Advanced Programming 2025
Deep Embedded DSL
Assignment 7

April 10 2025

1 Goal

The goal of this exercise is to familiarize yourself with the design of a deep embedded DSL in Clean. You create a query language for *ships*, *ports*, and wind *farms*. You can find their definitions in the provided file `ships.icl` on Brightspace, together with a sample collection by the same names, viz. `ships`, `ports`, and `farms`.

The grammar of the query language is:

Gen	=	*Ship Var Gen*
	|	*Farm Var Gen*
	|	*Port Var Gen*
	|	*Cond Cond Gen*
	|	*Return Expr*
Cond	=	*Le Expr Expr*
	|	*Eq Expr Expr*
	|	*Not Cond*
	|	*And Cond Cond*
	|	*HasFlag Expr [Country]*
	|	*HasName Expr [String]*
	|	*HasKind Expr [Kind]*
Expr	=	*Var*
	|	*Real*
	|	*SelectName Expr*
	|	*Add Expr Expr*
	|	*Distance Expr Expr*
Kind	=	*Navy* | *Fisher* | *Tanker* | *Cargo* | *Tugboat*

Examples of queries are:

- E_0 = *Ship s (Return (SelectName s))*
- E_1 = *Ship s (Cond (HasFlag s [NL,UK]) (Return (SelectName s)))*
- E_2 = *Farm w (Ship s (Cond (Le (Distance s w) 10.0) (Return (SelectName w))))*
- E_3 = *Port p (Ship s (Cond (Le (Distance s p) 0.50) (Return (SelectName p))))*

E_0 displays the names of all ships, E_1 displays the names of all ships that sail under a NL or UK flag, E_2 displays the names of wind farms that have at least one ship in their vicinity (10km), and E_3 displays the names of ports in which at least one ship is in or very close to the harbour (0.50km).

2 Assignment

2.1 DSL

Define a deep embedded DSL for the query language outlined above.

2.2 Evaluator

Define an evaluator for queries. For the operational semantics we require the following state: *State : Var* $\rightarrow$ *Ship* $\cup$ *Port* $\cup$ *Farm*. The evaluator should adhere to the following operational semantics A:

Gen:

$$
\begin{array}{lcll}
A\ [\![Ship\ \ v\ gen]\!]\ s & = & \cup\{A\ [\![gen]\!]\ ((v,x) \mapsto s) \mid x \in \texttt{ships}\} & \\
A\ [\![Farm\ v\ gen]\!]\ s & = & \cup\{A\ [\![gen]\!]\ ((v,x) \mapsto s) \mid x \in \texttt{farms}\} & \\
A\ [\![Port\ \ v\ gen]\!]\ s & = & \cup\{A\ [\![gen]\!]\ ((v,x) \mapsto s) \mid x \in \texttt{ports}\} & \\
A\ [\![Cond\ c\ gen]\!]\ s & = & A\ [\![gen]\!]\ s & \text{if } A\ [\![c]\!]\ s = \{true\} \\
 & = & \emptyset & \text{otherwise} \\
A\ [\![Return\ e]\!]\ s & = & A\ [\![e]\!]\ s &
\end{array}
$$

Cond:

$$
\begin{array}{lcll}
A\ [\![Le\ e_1\ e_2]\!]\ s & = & \{r_1 \leq r_2\} & \text{if } A\ [\![e_i]\!]\ s = \{r_i\} \wedge r_i : Real \\
 & = & \emptyset & \text{otherwise} \\
A\ [\![Eq\ e_1\ e_2]\!]\ s & = & \{r_1 = r_2\} & \text{if } A\ [\![e_i]\!]\ s = \{r_i\} \wedge r_i : T \wedge T \in \{Real, String, Bool\} \\
 & = & \emptyset & \text{otherwise} \\
A\ [\![Not\ e]\!]\ s & = & \{\neg b\} & \text{if } A\ [\![e]\!]\ s = \{b\} \wedge b : Bool \\
 & = & \emptyset & \text{otherwise} \\
A\ [\![And\ e_1\ e_2]\!]\ s & = & \{b_1 \wedge b_2\} & \text{if } A\ [\![e_i]\!]\ s = \{b_i\} \wedge b_i : Bool \\
 & = & \emptyset & \text{otherwise} \\
A\ [\![HasFlag\ e\ cs]\!]\ s & = & \{x.flag \in cs\} & \text{if } (A\ [\![e]\!]\ s = \{x\} \vee A\ [\![e]\!]\ s = \{v\} \wedge s\ v = x) \wedge x : Ship \\
 & = & \{x.country \in cs\} & \text{if } (A\ [\![e]\!]\ s = \{x\} \vee A\ [\![e]\!]\ s = \{v\} \wedge s\ v = x) \wedge x : Farm \\
 & = & \emptyset & \text{otherwise} \\
A\ [\![HasName\ e\ ns]\!]\ s & = & \{x.name \in ns\} & \text{if } (A\ [\![e]\!]\ s = \{x\} \vee A\ [\![e]\!]\ s = \{v\} \wedge s\ v = x) \wedge x : T \\
 & & & \quad \wedge T \in \{Ship, Port, Farm\} \\
 & = & \emptyset & \text{otherwise} \\
A\ [\![HasKind\ e\ ks]\!]\ s & = & \{x.kind \in ks\} & \text{if } (A\ [\![e]\!]\ s = \{x\} \vee A\ [\![e]\!]\ s = \{v\} \wedge s\ v = x) \wedge x : Ship \\
 & = & \emptyset & \text{otherwise}
\end{array}
$$

Expr:

$$
\begin{array}{lcll}
A\ [\![v]\!]\ s & = & \{s\ v\} & \\
A\ [\![r]\!]\ s & = & \{r\} & \\
A\ [\![SelectName\ e]\!]\ s & = & \{x.name\} & \text{if } A\ [\![e]\!]\ s = \{x\} \wedge x : T \wedge T \in \{Ship, Port, Farm\} \\
 & = & \emptyset & \text{otherwise} \\
A\ [\![Add\ e_1\ e_2]\!]\ s & = & \{r_1 + r_2\} & \text{if } A\ [\![e_i]\!]\ s = \{r_i\} \wedge r_i : Real \\
 & = & \emptyset & \text{otherwise} \\
A\ [\![Distance\ e_1\ e_2]\!]\ s & = & \{distance\ v_1\ v_2\} & \text{if } A\ [\![e_i]\!]\ s = \{v_i\} \wedge v_i : T_i \wedge T_i \in \{Ship, Port, Farm\} \\
 & = & \emptyset & \text{otherwise}
\end{array}
$$

Deadline

To receive feedback, hand in your solution before April 16 23:59h.