CSVreader Module

Module

CSVreader

Uses

CityPostT, CityT, EarthquakeT,
EarthquakeT.ColorRating, EarthquakeT.MagType,
EarthquakeBag, GeoCollection, RedBlackBST

Syntax

Exported Constants

None

Exported Access Programs

Routine name	In	Out	Exceptions
readEarthquakes	String, EarthquakeBag		IOException
readEarthquakesBST	String, RedBlackBST		IOException
readPopulation	String, GeoCollection		IOException
readCityPosition	String, seq of CityPostT		IOException
rmFirstLastQuote	String	String	
generateColorRating	$\mathbb{R}$	ColorRating	
fullProvName	String	String	

Semantics

Environment Variables

A file listing Earthquake Information.
A file listing Population Densities.
A file listing City Coordinates.

State Variables

None

State Invariant

None

Assumptions

The input file by filename will match the specific format required by the read method.

Access Routine Semantics

readEarthquakes(filename, bag):

- transition: Read each line of the earthquake csv file and convert to a EarthquakeT object, which is stored in a EarthquakeBag.
- exception: If the file by filename does not exist, produces IOException.

readEarthquakesBST(filename, bst):

- transition: Read each line of the earthquake csv file and convert to a EarthquakeT object, which is stored in a RedBlackBST.
- exception: If the file by filename does not exist, produces IOException.

readPopulation(filename, geoCollec):

- transition: Read each line of the population csv file and convert to a CityT object, which is stored in a GeoCollection HashMap.
- exception: If the file by filename does not exist, produces IOException.

readCityPosition(filename, cityPostList):

- transition: Read each line of the city coordinates csv file and convert to a CityPostT object, which is stored in a list of cities.
- exception: If the file by filename does not exist, produces IOException.

rmFirstLastQuote(cell):

- transition: Remove first and last double quotations from a string value.
- exception: None

generateColorRating(cell4):

- transition: Generate an enum ColorRating type based on the magnitude of earthquake.
- exception: None

fullProvName(nameP):

- output: a new province name similar to the following table.

	nameP =	*out* :=
|nameP| = 2	ON	Ontario
	QC, PQ	Quebec
	NS	Nova Scotia
	NB	New Brunswick
	MB	Manitoba
	BC	British Columbia
	PE	Prince Edward Island
	SK	Saskatchewan
	AB	Alberta
	NL	Newfoundland and Labrador
	NU	Nunavut
	NT	Northwest Territories
	YT	Yukon
	AK	Alaska
	WA	Washington
	default	UNLOCATED
|nameP| $\neq$ 2	VANCOUVER ISLAND	British Columbia
	SOUTHERN QUEBEC	Quebec
	default	UNLOCATED

- exception: None

Considerations

There are a number of different variations of geolocation names in the earthquake csv file, for these an appropriate province name should be assigned. For any that could not be matched to a province name, UNLOCATED should be assigned.

Point ADT Module

Template Module

PointT

Uses

N/A

Syntax

Exported Types

PointT = ?

Exported Access Programs

Routine name	In	Out	Exceptions
new PointT	$\mathbb{R}, \mathbb{R}$	PointT	RuntimeException
getLat		$\mathbb{R}$	
getLong		$\mathbb{R}$	
distance	PointT	$\mathbb{R}$	
latFilter	$\mathbb{R}$	$< \mathbb{R}, \mathbb{R} >$	
equals	PointT	$\mathbb{B}$	

Semantics

State Variables

$x : \mathbb{R}$
$y : \mathbb{R}$

Access Routine Semantics

PointT($lat, long$):

- transition: $x, y := lat, long$
- output: $out := self$
- exception: $exc := ((lat > 90 \vee lat < -90) \Rightarrow \text{IndexOutOfBoundsException})$

getLat():

- output: $out := x$

getLong():

- output: $out := y$

distanceTo(that):

- output: $out :=$ d such that d is the distance(in km) between current point and that

latFilter(radius):

- output: $out :=< minLat, maxLat >$ such that $\forall(p : PointT | distanceTo(p) \leq radius : p.getLat() \geq minLat \wedge p.getLat() \leq maxLat$

equals(that):

- output: $out := (x = that.getLat()) \wedge (y = that.Long())$

City ADT Module

Template Module

CityT

Uses

N/A

Syntax

Exported Types

CityT = ?

