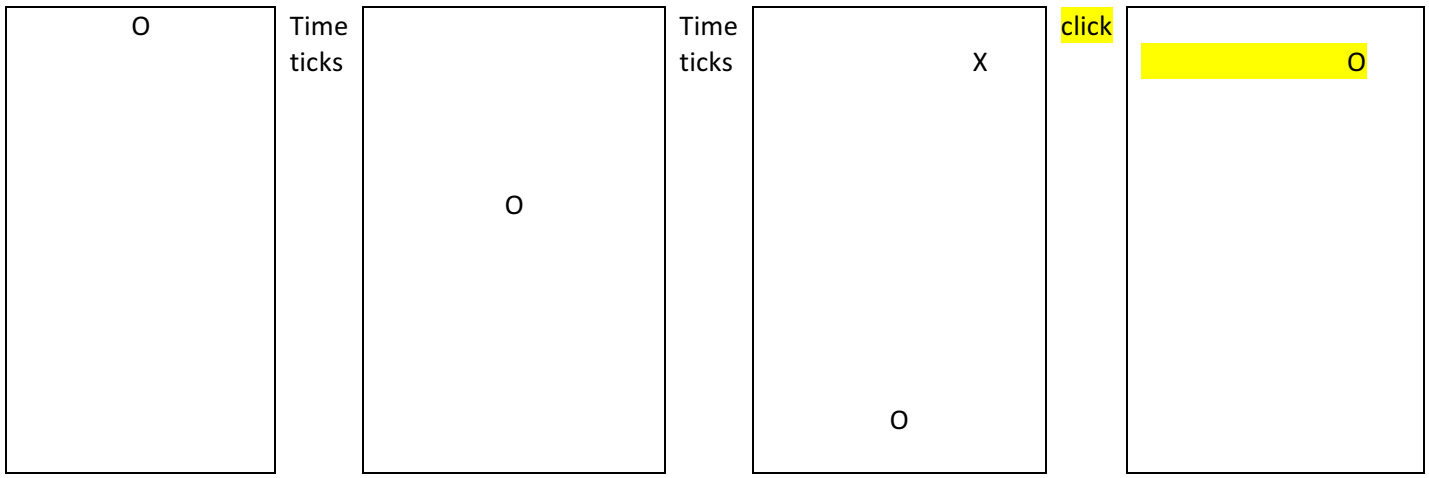
Domain Analysis – dropping spider



Constant Information	Changing Information	Big Bang options
MTS Spider image Width screen Height screen Ctr x Speed Top Bottom	Y coordinate of spider	On tick To draw

Yellow highlighted portions are omitted from handout given to students and are filled in during lecture.

Domain Analysis – dropping spider continued…



Constant Information	Changing Information	Big Bang options
MTS Spider image Width screen Height screen Ctr x Speed Top Bottom	Y coordinate of spider X coordinate of spider	On tick To draw On mouse

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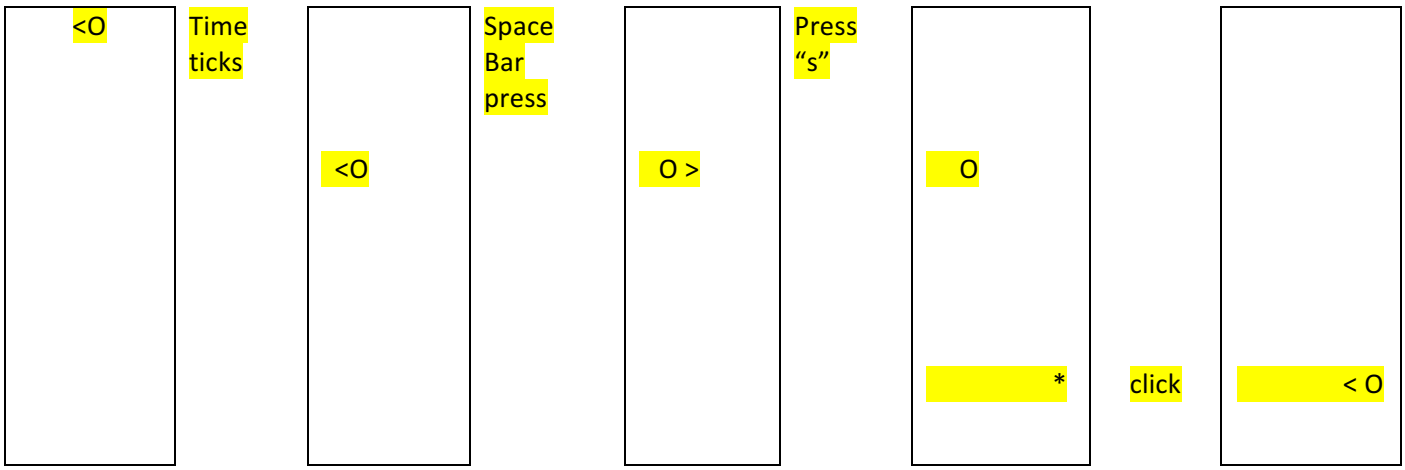
Domain Analysis – butterfly change direction…



Constant Information	Changing Information	Big Bang options
MTS Butterfly image Width screen Height screen Ctr x Ctr y Speed	Y coordinate of butterfly X coordinate of butterfly Direction of butterfly	On tick To draw On mouse On key

