

# Assignment Project Exam Help

Data-Structures

<https://tutorcs.com>

J. Carette  
McMaster University

WeChat: cstutorcs

Fall 2023

Adapted from “Types and Programming Languages” by Benjamin C. Pierce

$\langle t \rangle ::= \dots$   
 $\quad | \{t, t\}$   
 $\quad | \{t, t\}.1$   
 $\quad | \{t, t\}.2$

$\langle v \rangle ::= \dots$   
 $\quad | \{v, v\}$

# Assignment Project Exam Help

<https://tutorcs.com>

$$\frac{t \rightarrow t'}{t.1 \rightarrow t'.1}$$

(E-Proj1)

$$\frac{t \rightarrow t'}{t.2 \rightarrow t'.2}$$

(E-Proj2)

$$\frac{t_2 \rightarrow t'_2}{\{v_1, t_2\} \rightarrow \{v_1, t'_2\}}$$

(E-Pair2)

$$\{v_1, v_2\}.1 \rightarrow v_1 \quad (\text{E-PairBeta1})$$

$$\{v_1, v_2\}.2 \rightarrow v_2 \quad (\text{E-PairBeta2})$$

$$\frac{t_1 \rightarrow t'_1}{\{t_1, t_2\} \rightarrow \{t'_1, t_2\}}$$

(E-Pair1)

$\langle T \rangle ::= \dots$

$\langle T \rangle \times \langle T \rangle$

## Assignment Project Exam Help

This is known as the **product** or the **Cartesian Product** type constructor.

$$\frac{\Gamma \vdash t_1 : T_1 \quad \Gamma \vdash t_2 : T_2}{\Gamma \vdash \{t_1, t_2\} : T_1 \times T_2} \quad (\text{T-Pair})$$

<https://tutorcs.com>

$$\frac{\Gamma \vdash t : T_1 \times T_2}{\Gamma \vdash t.1 : T_1} \quad (\text{T-Proj1})$$

WeChat: [tutorcs](https://tutorcs.com)

$$\frac{\Gamma \vdash t : T_1 \times T_2}{\Gamma \vdash t.2 : T_2} \quad (\text{T-Proj2})$$

$\langle t \rangle ::= \dots$   
 $\quad | \{ \langle t \rangle, \langle t \rangle, \dots, \langle t \rangle \}$   
 $\quad | t.i$

# Assignment Project Exam Help

where there are  $n$  terms in the first case, and  $1 \leq i \leq n$  in the second.

$\langle v \rangle ::= \dots$   
 $\quad | \{ \langle v \rangle, \langle v \rangle, \dots, \langle v \rangle \}$

<https://tutorcs.com>

$\langle T \rangle ::= \dots$   
 $\quad | \{ \langle T \rangle \times \langle T \rangle \times \dots \times \langle T \rangle \}$

WeChat: cstutorcs

As this ... notation can get tiresome, we use  $\vec{t}$ ,  $\vec{v}$  and  $\vec{T}$ .

## Assignment Project Exam Help

$$\frac{j \in 1..n}{\{\vec{v}\}.j \rightarrow v_j}$$

(E-ProjTuple)

<https://tutorcs.com>

$$\frac{j \vdash t'}{t.i \rightarrow t'.i}$$

(E-Proj)

$$\frac{t_j \rightarrow t'_j}{\{v_1, v_2, \dots, v_{j-1}, t_j, \dots, t_n\} \rightarrow \{v_1, v_2, \dots, v_{j-1}, t'_j, \dots, t_n\}}$$

(E-Tuple)

## Assignment Project Exam Help

$$\frac{\Gamma \vdash t_1 : T_1 \quad \Gamma \vdash t_2 : T_2 \quad \dots \Gamma \vdash t_n : T_n}{\Gamma \vdash \{t_i\} : \{\vec{T}_i\}}$$

(T-Tuple)

<https://tutorcs.com>

$$\frac{j \in 1..n \quad \Gamma \vdash t : \{\vec{T}\}}{\Gamma \vdash t.j : T_j}$$

(T-Proj)

WeChat: cstutorcs

Numbers are silly labels, let's use names as **labels**.  $l \in \mathcal{L}$ .

**Assignment Project Exam Help**

$\langle t \rangle ::= \dots$   
|  $\{ \langle l \rangle = \langle t \rangle, \langle l \rangle = \langle t \rangle, \dots, \langle l \rangle = \langle t \rangle \}$   
|  $\langle t \rangle . \langle l \rangle$

$\langle v \rangle ::= \dots$   
|  $\{ \langle l \rangle = \langle v \rangle, \langle l \rangle = \langle v \rangle, \dots, \langle l \rangle = \langle v \rangle \}$

$\langle T \rangle ::= \dots$   
|  $\{ \langle l \rangle : \langle T \rangle, \langle l \rangle : \langle T \rangle, \dots, \langle l \rangle : \langle T \rangle \}$

structs in C, object with only fields in Java, dictionaries (sort of) in Python

Assignment  $\frac{j \in 1..n}{\{l = v\} \cdot l_j \rightarrow v_j}$  (E-PrjRcd)

<https://tutorcs.com>  $\frac{t \rightarrow t'}{t.l_j \rightarrow t'.l_j}$  (E-Prj)

WeChat:  $\frac{t_j \rightarrow t'_j}{\{l_1 = v_1, \dots, l_{j-1} = v_{j-1}, l_j = t_j, \dots, l_n = t_n\} \rightarrow \{l_1 = v_1, \dots, l_{j-1} = v_{j-1}, l_j = t'_j, \dots, l_n = t_n\}}$  (E-Rcd)

Note: order of labels is induced by the language somehow. Usually at type declaration time.



## Assignment Project Exam Help

$$\frac{\Gamma \vdash t_1 : T_1 \quad \Gamma \vdash t_2 : T_2 \quad \dots \Gamma \vdash t_n : T_n}{\Gamma \vdash \{\overrightarrow{f} = \overrightarrow{t}\} : \{\overrightarrow{f} : \overrightarrow{T}\}}$$

(T-Tuple)

<https://tutorcs.com>

$$\frac{j \in 1..n \quad \Gamma \vdash t : \{\overrightarrow{T}\}}{\Gamma \vdash t.j : T_j}$$

(T-Proj)

WeChat: cstutorcs