Exported Access Programs

Routine name	In	Out	Exceptions
new CityT	String, String, $\mathbb{R}$	CityT	
getCityName		String	
getProvince		String	
getPopDensity		$\mathbb{R}$	
equals	CityT	$\mathbb{B}$	

Semantics

State Variables

cityName : String
province : String
popDensity : $\mathbb{R}$

Access Routine Semantics

CityT(*city*, *pro*, *pop*):

- transition: $cityName, province, popDensity := city, pro, pop$
- output: $out := self$

getCityName():

- output: $out := cityName$

getProvince():

- output: $out := province$

getPopDensity():

- output: $out := popDensity$

equals(that):

- output: $out := (cityName = that.getCityName()) \wedge (province = that.getProvince()) \wedge (popDensity = that.getPopDensity())$

City Position ADT Module

Template Module

CityPostT

Uses

PointT

Syntax

Exported Types

CityPostT = ?

Exported Access Programs

Routine name	In	Out	Exceptions
new CityPostT	String, $\mathbb{R}, \mathbb{R}$	CityPostT	
getPoint		PointT	
getCityName		String	

Semantics

State Variables

cityName : String
point : PointT

Access Routine Semantics

CityT($city, lat, lon$):

- transition: $cityName, point := city, newPointT(lat, lon)$
- output: $out := self$

getPoint():

- output: $out := point$

getCityName():

- output: $out := cityName$

CityT Collection Module

Template Module

GeoCollection

Uses

CityT

Syntax

Exported Types

GeoCollection = ?

Exported Access Programs

Routine name	In	Out	Exceptions
add	CityT		
getCities	String	seq of CityT	
getAllCities		set of tuple of(String, seq of CityT)	
isEmpty		$\mathbb{B}$	

Semantics

State Variables

s : set of tuple of (String, seq of CityT)

Access Routine Semantics

add(city):

- transition: $s := \{< str, cities >:< String, \text{seq of CityT} > \mid < str, cities > \in s : (str = getFirstCityLetter(city) \Rightarrow < str, cities || [city] > \mid true \Rightarrow < str, cities >)\}$

isEmpty():

- output: $out := (|s| = 0 \Rightarrow true \mid true \Rightarrow false)$

getCities(firstLetter):

- output: $out := \{< str, cities >:< String, \text{ seq of CityT} > \mid < str, cities > \in s \wedge str = firstLetter : cites\}$

getAllCities():

- output: $out := s$

Local Functions

getFirstCityLetter : String $\rightarrow$ String
getFirstCityLetter($city$) $\equiv city[0]$

Earthquake ADT Module

Template Module

EarthquakeT

Uses

LocalDateTime, PointT

Syntax

Exported Types

EarthquakeT = ?

ColorRating = { NOCOLOR, ZERO, PURPLE, BLUE, GREEN, YELLOW, ORANGE, RED }

MagType = { M5, mb, MB, Mb, MC, Mc, mc, ML, MLSn, MN, MS, MW, Ms, Mw, BLANK }

 # EarthquakeT implements Comparable(EarthquakeT)

Exported Constants

None

Exported Access Programs

Routine name	In	Out	Exceptions
new EarthquakeT	String, String, LocalDateTime, $\mathbb{R}, \mathbb{R}, \mathbb{R}, \mathbb{R}$, MagType, ColorRating	EarthquakeT	
getNameOfProv		String	
getPlace		String	
getPointT		PointT	
getMag		$\mathbb{R}$	
getDph		$\mathbb{R}$	
getMagitudeType		MagType	
getDate		LocalDateTime	
getColor		ColorRating	
compareTo	EarthquakeT	$\mathbb{Z}$	
equals	EarthquakeT	$\mathbb{B}$	

Semantics

State Variables

place: String
nameOfProv: String
date: LocalDateTime
lat: $\mathbb{R}$
lng: $\mathbb{R}$
dph: $\mathbb{R}$
mag: $\mathbb{R}$
magnitudeType: MagType
color: ColorRating

State Invariant

None

Assumptions

Two earthquakes are not the same if they happened to have two different dates or two different places recorded.

