Θ asymptotic notation, 157  [-] floor function, 46, 52, 62  ⊥ undefined value, 24, 28, 30, 104, 177, 215, 217, 226, 233  π, 50, 215  ⊑ approximation ordering, 217  (%) integral ratio, 50  "" empty list of characters, 18  "double quotes, 4  ' single quote, 3  (!!) list-indexing operation, 9  (!) array-indexing operation, 261  (\$!) strict application operator, 153, 252  (\$) application operator, 153  (&&) boolean conjunction, 10  () null tuple, 30, 33, 240  (**) exponentiation, 59  (,) pair constructor, 74, 146  (-) subtraction operator, 27  (->) function type, 1  (.) function composition, 3, 15, 31  (//) array update operation, 262  (/=) inequality test, 9  (:) cons, list constructor, 64  (<=) comparison test, 9, 76  (<<<') right-to-left Kleisli composition, 247  (==) equality test, 9  (>>>) left-to-right Kleisli composition, 247  (>>) sequence operation, 240  (>>=) monadic bind, 241, 279  (^) exponentiation, 59  (^) exponentiation, 59  (  ) boolean disjunction, 32  .hs Haskell script, 35, 227	\n newline character, 3, 18 \t tab character, 18     back-quote, 9, 25 (++) list concatenation, 10, 15, 69, 113 n+k patterns, 111 abs, 50, 54 absolute value, see abs abstract data types, 194, 239, 259 abstract syntax trees, 201 accumArray, 260 accumulating functions, 260 accumulating parameters, 159, 171, 288, 289, 323 actions, 239 Agda, 48 Algorithm Design, 145, 154 all, 94 alphabetical order, 5, 19 anagrams, 16 and, 74 anti-symmetric relation, 217 any, 102 approx, 218 Array, 259 array, 259 arrays immutable, 259 mutable, 254 associative operations, 15, 26, 70, 112, 113, 119, 124, 129, 184, 231, 246, 247, 281, 326 assocs, 262 asymptotic complexity, 155 Augustsson, L., 47 auxiliary results, 114, 117, 140
. 1hs literate Haskell script, 8, 35, 227 :load instruction, 13 :set instruction, 13, 148 :type instruction, 22 @ as patterns, see patterns [] empty list, 17, 63, 64, 104, 121, 151 \ escape character, 18	base cases, <i>see</i> induction Bentley, J., 21, 127, 144 Bifunctor, 82 bifunctors, 82, 87, 302, 326 binary operators, 25 binary search, 54 binary trees, 165, 249

binding power, 2, 14, 25	Data.STRef, 251
Bird, R., 87, 180	de Moor, O., 87
blank characters, 3	deep embeddings, 194
BNF (Backus-Naur form), 286, 305	default definitions, 31
Bool, 10, 30	dependently-typed languages, 48, 90
boolean	deriving clauses, 39, 57
conjunction, see (&&)	directed graphs, 260
disjunction, see (  )	distributive operations, 130
bottom, $see \perp$ undefined value	div, 9, 24, 59
braces, 15, 36, 242	divide and conquer algorithm, 46, 76
brackets, 15	divMod, 51
breadth-first search, 257	do-notation, 34, 36, 239, 242, 245
break, 102	done, 240
· ·	Double, 49
C, 239	drop, 79
C#, x	dropWhile, 106
case expression, see expressions	•
case analysis, 10, 53	e, 141
Category Theory, 71, 87	echoing, 241
chain completeness, 116, 212, 220	efficiency, ix, 145
chain of approximations, 215, 218, 225	Either, 82, 132
Char, 3, 30, 90, 254	either, 132
Chitil, O., 209	else, 12
comment convention, 8	embedded domain-specific language, 209
common subexpression elimination, 147	empty list, see []
commonWords, 3, 4, 34, 75	Enum, 65, 90, 211
comparison operations, 32	enumerations, 65, 210, 217
compiled functions, 154	enumFrom, 211
compilers, 36, 154	Eq, 31, 56
complete partial orderings, 218	equality operations, 31
Complex, 49	equational reasoning, ix, 1, 73, 81, 89, 96, 99, 110,
concat, 6, 67, 70, 157	135, 298
concatMap, 307	error, 36, 39, 179
concrete data types, 194	error messages, 23, 24, 39, 43, 103, 151, 192, 250,
