-	(E)	
	Semantics Car (Hybrid) Programming	
	The Hybrid while-language	
	Fix a stock of variables X = { 22,, 201. then, we have,	
	Linear Terms	
	lTerm(X) 3 r r.t x t+s	7
	real number	
	Atomic Programs	1
	At(x) > x:=t x1'=ts,, x'n=tn Ban t run the system of differential equations Ban t seconds	
	Prog(X) > a p; q eg b then p else q while b do fp}	
	Tragital a There person	
	A language of Linear Terms and its Semantics	
	LTerm(x) 3 r lr.tlx1t+5	
	Let o: X → IR be an environment, i.e a memory on which the	
	program personms computations.	The same of the sa
	The expression < t, o > " r tells that the linear expression toutputs	
	rib the current memory is o.	Tool .
	(var) (con)	1
	<2,0740(x) <1,0741	
	<t, (add)<="" (sce)="" 0745="" 07451="" 07452="" <t1,="" <t2,="" th=""><th>4</th></t,>	4
	(5.t, 074) 5.r < 61+te, 074 14+re	
0	The Rineas term 2+2.4 carresponds to the tree	
	(+)	
	2 (a-)	
	1	
	y	100
	IB o(12)=3 and o(y1=4, we can build the Bollowing deniation	
	tree!	-
	24,074	100
	L2.4,0743 <2.4,0748	
	<22+2.4, 07 Usi	
		THE PERSON NAMED IN

O CONTRACTOR			
4/	The program x := 2+1; x:= x.	+2 corresponds to the tree	
1	(;)_		
	2 = 21+A	7 2:= 2:+2	
	Consider the enveronment o =		
	<2+1,2 →3744		
	< 2:= 2+1, 2+3702+34	<x:= th="" x+2,="" x+4722+6<=""><th></th></x:=>	
	< x:= x+1; x:= x+2, x +3)	Company of the Compan	The Late of the Late of
	Exercise		
	· x:=0; y:=1; while x ≤ y do f	2:= 2+y; y:= y+13 U?	
			T (b 88
0			3
	故文	刘	
	2		
	0	(0)	
	6 : 9	(*) 3 PA	
	27 14	2 × ×	
	5 3		
		2 2 2	
	2	6 6	6
	b	3 6 0	T 1
	1 6	7	100
	3	2 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	(1, 6/13), 0
-	# D	10 p 7 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	36
		6 3	77 77
	D'757	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	3 50
	Y Y	* * *	13:4:=R
	BARRIOTE - CONTRACTOR	* 5	1 × × × × × × × × × × × × × × × × × × ×
	7.30	5	8 625
			1 2 0
		5	00 K = 3
	27	1 T T T T T T T T T T T T T T T T T T T	0 7 7
	7	10	(1000) (1-10) (1
		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	8 3
		(4 d) (4 d) (4 d) (4 d) (4 d)	क स
0		100 de 10	0 2 3
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	3 3 3	260
	1/2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	36	6 0 11
	CHO, WOW WAS A CHO, WHO CHO, W	(2000 4) (2000)	ं दें दें 3

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Exercises	-
\[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fmathcap ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fmathcap ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fmathcap ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fmathcap ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fmathcap ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} + \text{A} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} \cdot \text{X} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} \cdot \text{X} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} \cdot \text{X} \cdot \text{X} \cdot \text{Y}, \sigma 7\fm ? \] \[\lequiv \text{X} \t	
<2.7,070 6 <0.7,070 8 (add) 5(4)=4	
(2.x+p.y, 0)1/14 0(2)=8	
· <3. (2.21) +2. (y+2), 074? (var)	
< 2,0743 (300) < 4,0744 (2,0748 (add)	
<2.2,0746 (see) <4+8,074420 (see)	
<3.(2-20),07018 <2.(y+2),07024 (add)	
<3-(2-70)+2-(y+2), 57442	
Equivalence of Linear Terms	
L~s :8 gar all environments o <t, (5,074)<="" 0741="" :68="" td=""><td></td></t,>	
A Language of Boolean Terms and its semantics	
BTerm(x) 3 t1 \le t2 b \c 17b	
<ts, or=""> Urs <ta, or=""> Urs rs = rs = (leq) <5, or UV (not)</ta,></ts,>	
< t1 < t0, 07 5 tt < 75, 07 57 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	
(ts.07 Urs <t2,07 \$12="" (gtr)<="" rs="" td="" ur2=""><td></td></t2,07>	
<t1 <="" bb<="" t0,074="" td=""><td>1 2 2 2</td></t1>	1 2 2 2
<ba, 0=""> UV1 < ba, 0 > UV2 (and)</ba,>	
(banba, 074 VANVa	
A While-language and its Semantics	
Prog(x) > x:=t p; q 1 = b then p else q I while b do {p}	
<t, (asg)="" (seq)<="" 0'7="" 07="" <p,="" <q,="" td="" ur="" ur"="" ur'=""><td></td></t,>	
	100
<	
SO O THEE SPICIOUS HALL SO OTHER SHIP (SO)	
<igb o="" pelse="" q,="" then=""> to' <igb o="" palse="" q,="" then=""> to'</igb></igb>	
<pre><igb o="" pelseq,="" then=""> vo' <b, o=""> vt < < p. o > vo' <br< td=""><td></td></br<></b,></igb></pre>	
<pre> <igb o="" pelse="" q,="" then=""> vo' <b, o=""> vote < P. o > vo' <b, o=""> vote < P. o > vo' <while b="" do="" fp's,="" o=""> vo' <while b="" do="" fp's,="" o=""> vo' </while></while></b,></b,></igb></pre>	
<pre> <igb or="" pelseq,="" then=""> Uo' <b, or=""> Utt < P. or > Uo' <b, or=""> Utt < P. or > Uo' <br< td=""><td>C</td></br<></b,></b,></igb></pre>	C
<pre> <igb or="" pelseq,="" then=""> Uo' <b, or=""> Utt < p. or > Uo' <while b="" do="" or="" {p},=""> Uo'' <while b="" do="" or="" {p},=""> Uo'' <while b="" do="" or="" {p},=""> Uo'' </while></while></while></b,></igb></pre>	G