Access Routine Semantics

EarthquakeT(place, prov, date, lat, lng, dph, mag, mgT, color):

- transition:
  lat, lng, place, nameOfProv, date, dph, mag, magnitudeType, color :=
  lat, lng, place, prov, date, dph, mag, mgT, color
- output: *out* := *self*
- exception: None

getNameOfProv():

- output: *out* := nameOfProv
- exception: None

getPlace():

- output: *out* := place
- exception: None

getPointT():

- output: *out* := PointT(lat, lng)
- exception: None

getMag():

- output: *out* := mag
- exception: None

getDph():

- output: *out* := dph
- exception: None

getMagitudeType():

- output: *out* := magnitudeType
- exception: None

getDate():

- output: *out* := date
- exception: None

getColor():

- output: *out* := color
- exception: None

compareTo(eq):

- output: *out* := an integer value according to the following table.

	out :=
this.mag < eq.mag	-1
this.mag > eq.mag	1
this.mag = eq.mag	0

- exception: None

equals(that):

- output: *out* := (sameDate ∧ samePoint ∧ samePlace ∧ sameDepth ∧ sameMagValue ∧ sameMagType ∧ sameEqClass) ⇒ $True | True \Rightarrow False$
- exception: None

Local Functions

sameDate: EarthquakeT $\rightarrow \mathbb{B}$
sameDate(d) $\equiv$ (d.date) = ($this$.date)
 # Returns true if the given EarthquakeT object has the same date as the current.

samePoint: EarthquakeT $\rightarrow \mathbb{B}$
samePoint(d) $\equiv$ (d.Point) = ($this$.Point)
#Returns true if the given EarthquakeT object has the same Point as the current.

samePlace: EarthquakeT $\rightarrow \mathbb{B}$
samePlace(d) $\equiv$ (d.place) = ($this$.place)
#Returns true if the given EarthquakeT object has the same place as the current.

sameDepth: EarthquakeT $\rightarrow \mathbb{B}$
sameDepth(d) $\equiv |d.\text{dph} - this.\text{dph}| < 0.0000001$
#Returns true if the given EarthquakeT object has the same depth value as the current within the tolerance.

sameMagValue: EarthquakeT $\rightarrow \mathbb{B}$
sameMagValue(d) $\equiv |d.\text{mag} - this.\text{mag}| < 0.0000001$
#Returns true if the given EarthquakeT object has the same magnitude value as the current within the tolerance.

sameMagType: EarthquakeT $\rightarrow \mathbb{B}$
sameMagType(d) $\equiv$ (d.magnitudeType) = ($this$.magnitudeType)
#Returns true if the given EarthquakeT object has the same magnitude type as the current.

sameEqClass: EarthquakeT $\rightarrow \mathbb{B}$
sameEqClass(d) $\equiv$ (d.color) = ($this$.color)
#Returns true if the given EarthquakeT object has the same earthquake class as the current.

Edge ADT Module

Template Module

Edge

Uses

N/A

Syntax

Exported Types

Edge = ?

Exported Access Programs

Routine name	In	Out	Exceptions
new Edge	String, String, $\mathbb{Z}$	Edge	
weight		$\mathbb{Z}$	
from		String	
to		String	

Semantics

State Variables

v : String
w : String
$weight$: $\mathbb{Z}$

Access Routine Semantics

Edge($from, to, w$):

- transition: $v, w, weight := from, to, w$
- output: $out := self$

weight():

- output: $out := weight$

from():

- output: $out := v$

to():

- output: $out := w$

City Graph Module

Template Module

CityGraph

Uses

Edge

Syntax

Exported Types

CityGraph = ?

Exported Access Programs

Routine name	In	Out	Exceptions
new CityGraph		CityGraph	
addEdge	Edge		
adj	String	seq of Edge	

Semantics

State Variables

adj : set of tuple of (String, seq of Edge)

Access Routine Semantics

CityGraph():

- transition: $adj := \{\}$
- output: $out := self$

addEdge(e):

- transition: $adj := \{< str, edges >:< String,$ seq of Edge $> \mid < str, edges > \in adj : (str = e.from() \Rightarrow < str, edges || [e] > \mid true \Rightarrow < str, edges >)\}$

adj(v):

- output: $out := \{< str, edges >:< String,$ seq of Edge $> \mid < str, edges > \in adj \wedge str = v : edges\}$

EarthquakeBag Module

Template Module

EarthquakeBag is seq of EarthquakeT

 # Used only for testing time performance against RedBlackBST module.
 # This module is not part of the actual application.

Generic Queue Module

Generic Template Module inherits Iterable(T)

Queue(T)

Uses

None

Syntax

Exported Constants

None

Exported Types

Queue = ?

Internal Types

Node = ?

