程序代写代做 CS编程辅导

G5029

ERSITY OF SUSSEX

BSc F and MComp THIRD YEAR

INATION 2020

JUNE 2020 (A2)

WeChat: cstutorcs

Limits of Computation

Assignment Project Exam Help

Date: Wednesday, 3 June 2020

24 Hour Window starts at: 14.00

Exam Duration: 3 hours (including time for scanning and uploading)

Email: tutorcs@163.com

Candidates should answer TWO questions out of THREE. If all three questions are attempted only the first two answers will be marked.

QQ: 749389476

Each question is worth 50 marks.

https://tutorcs.com

Write your answers on A4 paper, scan and save as a single PDF file and upload to Canvas

PDF file name: candidate number_module

Please make sure that your submission includes the following:

Your candidate number (Do not put your name on your paper)
The title of the module and the module code

Academic Integrity Statement

You are reminded that you should not access online materials, notes etc. during this examination or discuss this assessment with others before the end of its 24 hour window.

By submitting this assessment you confirm that you have read the above Statement and are responsible for understanding and complying with Academic Misconduct regulations as they relate to this assessment.

程序代写代做 CS编程辅导

1. This question is about WHILE and other notions of effective computability.

   (a) The WH one built-in data type, the type of binary trees where ways atom nil (for pure WHILE). Explain briefly why th fine the notion of computability. [4 marks]

   (b) Let fo ure WHILE-program:

```
foo re
  out := cons nil nil;
  while L {
      X := hd L;
      if X
      { L:= tl L
      }
      else {
      out := nil;
      L:= nil
      }
  }
}
write out
```

   i. What is $[\![\texttt{foo}]\!]^{\texttt{WHILE}}(\ulcorner 1 \urcorner)$ and $[\![\texttt{foo}]\!]^{\texttt{WHILE}}(\ulcorner [1] \urcorner)$, respectively? No explanation required. [2 marks]

   ii. Give the semantics of the program foo; in other words give a precise definition of the partial function $[\![\texttt{foo}]\!]^{\texttt{WHILE}} : \mathbb{D} \to \mathbb{D}_\perp$. Do *not* re-explain or narrate the program. [6 marks]

   (c) Explain the *semantical* difference between a WHILE-expression and a WHILE-command. [4 marks]

   (d) Write a WHILE-program that has the following data representation:

```
[ 0,
  [
    [while,[var,0],[ [:=,1,[cons,[hd,[var,0]],[quote,nil]] ],
                     [:=,0,[tl,[var,0]] ]
                   ]
    ]
  ],
1]
```

   [10 marks]

   (e) Why is it important to have a computation model that supports programs-as-data? [6 marks]

   (f) Consider now computability of functions on natural numbers, i.e. functions of type $\mathbb{N} \to \mathbb{N}_\perp$.

WeChat: cstutorcs
Assignment Project Exam Help
Email: tutorcs@163.com
QQ: 749389476
https://tutorcs.com

程序代写代做CS编程辅导

i. For each of the following functions f on natural numbers state whether it is WHILE-computable or not. Briefly explain your answer.

A

B $\{k \mid \llbracket p \rrbracket^{\texttt{WHILE}}(\text{nil}) = \ulcorner k \urcorner \text{ for program } p \text{ s.t. } |p| \leq n\}$ where

C. $f(n) = \begin{cases} 1 & \text{iff } \llbracket p \rrbracket^{\texttt{WHILE}}(p) \neq \bot \text{ where } p \text{ is the } n\text{-th WHILE-program} \\ 0 & \text{otherwise} \end{cases}$

D. $f(n) = \bot$ for all $n \in \mathbb{N}$

E. $f(n) = \min K_n$ where $K_n = \{k \in \mathbb{N} \mid \llbracket p \rrbracket^{\texttt{WHILE}}(\text{nil}) = \ulcorner k \urcorner \text{ for program } p \text{ s.t. } |p| \leq n\}$

[10 marks]

ii. Does computability of such functions depend on whether they are implemented in WHILE or RAM? Briefly explain your answer. [3 marks]

iii. If we removed the conditional statement (`if then else`) from the pure WHILE-language, could we still compute the same functions of type $\mathbb{N} \to \mathbb{N}_\bot$ that we did with the conditional? Explain your answer briefly. [5 marks]