conditional expressions, 189	279
const, 86	evaluation
context, 11	eager, 28, 154, 157
Control.Monad, 247, 264	innermost, 28
Control.Monad.ST, 251	lazy, 28, 75, 80, 89, 145, 154, 175, 198, 243
Control.Monad.State.Lazy, 251	outermost, 28
Control.Monad.State.Strict, 251	to normal form, 22, 27, 146, 156
conversion functions, 53	exception handling, 239
coprime numbers, 66	exp, 40, 110, 141
Coq, 337	explicit layout, 242
cosine function, ix	exponentiation, 40, 59, 110
cp cartesian product, 92, 93, 97, 131, 155, 244, 320	export declarations, see modules
cross, 81, 301	expressions
curry, 86, 135	case, 127, 245
Curry, H.B, 87	conditional, 12, 23, 181
cycle, 232	lambda, 26, 148, 242
cyclic lists, 212	let, 24, 146, 147, 248
data constructors, 25, 56	well-formed, 22
data type declarations, 30, 56, 189, 194, 202, 229	factorial function, 28, 220
Data. Array, 259	factoring parsers, 282
Data.Char, 13, 42, 227, 283	failure, 39
Data.Complex, 49	Feijen, W., xi
Data.List, 75, 106, 125, 154, 311	Fibonacci function, 164, 232, 251, 266
Data.Maybe, 319	FilePath, 34
<b>V</b> 17.5	,

filter, 38, 67, 70, 72, 97, 98, 119, 134, 299	Hamming, W.R., 232
flat ordering, 217	Hangman, 266
flip, 59, 123, 148	Hardy, G.H., 78
Float, 2, 30, 49	Harper, B., 47
Floating, 52	hash tables, 256
floating-point literal, 51	Haskell, x, 1
floating-point numbers, 112, 293	1998 online report, 21
floor, 46, 52, 60	2010 online report, 21, 111
fmap, 71	commands, 1, 33, 34, 239
-	
foldl, 122, 150, 152, 260	layout, 36
fold1', 150, 152	libraries, 7, 181
fold11, 231	numbers, 2, 112
foldr, 117, 152, 164	Platform, 12, 154
foldr1, 121, 231	reserved words, 12
foral1, 253	standard prelude, see standard prelude
fork, 81, 134, 301	syntax, 22
Fractional, 50	values, 22
fromInteger, 50, 67, 151	well-formed literals, 122
fromIntegral, 51, 67, 151	head, 38, 68, 72
fromJust, 319	head normal form, 146, 157, 172
fst, 28, 51	helper functions, 26
function, 1	Hinze, R., 275
application, 2, 4, 14	History of Haskell, 20
arguments, 1, 3	homomorphisms, see laws
	•
composition, see (.)	Hughes, J., 209
computable, 219	Hutton, G., 21, 297
continuous, 219	id, 18, 70, 71, 94, 96, 253
conversion, 50	idempotence, 205, see laws
higher-order, 110	identities, see laws
identity, see id	identity elements, 15, 96, 184, 247, 281
monotonic, 219	identity function, see id
non-strict, 29, 58	if, 12
overloaded, 31	imperative languages, x
partial, 9	import declarations, see modules
polymorphic, 31, 72	in-place algorithms, 170, 254
primitive, 150	indexitis, 95
recursive, 17, 219	induction, 110, 111
results, 1, 3	base case, 77, 111
strict, 29, 59, 72, 120, 137, 150, 154	general, 179
type, see ->	inductive case, 77, 111
values, 145	
Functor, 71, 264	over lists, 113
functors, 87, 264	over numbers, 110
	pre-packaged, 120
getChar, 240	inductive cases, see induction
getLine, 241	infinite loops, 24, 28, 30, 77, 124, 211
GHC, 35, 36, 154, 169, 275	infix data constructors, 194
GHCi, 12, 22, 36, 154	infix operations, 9
Gibbons, J., 209, 275	infixr fixity declaration, 153
global definition, see top-level definition	inits, 125
Goerzen, J., 21	inlining, 54
Gofer, x, 275	insertion sort, see sorting
golden ratio, 164	instance declarations, 32
Graham, R., 62	Int, 2, 30, 49, 155, 254
grammars, 286	Integer, 2, 49, 155
greedy algorithms, 192	integer literals, 50
guard, 306	Integral, 51, 155
guarded equations, 9, 12, 332	interact, 227
guards, 10	interaction, 221

interactive programs, 227	finite, 64
interpreters, 36	identity function, 118
involutions, see laws	indexing, see (!!)