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ListOfNatural v Natural (atomic) v Natural (self-ref)

ListOfNatural Data Definition	Natural Data Definition
An arbitrary number of values	**A single value that specifies how many times to repeat something**

`;; ListOfNatural is one of:`
`;; - empty`
`;; - (cons Natural ListOfNatural)`
`;; interp. a list of natural numbers`
`(define LON-MT empty)`
`(define LON-1 (cons 3 empty))`
`(define LON-2 (cons 3 (cons 4 empty)))`
	`;; Natural is one of:`
	`;; - 0`
	`;; - (add1 Natural)`
	`;; interp. a natural number`
	`(define N0 0)  ;0`
	`(define N1 (add1 N0))  ;1`
	`(define N2 (add1 N1))  ;2`

`(define (fn-for-lon lon)`
`  (cond [(empty? lon) (...)]`
`  [else`
`  (... (first lon)`
`  (fn-for-lon (rest lon n)))]))`
	6
	`(define (fn-for-natural n)`
	`  (cond [(zero? n) (...)]`
	`  [else`
	`  (... n`
	`  (fn-for-natural (sub1 n)))]))`

Produce a list one element longer, use cons:
 	
`(cons 6 LON-2)`
 	
`(cons 6 (cons 3 (cons 4 empty)))`
	1
	Produce a natural one bigger, use add1:
	
	`(add1 N2) ==> 3`
	
	`(add1 2) ==> 3`

Produce a list one element shorter, use rest:
 	
`(rest LON-2)`
`  ==> (cons 4 empty)`
 	
`(rest (cons 3 (cons 4 empty)))`
`  ==> (cons 4 empty)`
	2
	Produce a natural one smaller, use sub1:
	
	`(sub1 N2) ==> 1`
	
	`(sub1 2) ==> 1`

Access the first element in the list, use first:
 	
`(first LON-2) ==> 3`
 	
`(first (cons 3 (cons 4 empty))) ==> 3`
	3
	What is the first natural encountered in the countdown?
	
	`n`

To operate on the remaining elements in the list, use NR: `(recursive-call (rest LON-2))`	**4** To operate on the remaining naturals, use NR: `(recursive-call (sub1 n))`
Base-case (when the recursion stops) is: when the list is empty… `(empty? lon)`	**5** Base-case (when the recursion stops) is: when the Natural is 0… `(zero? n)`

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Functions

Use them…	Define them…	
CALL by name, passing the expected value(s)	**Already defined for us BSL built-in/primitive functions/operators**	**Define our own using HtDF recipe**

`(+ 4 5)`
`(* (+ 4 3) 5)`
`(substring "Hi" 0 1)`
 	
`(bulb "red")`
 	
`(pos? -1)`
`(pos? (- 5 7))`
	+, * , /, -
	string-append
	substring
	positive?
	
	More in helpdesk…
		`(define (bulb c)`
		`(circle 20 "solid" c))`
		
		`(define (pos? n)`
		`(> n 0))`
		
		`(define (sum-to-n n)`
		`(cond [(zero? n) 0]`
		`[else`
		`(+ n`
		`(sum-to-n (sub1 n)))]))`

Data Types

Use them…	Define them…	
In the signature of our function	**BSL built-in/primitive types**	**Define our own using HtDD recipe**

`;; Natural -> Natural`
`;; produce 2 * n`
`(define (double n)`
`(* n 2))`
 	
`;; String Number -> String`
 	
`;; TeamName -> Boolean`
 	
`;; Age -> Boolean`
 	
`(define S1`
`(make-student "Jim"`
`3.5))`
 	
`(student-name S1)`
`;evaluates to "Jim"`
 	
`(student-id S1)`
`;evaluates to 3.5`
 	
`;; Student -> Number`
`;; produce gpa of s as %`
 	
`;; Natural -> Natural`
`;; produce sum o number`
`;; 0 to n inclusive`
	Number
	Integer
	Natural
	String
	Boolean
	More in helpdesk…
		`;; TeamName is String`
		
		`;; Age is Natural[0,110]`
		
		`(define-struct student (name gpa))`
		`;; Student is (make-student String Number)`
		
		`;; Natural is one of:`
		`;; - 0`
		`;; - (add1 Natural)`
		`;; interp. a natural number`

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Abstract Functions – add them to concept model

Functions		
Use them…	**Define them…**	
CALL **by name, passing the expected value(s)**	**Already defined for us** **BSL built-in/primitive functions/operators**	**Define our own** **using HtDF recipe**

`(+ 4 5)`
`(* (+ 4 3) 5)`
`(substring "Hi" 0 1)`
 	
`(bulb "red")`
 	
`(pos? -1)`
`(pos? (- 5 7))`
 	
`(map sqr (list 2 3 4))`
`⇨ (list 4 9 16)`
 	
`(foldr + 0`
`(list 2 3 4))`
`⇨ 9`
	+, *, /, -
	string-append
	substring
	positive?
	
	More in helpdesk…
	
	map
	filter
	foldr
	build-list
	andmap
	ormap
		`(define (bulb c)`
		`(circle 20 "solid" c))`
		
		`(define (pos? n)`
		`(> n 0))`
		
		`created from examples:`
		`map-2`
		`filter-2`
		
		created from template:
		fold
		fold-unit