WeChat: cstutorcs
Assignment Project Exam Help
Email: tutorcs@163.com
QQ: 749389476
https://tutorcs.com

程序代写代做 CS编程辅导

2. This question is about semi-decidability, decidability, and various forms of reduction.

(a) For ea[illegible]g problems state whether it is WHILE-semi-decida[illegible] your answer in one sentence.

i. N[illegible]nt of $\mathbb{D}$, does it encode a natural number?

ii. H[illegible]blem for WHILE);

iii. Th[illegible]HALT;

iv. The complement of the Traveling Salesman Problem.

[8 marks]

WeChat: cstutorcs

(b) For the following sets $A \subseteq$ WHILE-data state whether they are WHILE-decidable or undecidable and explain your answer. In cases where A is decidable this explanation should consist of a description of the decision procedure. Recall that $\ulcorner p \urcorner$ denotes the encoding of WHILE-program p in $\mathbb{D}$.

Assignment Project Exam Help

i. $A = \{\, \ulcorner p \urcorner \mid p \text{ returns } nil \text{ if its input encodes a natural number } \}$ [4 marks]

Email: tutorcs@163.com

ii. $A = \{\, \ulcorner p \urcorner \mid \ulcorner p \urcorner = \ulcorner \texttt{read X } \{\, \texttt{while true } \{\}\} \texttt{ write X} \urcorner \,\}$. [4 marks]

iii. $A = \{\, \ulcorner [p, k] \urcorner \mid p \in \mathcal{O}(n^k) \,\}$ [4 marks]

QQ: 749389476

(c) This question addresses the importance of *effective problem reduction* in computability theory.

https://tutorcs.com

i. For each of the following statements say whether the given effective reductions from $A \subseteq \mathbb{D}$ to $B \subseteq \mathbb{D}$, $A \leq_{\text{rec}} B$, are true or false. Explain each answer briefly. In case where the answer is true this explanation should be a description of the reduction function.

A. $\{\ulcorner 1 \urcorner, \ulcorner 2 \urcorner, \ulcorner 4 \urcorner\} \leq_{\text{rec}}$ HALT

B. $\{\ulcorner n \urcorner \mid n \in \mathbb{N} \wedge n \text{ is odd}\} \leq_{\text{rec}} \{\ulcorner n \urcorner \mid n \in \mathbb{N} \wedge n \text{ is even}\}$

C. $\{\text{nil}\} \leq_{\text{rec}}$ HALT

D. HALT $\leq_{\text{rec}} \{\text{nil}\}$

E. $\mathbb{D} \setminus$ HALT $\leq_{\text{rec}} \{\text{nil}\}$

[10 marks]

ii. Explain in one or two sentences only the difference between effective problem reduction and polynomial time reduction. [5 marks]

(d) For each of the following statements about the recursion theorem say whether it is true or false. Explain your answer in one sentence.

i. The recursion theorem implies that there exists a WHILE program that returns its own description as data whatever the input.

ii. The recursion theorem does not apply to Java.

iii. The recursion theorem implies that any programming language meeting the theorem's assumptions allows indirectly for recursive program definitions.

程序代写代做CS编程辅导

[6 marks]

(e) For ea problems state whether they are closed under the giv ain your answer briefly.

i. If i-decidable, is the set $C = A \cap B$, i.e. the int B, semi-decidable? [3 marks]

ii. if , is the set of all identical pairs of numbers, i.e. $\{ ($ able? [3 marks]

iii. if $A \subseteq \mathbb{N}$ is decidable, is the set of all numbers for which the busy-beaver function returns a number in A that is smaller than 500 decidable, i.e. $\{ a \mid a \in A \wedge BB(a) < 500 \}$ decidable? [3 marks]