10, 33, 239	infinite, 53, 64, 75, 108, 210
isAlpha, 42	notation, 3
isSpace, 283	partial, 64, 115, 211
it, 229	listArray, 260
iterate, 64, 213, 301	lists
Ix, 254, 255	adjacency, 261
Jeuring, J., 209	literate programming, 8
join, 264	local definitions, 11, 149, 256
Jones, M., 144, 275	log, 141
Just, 244	logarithmic factors, 159
,	logarithmic time, 56
Knuth, D.E., 21, 62, 167	logBase, 2, 141
KRC, x	lookup, 244, 319
Lapalme, G., 180	loop invariants, 255, 263
last, 68	lower bounds, 157
Launchbury, J., 275	lowercase, 5
laws	Loyd, S., 267
arithmetic, 17	Mac, 12
bifunctor, 302	main, 34, 227
commutative, 186	map, 5, 23, 31, 38, 67, 70, 80, 91, 119, 299
distributive, 186	mapM, 265
equational, ix	mapM_, 265
functor, 71, 81, 303, 330	Marlow, S., 20
fusion, 120, 131, 176	Maslanka, C., 48
homomorphisms, 185, 186	mathematical operators, 217
idempotence, 204	matrices, 90, 94, 234
identities, ix, 110	matrix
involutions, 96, 113	addition, 105
leapfrog, 247, 265	multiplication, 105
left-distributive, 293	transpose, 94, 106
left-zero, 293	maximum, 122
monad laws, 246, 279	Maybe, 39, 244
naturality, 72, 87, 97	McIlory, D., 21
point-free, 110	mean, 151
right-zero, 293	Meijer, E., 209, 297
trigonometric, ix	merge, 76, 211, 231
tupling, 152, 165	mergesort, see sorting
layout description language, 182	minimum, 104, 107, 122, 157, 211
lazy evaluation, see evaluation	Miranda, x
least fixed points, 220	mkStdGen, 223
least upper bounds, 218	ML, 29, 48
left-recursion problem, 287	mod, 9
Leibniz, G., 243	modules, 13, 25, 35, 309
length, 69, 79, 160	export declarations, 35, 199
let, see expressions	hierarchical names, 21
lexicographic order, 76, 189, 217	import declarations, 13, 35
liftM, 264	Monad, 243, 264
lines, 188, 200	monadic programming, 239
Linux, 12	MonadPlus, 292
list	monads, 243
adjacency, 261	commutative, 264
comprehensions, 66, 92, 156, 244, 245, 248	monoids, 247
concatenation, see (++)	mplus, 292
cyclic, 210	mutable structures, 248
doubly-linked, 228	mzero, 292
actory miner, 220	

Nat, 56, 110, 132	perfect numbers, 65
natural transformations, 87	Perlis, A., 145
negate, 50	persistent data structures, 254
newline character, see \n	Peyton Jones, S., 21, 209
newSTRef, 251	Pierce, B., 87
Newton's method, 60	plumbing combinators, 86
newtype declarations, 278	point-free calculations, 86, 330
non-decreasing order, 74	point-free reasoning, 298
none, 134	pointers, 146
normal form, 146	postconditions, 255, 263
not, 30	precedence, 14, 25, 37
notElem, 98	preconditions, 255, 263
Nothing, 244	prefix names, 25
nub, 106, 108	prefix operators, 50
null, 39, 68	Prelude, 25
null tuple, see ()	primes, 148, 213, 219, 220, 233
Num, 23, 31, 49, 56	printing values, 33
Number Theory, 219	profiling tools, 154
numbers	program variables, 251
complex, see Complex	programs, 7
floating point, see Float, Double	prompt symbol, 13
floating-point, 60	prompts, 229, 240
integer, see Int, Integer	proof format, xi, 112
limited precision integers, see Int	properFraction, 56
natural, 56, 110	putChar, 240
unlimited precision integers, see Integer	putStrLn, 16, 33, 239, 240
O'Neill, M., 237	Pythagorean triads, 66
O'Sullivan, B., 21	Python, x, 239, 252
offside rule, 36, 242	qualified names, 306
one, 134	quicksort, see sorting
Oppen, D., 209	Rabbi, F., 180
or, 102	Ramanujan, S., 78
Ord, 32	random numbers, 223, 250
order of association, 2-4, 17, 25, 62, 196	
	randomB 223
	randomR, 223
Orwell, x	rank 2 polymorphic types, 253
Orwell, x otherwise, 11	rank 2 polymorphic types, 253 Rational, 49, 50
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper-rock-scissors, 221	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper–rock–scissors, 221 paragraphs, 191	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper–rock–scissors, 221 paragraphs, 191 parentheses, 15	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper–rock–scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper–rock–scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 readSTRef, 251
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper–rock–scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 readSTRef, 251 Real, 50