 # Internal Node type has a link to next item in the queue.

Exported Access Programs

Routine name	In	Out	Exceptions
Queue		Queue	
isEmpty		$\mathbb{B}$	
enqueue	T		
toString		String	
start			
next		T	NoSuchElementException

Semantics

State Variables

first: Node
last: Node
$n : \mathbb{N}$
s: seq of T

 # For simplification, the linked-node structure is represented by seq of T.
 # s[1] is the first Node.
 # s[n] is the last Node.

State Invariant

None

Assumptions

None

Access Routine Semantics

Queue():

- transition: first, last, n := null, null, 0
- output: *out* := self
- exception: none

isEmpty():

- output: $out := (n = 0) \Rightarrow True | True \Rightarrow False$
- exception: None

enqueue(item):

- output: $out := s||\text{item}$
- exception: None

toString():

- output: $out := out || (\forall\, i : \mathbb{N} | i \in [1..n] : s[i])$
- exception: None

Iterator Methods:

$i : \mathbb{N}$

start():

- transition: $i := 0$
- exception: none

next():

- transition-output: $i, out := i + 1, s[i]$
- exception: $(i > n) \Rightarrow$ NoSuchElementException

Considerations

When an instance of Queue is iterated in a loop, an iterator consisting of these two methods is returned, and the start() method is call initially, and for the successive iterations next() method is call.

Generic RedBlackBST Module

Generic Template Module

RedBlackBST(T with Comparable(T), V)

Uses

Queue

Syntax

Exported Types

RedBlackBST = ?

Internal Types

Node = ?
State Variables of Node:
key: Key, lst: seq of V, left: Node, right: Node, color: B, size: N

 # Internal Node type was modified to store a seq of V.

Exported Access Programs

Routine name	In	Out	Exceptions
RedBlackBST		RedBlackBST	
size		$\mathbb{N}$	
isEmpty		$\mathbb{B}$	
get	T	seq of V	
put	T, V		
min		T	
max		T	
keys		seq of T	
keys	T, T	seq of T	
values	T, T	seq of V	

Semantics

State Variables

root: Node
RED: $\mathbb{B}$
BLACK: $\mathbb{B}$
s: set of $\langle T, V \rangle$

 # For simplification, the linked-node structure is represented by set of $\langle T, V \rangle$*.*

State Invariant

RED = True
BLACK = False

Assumptions

None

Access Routine Semantics

RedBlackBST():

- transition: None
- output: $out := self$
- exception: None

size():

- output: $out := root.size$
- exception: None

isEmpty():

- output: $out := (root = null) \Rightarrow True | True \Rightarrow False$
- exception: None

get(key):

- output: $out :=$ L where $\langle x, L \rangle \in s \wedge (x.key = key)$

- exception: None

put(key, val):

- transition: $s := \{\langle x, L\rangle : \langle T, V\rangle | \langle x, L\rangle \in s : (x.key = key \Rightarrow \langle x, L||[val]\rangle | \text{True} \Rightarrow \langle x, L\rangle)\}$
- exception: None

min():

- output: $out :=$ smallest key in s
- exception: None

max():

- output: $out :=$ largest key in s
- exception: None

keys():

- output: $out := out||(\forall \langle x, L\rangle : \langle T, V\rangle | \langle x, L\rangle \in s : x.key)$
- exception: None

keys(lo, hi):

- output: $out := out||(\forall \langle x, L\rangle : \langle T, V\rangle | \langle x, L\rangle \in s \wedge lo \leq x.key \leq hi : x.key)$
- exception: None

values(lo, hi):

- output: $out := out||(\forall \langle x, L\rangle : \langle T, V\rangle | \langle x, L\rangle \in s \wedge lo \leq x.key \leq hi : L)$
- exception: None

Search Earthquakes Module

Module

SearchEarthquakes

Uses

RedBlackBST, PointT

Syntax

Exported Types

None

Exported Access Programs

Routine name	In	Out	Exceptions
searchEarthquakeInCircle	RedBlackBST, PointT, $\mathbb{R}$	seq of EarthquakeT	

Semantics

State Variables

N/A

Access Routine Semantics

searchEarthquakeInCircle(bst, location, radius):

- output: $out := \{e : EarthquakeT \mid e \in bst \wedge location.distanceTo(e.getPointT()) \leq radius : e\}$

Sort Module

Module

Sort

Uses

PointT

Syntax

Exported Types

N/A

Exported Access Programs

Routine name	In	Out	Exceptions
sortByDistance	PointT, seq of EarthquakeT		
sortByMagnitude	seq of EarthquakeT		