		1
1		
1%	F	
	Examples	
	<1,(21 + 2)741 1/2<1	
	(21 = 0 BO2 1, (21-2), 1/2) U Stop, (21-2)	
	<(21'=0 Bar 1); (21'=1 Bor 1), (21-2), 1/2 2 stop, (21-2)	
	<u> </u>	
	$=(\chi\mapsto 2)[\varphi(2,\frac{1}{2})/\chi]$	
		1 2 7
	(2)=0 Bon 1, (2H2), 17USHip, (2H2) (2)=1 Bon 1, (2H2), 427UStop, (2H2+4/2)	
	< (2=0 Bor1); (2=1 Bor1), (21+2), 1+4/2>Ustop, (21+2+1/2)	
	r.	
•	txercises	
	· < (21=1 Box 1); (21=-1 Box 1), (21+5), 1/274?	
17711	<1,(20→5)742 1/2<1	
	< 21= 1 Bon 1, (21 > 5), 1/0 > U stop, 20 1- 5+1/2	
	<(n'=1 Bon 1); (n'=-1 Bon 1), (nH5), 1/274 stop, nH 5+1/2	
	. < (x'=1 gon 1); (x'=-1 gon 1), (21→5), 27 U	1
	1 2 3 2 1 1 2 2 3 2 1 1 2 1 2 1 2 1 2 1	1-00
	<1,(21-51)U1 1=1 <1,(21-61)U-1 1=1	
	< 21=1 BOD 1, (24-5), 17 USKIP, 246 < 21=-1 BOD 1, (24-6), 17USKIP, 24-5	
	<(2'=180,1); (2'=-180,1), (20+5), 27 U SKEP, 2C+5	
	Mone rules	
	reg b then pelse q, o, t>US, o' <ibb o,="" pelse="" q,="" t="" then="">US, o'</ibb>	
	<b, or=""> tt <p; b="" do="" o'<="" o,="" p="" tr="" us,="" while="" {p},=""></p;></b,>	
	Zwhile b do fpt, o, t7 Us, o'	
	< b, 0 7 4 0 B	
	< while b do fpt, or, 074 ship, or	
0		
		5
		1

	/
	1
	11
Equalence of while programs	10/
pro & Bon all environments of <p,0) 40'="" <9,0740'<="" igh="" td=""><td></td></p,0)>	
Preleminaries about Differential Equations	
Consider a stock X= freg, rent of vaniables.	
Systems of differential equations 24'= ts, , zin = tn always have	
unique salutions.	
$\phi: \mathbb{R}^n \times [0, \infty) \longrightarrow \mathbb{R}^n$	
Example (The Continuous Dynamics of a Vehicle)	
p'=V, V'=a which admits the solution	
	A
\$ ((20, vo), t) = (20 + Vot + fate, vo + at)	122
We will aften abreviate a list vs,, va simply to v.	
O [V/Z] => Ve ne=ve	
Example	
Va ib y= u1	
0 [vs, va/xs, ne] (y) = { v2 18 y=ne	1 700
o(y) otherwise	1-11
We will agten treat o: { 21,, 21, -1 R as [o(21),, o(21)].	
Adding time dependency to Hybrid While-language	
(P, 0, £740'	
(5,070 t <r< td=""><td></td></r<>	
(Σ'= E βor s, σ, t) U stop, σ[Φ(σ, t)/2]	
<5,07Ur t=r	
<π'= E gor s,σ, t) ψ ship, σ[Φ(σ, t)/2]	
<t, o="">Ur <p, o,="" t=""> Ustop, o'</p,></t,>	
く2:=t, 0,0200[r/2] <p:9,0,t>い stop,0'</p:9,0,t>	
<pre><pre><pre><pre><pre><pre><pre><pre></pre></pre></pre></pre></pre></pre></pre></pre>	
<pre><piq, 7="" o"<="" o,="" pre="" t+t'="" us,=""></piq,></pre>	
	13.5
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