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper–rock–scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partial numbers, 58	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper-rock-scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partial numbers, 58 partition, 311	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219 reduction, see evaluation
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper-rock-scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partial numbers, 58 partition, 311 Patashnik, O., 62	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219 reduction, see evaluation reduction steps, 155, 156
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper-rock-scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partial numbers, 58 partition, 311 Patashnik, O., 62 Paterson, R., 337	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219 reduction, see evaluation reduction steps, 155, 156 reference variables, 251
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper-rock-scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partial numbers, 58 partition, 311 Patashnik, O., 62 Paterson, R., 337 patterns	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219 reduction, see evaluation reduction steps, 155, 156 reference variables, 251 reflexive relation, 217
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper—rock—scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partial numbers, 58 partition, 311 Patashnik, O., 62 Paterson, R., 337 patterns n+k, 111	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219 reduction, see evaluation reduction steps, 155, 156 reference variables, 251 reflexive relation, 217 repeat, 108, 212
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper-rock-scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partial numbers, 58 partition, 311 Patashnik, O., 62 Paterson, R., 337 patterns n+k, 111 as patterns, 77, 83	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219 reduction, see evaluation reduction steps, 155, 156 reference variables, 251 reflexive relation, 217 repeat, 108, 212 return, 241
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper-rock-scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partital numbers, 58 partition, 311 Patashnik, O., 62 Paterson, R., 337 patterns n+k, 111 as patterns, 77, 83 disjoint, 68	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219 reduction, see evaluation reduction steps, 155, 156 reference variables, 251 reflexive relation, 217 repeat, 108, 212 return, 241 reverse, 42, 72, 113, 117, 123, 159
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper-rock-scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partial numbers, 58 partition, 311 Patashnik, O., 62 Paterson, R., 337 patterns n+k, 111 as patterns, 77, 83 disjoint, 68 don't care, 67, 73, 103, 268	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219 reduction, see evaluation reduction steps, 155, 156 reference variables, 251 reflexive relation, 217 repeat, 108, 212 return, 241 reverse, 42, 72, 113, 117, 123, 159 running sums, 125
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper-rock-scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partial numbers, 58 partition, 311 Patashnik, O., 62 Paterson, R., 337 patterns n+k, 111 as patterns, 77, 83 disjoint, 68 don't care, 67, 73, 103, 268 exhaustive, 68	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 reads Z77 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219 reduction, see evaluation reduction steps, 155, 156 reference variables, 251 reflexive relation, 217 repeat, 108, 212 return, 241 reverse, 42, 72, 113, 117, 123, 159 running sums, 125 runST, 252
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper-rock-scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partial numbers, 58 partition, 311 Patashnik, O., 62 Paterson, R., 337 patterns n+k, 111 as patterns, 77, 83 disjoint, 68 don't care, 67, 73, 103, 268 exhaustive, 68 irrefutable, 231	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 reads Z77 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219 reduction, see evaluation reduction steps, 155, 156 reference variables, 251 reflexive relation, 217 repeat, 108, 212 return, 241 reverse, 42, 72, 113, 117, 123, 159 running sums, 125 runST, 252 SASL, x