Semantics

State Variables

N/A

Access Routine Semantics

sortByDistance(location, eqList):

- transition: $eqList := eqList$ such that $\forall(i : \mathbb{N} \mid i \in [0..|eqLisi| - 2] : location.distanceTo(eqList[i].getPointT()) < location.distanceTo(eqList[i{+}1].getPointT()))$

sortByMagnitude(eqList):

- transition: $eqList := eqList$ such that $\forall(i : \mathbb{N} \mid i \in [0..|eqLisi| - 2] : eqList[i] > eqList[i + 1]$

Risk Assessment Module

Template Module

RiskAssessment

Uses

SearchEarthquakes, GeoCollection, CityGraph, CityPostT

Syntax

Exported Types

RiskAssessment = ?

Exported Access Programs

Routine name	In	Out	Exceptions
new RiskAssessment	RedBlackBST, PointT		
getRisk		$\mathbb{Z}$	
getCity		String	
getFrequency		$\mathbb{Z}$	
getMag		$\mathbb{R}$	
getPoplationDensity		$\mathbb{R}$	
nearestLowerRiskCity	CityGraph	String	

Semantics

State Variables

earthquakeTree : RedBlackBST $< \mathbb{R}, \text{EarthquakeT} >$
cityProv :<>
frequency : $\mathbb{Z}$
averageMag : $\mathbb{R}$
populationDensity : $\mathbb{R}$
rating : $\mathbb{Z}$

Access Routine Semantics

RiskAssessment(bst, location):

- transition: earthquakeTree := bst,
  cityPov := getCityProv(location, SearchEarthquakes.searchEarthquakeInCircle(bst, location, 100)),
  frequency :=getFrequency(),
  averageMag :=getAverageManitude(),
  populationDensity := getPopulation() ,
  rating := OverallRating(frequency, averageMag, populationDensity)

getRisk():

- output: $out := rating$

getCity():

- output: $out := cityProv[0]$

getFrequency():

- output: $out := frequency$

getMag():

- output: $out := averageMag$

getPoplationDensity():

- output: $out := populationDensity$

nearestLowerRiskCity(graph):

- output: $out := min.to()$ such that $min \in graph.adj(getCity) \wedge RiskAssessment(earthquakeTree, getLocation(min.to()).getRisk() < rating \wedge \forall(e : Edge \mid e \in graph.adj(getCity) \wedge RiskAssessment(earthquakeTree, getLocation(e.to()).getRisk() < rating : e.weight \geq min.weight)$

Local Functions

getLocation : String $\rightarrow$ PointT
getLocation($city$) $\equiv$ $cityPost.getPoint()$ such that $\forall(c : CityPostT \mid c \in$ seq of CityPostT $\wedge$ $c.getCityName = city : cityPost = c)$

getCityProv : PointT, seq of EarthquakeT $\rightarrow$ tuple of (String, String)
getCityProv($location, eqList$) $\equiv <$ $eq.getPlace(), eq.getNameOfProv() >$ such that $\forall(e :$ $EarthquakeT \mid c \in eqList : location.distanceTo(e.getPointT()) \geq location.distanceTo(eq.getPointT()))$

getPopulation :
getPopulation $\equiv$ $city.getPopDensity()$ such that $\forall(c : CityT \mid c \in$ seq of CityT $\wedge$ $c.getCityName = cityProv[0] \wedge c.getProvince = cityProv[1] : city = c)$

getFrequency : seq of EarthquakeT $\rightarrow \mathbb{Z}$
getFrequency(s) $\equiv |s|$

getAverageMagnitude : seq of EarthquakeT $\rightarrow \mathbb{R}$
getAverageMagnitude(s) $\equiv +(e : EarthquakeT \mid e \in s : e.getMag())/|s|$

frequencyRating : $\mathbb{R} \rightarrow \mathbb{Z}$
frequencyRating($frequency$) $\equiv$ $(frequence < 1 \Rightarrow 0 \mid frequence \geq 1 \wedge frequence <$ $10 \Rightarrow 1 \mid frequence \geq 10 \wedge frequence < 100 \Rightarrow 2 \mid frequence \geq 100 \wedge frequence <$ $1000 \Rightarrow 3 \mid frequence \geq 1000 \Rightarrow 4)$