WeChat: cstutorcs

Assignment Project Exam Help

Email: tutorcs@163.com

QQ: 749389476

https://tutorcs.com

程序代写代做 CS编程辅导

3. This question is about complexity.

(a) A func[illegible] a *time bound* for an L-program p if, and only if, for all [illegible] t holds that $time_p^{\mathtt{L}}(d) \leq f(|d|)$ where $|d|$ is the size of

i. Ho[illegible] sure the size of d, $|d|$, for $d \in \mathtt{WHILE}-\mathrm{data}$? [2 marks]

ii. In [illegible] we have $time_p^{\mathtt{L}}(d) = \bot$? [2 marks]

iii. Explain why it makes a difference for the time bound of a WHILE-program p on natural numbers whether p uses natural numbers in unary or decimal representation, i.e. whether it encodes a number like 12 as $\ulcorner 12 \urcorner$ or as a list $\ulcorner [1,2] \urcorner$ where $\ulcorner \_ \urcorner$ denotes the standard encoding of data as presented in lectures. [6 marks]

(b) For each of the following statements, state whether they are (known to be) true, (known to be) false, or whether the answer is currently still unknown. Accordingly, write as answer either *true*, *false*, or *unknown*, respectively. Give a short reason for each answer (one sentence suffices).

i. The *Halting Problem* is in **P**.

ii. **NP** $\subseteq$ **EXP**

iii. **P** $\subseteq$ **NP**

iv. $\mathtt{WHILE} \preceq^{lintime} \mathtt{TM}$

v. The *Satisfiability Problem* (SAT) is in **P**.

vi. *Max-Cut* $\leq_P$ *Integer Programming*.

vii. The *0-1 Knapsack Problem* is in **P** if one represents integers as unary numbers.

viii. $\mathbf{NP}^{\mathtt{SRAM}} \neq \mathbf{NP}^{\mathtt{WHILE}}$

ix. $\mathtt{WHILE} \preceq^{lintime} \mathtt{WH^1LE}$.

x. (The optimisation problem version of) TSP is not in **APX**.

[20 marks]

(c) A sequence s is a subsequence of a sequence t if s can be obtained from t by deleting some (maybe none) elements in t. For instance, the sequence $1,4,7$, the sequence $2,3,4,6$ and sequence $4,7$ are all subsequences of $1,2,3,4,5,6,7$, respectively. Subsequence $1,4,7$ is obtained by deleting $2,3,5$ and 6; subsequence $2,3,4,6$ is obtained by deleting $1,4,5$ and 7; subsequence $4,7$ is obtained by deleting $1,2,3,5$ and 6.

The *common subsequence problem* (CSP) is the following decision problem: given a set of finite sequences $s_1,\ldots,s_n$ (over a given finite alphabet), is there a sequence s of length at least K such that s is a subsequence of *each* sequence $s_1,\ldots,s_n$?

Show that CSP is in **NP**. [8 marks]

WeChat: cstutorcs
Assignment Project Exam Help
Email: tutorcs@163.com
QQ: 749389476
https://tutorcs.com

程序代写代做 CS编程辅导

(d) Argue that $\mathbf{P}^{\texttt{WHILE}}$ is closed under complement, i.e. argue that the followi[illegible]
If A is [illegible]complement, $\mathbb{D} \setminus A$, is also in $\mathbf{P}^{\texttt{WHILE}}$. [6 marks]

(e) A seq[illegible]equence of a sequence t if s can be obtained from t [illegible] (maybe none) elements in t as set out in Questi[illegible]
The *ir*[illegible]*ence problem* (ISP) is the following decision proble[illegible]nce of integer numbers s and a number K, is there a sorted subsequence of s that has at least K elements? By sorted we mean that the integers in the sequence appear in ascending order. For instance, for $s = 4, 1, 3, 2, 1, 2, 5$ and $K = 3$, the answer is `YES` as $1, 2, 5$ is an increasing subsequence of s; for $K = 4$ the answer is `YES`, as $1, 1, 1, 5$ is an increasing subsequence of s. For any $K \geq 5$ the answer would be `NO`.
Show that ISP $\leq_p$ CSP, i.e. that ISP is polynomially reducible to CSP – where CSP was explained in Question 3c) – by answering the following questions:

i. Describe the required reduction function f. [4 marks]

ii. Argue that the function f you defined satisfies the condition of a reduction function, i.e. $x \in$ ISP iff $f(x) \in$ CSP (you will need to explain what x is). [2 marks]

You don't have to show that the function is computable in polynomial time or total.

WeChat: cstutorcs
Assignment Project Exam Help
Email: tutorcs@163.com
QQ: 749389476
https://tutorcs.com