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper-rock-scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partial numbers, 58 partition, 311 Patashnik, O., 62 Paterson, R., 337 patterns n+k, 111 as patterns, 77, 83 disjoint, 68 don't care, 67, 73, 103, 268 exhaustive, 68 irrefutable, 231 matching, 57, 67, 68, 74, 115, 194, 332	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 reads Z77 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219 reduction, see evaluation reduction steps, 155, 156 reference variables, 251 reflexive relation, 217 repeat, 108, 212 return, 241 reverse, 42, 72, 113, 117, 123, 159 running sums, 125 runST, 252 SASL, x scanl, 125, 127
Orwell, x otherwise, 11 pairs, 2, 74, 76, 82, 177 palindromes, 41 paper-rock-scissors, 221 paragraphs, 191 parentheses, 15 parsers, 276 parsing, 239 partial application, 87 partial numbers, 58 partition, 311 Patashnik, O., 62 Paterson, R., 337 patterns n+k, 111 as patterns, 77, 83 disjoint, 68 don't care, 67, 73, 103, 268 exhaustive, 68 irrefutable, 231	rank 2 polymorphic types, 253 Rational, 49, 50 Read, 41, 122, 277 read, 52, 122 readFile, 34 reading files, 34 ReadS, 277 reads, 277 reads Z77 readSTRef, 251 Real, 50 recursive definitions, 29, 77, 219 reduction, see evaluation reduction steps, 155, 156 reference variables, 251 reflexive relation, 217 repeat, 108, 212 return, 241 reverse, 42, 72, 113, 117, 123, 159 running sums, 125 runST, 252 SASL, x

scientific notation, 60, 112	Sundaram, S.P., 233
scope, 11	superclasses, 32
scripts, 7, 25, 148	Swierstra, D., 209
sections, 26, 52, 53	syntactic categories, 286
segments, 127, 316	System.Random, 223
select, 175	System. IO, 242
selection sort, see sorting	tail, 38, 68
semicolon, 36	tails, 128
separator characters, 200	take, 6, 30, 79, 218
seq, 150, 153, 226	takeWhile, 52, 106
sequence_, 264	taxicab numbers, 79, 88
set theory, 211	terminator characters, 200
shallow embeddings, 187, 192	texts, 3, 5, 181
shared values, 146	then, 12
Show, 32, 40, 56, 229, 276, 291	time efficiency, 92, 123, 126, 147, 154, 156, 182
ShowS, 289, 311	toInteger, 51, 151
showsPrec, 290, 291, 308	toLower, 5, 13, 38
side-effects, 243	top-level definitions, 147, 256
sieve of Sundaram, 233	toRational, 50
signum, 50	toruses, 234
Sijtsma, B., 237	toUpper, 44, 227
sin, 2, 14	transitive relation, 217
sine function, ix, xi, 2, 14	transpose, 106
size measures, 156, 202	trees, 71, 161, 165, 190, 194
snd, 51	trigonometry, ix, 2
sort, 14, 75, 154	tupling, 164, 170
sorting, 5, 6, 94, 167	tupling law of foldr, 165
insertion sort, 172	tying the recursive knot, 214, 238
mergesort, 76, 168	type
numbers, 262	annotations, 41
quicksort, 169, 254, 263	classes, 25, 30, 31, 155
selection sort, 172	declarations, 7, 20
space character, 3	inference, 20, 22
space efficiency, 29, 84, 147, 149, 154, 171	signatures, 6, 20, 30, 155
space leaks, 147, 151, 170, 171	synonyms, 5, 90, 183, 278
span, 75, 102	variables, 7, 31
Spivey, M., 337	well-formed, 22
splitAt, 80, 168	types
sqrt, 60	compound, 30
stand-alone programs, 34, 227	isomorphic, 278
standard prelude, 13, 30, 39, 42, 51, 56, 73, 80, 86,	polymorphic, 31, 72
87, 127, 150, 161, 168, 213, 232	primitive, 30
STArray, 254	UHC (Utrecht Haskell Compiler), 47
state monad, 247	uncurry, 86, 135
state threads, 251	undefined, 24, 64
state-thread monad, 251	underscore convention, 264
Stewart, D., 21	unlines, 227
stream-based interaction, 226	unsafeperformIO, 242
STRef, 251	until, 52, 65
strictness flags, 58, 194	unwords, 44
String, 6	unzip, 81
strings, 4	upper bounds, 218
subclasses, 50	**
subseqs, 133, 146, 158	visible characters, 3
subsequences, 146	Visual Basic, x
subtract, 53, 59	Wadler, P., 87, 209
Sudoku, 89, 258, 321	where clauses, 11, 24, 36, 147, 242
sum, 150	white space, 283

wholemeal programming, 95
Wilde, O., 145
Windows, 12
WinGHCi, 12
words, 4, 5, 38, 107, 191
World, 239
writeFile, 34
writeSTRef, 251
writing files, 34
zip, 73
zipWith, 73, 105
zipWith3, 230