magnitudeRating : $\mathbb{R} \rightarrow \mathbb{Z}$
magnitudeRating($averageMag$) $\equiv$ $(averageMag < 1 \Rightarrow 0 \mid averageMag \geq 1 \wedge averageMag <$ $4 \Rightarrow 1 \mid averageMag \geq 4 \wedge averageMag < 6 \Rightarrow 2 \mid averageMag \geq 6 \wedge averageMag <$ $7 \Rightarrow 3 \mid averageMag \geq 7 \Rightarrow 4)$

populationdensityRating : $\mathbb{R} \rightarrow \mathbb{Z}$
populationdensityRating($populationdensity$) $\equiv$ $(populationdensity < 1000 \Rightarrow 0 \mid populationdensity \geq$ $1000 \wedge populationdensity < 5000 \Rightarrow 1 \mid populationdensity \geq 5000 \Rightarrow 2)$

overallRating : $\mathbb{Z}, \mathbb{R}, \mathbb{R} \rightarrow \mathbb{Z}$
overallRating(f, a, p) $\equiv frequencyRating(f)+magnitudeRating(a)+populationdensityRating(p)$

View Interface Module

Interface Module

ViewList

Uses

PointT

Syntax

Exported Types

None

Exported Access Programs

Routine name	In	Out	Exceptions
display	seq of EarthquakeT, PointT		

display by magnitude Module

Module inherits ViewList

DisplayByMagnitude

Uses

PointT, Sort

Syntax

Exported Types

None

Exported Access Programs

Routine name	In	Out	Exceptions
display	seq of EarthquakeT, PointT		

Semantics

State Variables

N/A

Access Routine Semantics

display(eqList, location):

- print(e.getMag(), e.getColor(), e.getDate().getYear(), e.getPlace())
  for all e ∈ Sort.sortByMagnitude(eqList)

display by distance Module

Module inherits ViewList

DisplayByDistance

Uses

PointT, Sort

Syntax

Exported Types

None

Exported Access Programs

Routine name	In	Out	Exceptions
display	seq of EarthquakeT, PointT		

Semantics

State Variables

N/A

Access Routine Semantics

display(eqList, location):

- print(location.distanceTo(e.getPointT()), e.getMag(),e.getColor(), e.getDate().getYear(), e.getPlace()) for all e $\in$ Sort.sortByMagnitude(location, eqList)

view risk assessment Module

Module

ViewRisk

Uses

RiskAssessment, RedBlackBST, PointT

Syntax

Exported Types

None

Exported Access Programs

Routine name	In	Out	Exceptions
showRisk	RedBlackBST, seq of CityPostT, PointT, CityGraph		

Semantics

State Variables

N/A

Access Routine Semantics

display(bst, loc, s, graph):

- print(ra.getRisk(), ra.getCity(),ra.getFrequency(), ra.getMag(), ra.getPoplationDensity(), ra.nearestLowerRiskCity(graph)) such that ra = RiskAssessment(bst, loc)

Local Functions

initGraph : $RiskAssessment, seqofCityPostT, CityGraph \rightarrow CityGraph$
initGraph(ra, s, graph) $\equiv$ graph.addEdge(e) such that e = Edge(ra.getCity(), cityPost.getCityName, ra.getCity().getPoint().distanceTo(cityPost.getCityName.getPoint())) for all cityPost $\in$ s and ra.getCity().getPoint().distanceTo(cityPost.getCityName.getPoint()) $<$ 100

Controller Module

Module

Controller

Uses

CSVreader, SearchEarthquakes, ViewList, ViewRisk

Syntax

Exported Types

Controller = ?

Exported Access Programs

Routine name	In	Out	Exceptions
init	RedBlackBST, GeoCollection, seq of CityPostT		
search	RedBlackBST, PointT, $\mathbb{R}$		
updateViewOfList	ViewList		
updateViewOfRisk	RedBlackBST, PointT, seq of CityPostT, CityGraph		

Semantics

State Variables

location : PointT
eqList : seq of EarthquakeT

Access Routine Semantics

init(bst, geoCollection, cityPostList):

- transition:
  The states of bst, geoCollection, cityPostLists are modified by accessing the routes of readEarthquakesBST, readPopulation, and readCityPosition in CSVreader module.

search(bst, loc, radius):

- transition: location := loc,
  The states of variable eqList is modified by accessing the route of searchEarthquakeInCircle in SearchEarthquakes module.

updateViewOfList(view):

- print the list of earthquakes by accessing the route of display in ViewList module.

updateViewOfRisk(bst, loc, s, graph):

- print the the risk assessment result by accessing the route of showRisk in ViewRisk module.