MEMORIAL DAY PROGRAMMING RACE

The puzzle shown in the figure consists of nine blocks which are to be arranged in a three by three square array so that the line segments crossing a block meet the line segments on adjacent blocks. A solution is shown. Write a program to print the number of solutions not counting as different solutions obtainable from each other by rotating the whole puzzle.

The winner will be the person who completes the problem with the lowest composite time score determined as follows:

\[
\text{composite-time} = (\text{time from receipt of problem to time of start of use of console}) + 2.0 \times (\text{time from start of use of console to time of completion of creation of first version of program - this time ends with completion of first edit}) + 4.0 \times (\text{time from completion of first edit to successful completion of the problem}) + 20.0 \times (\text{total computer time charged by the system to the user})
\]

Any user whom the system charges more than 15 minutes will be disqualified.

SAIL, i.e., ALGOL, is an appropriate language for the problem.

The problem has already been done twice. In one case, the elapsed time was eight hours and the run time 20 minutes. In the other case, the elapsed time was 4 hours and the run time 27 seconds. We expect the winning elapsed time to be less than 2 hours, perhaps much less.

In case of a system crash or other emergency, the judges will make appropriate ad hoc rules.

YOU MUST KEEP TRACK OF YOUR OWN TIMES IN EACH OF THE FOUR CATEGORIES.

When you have an answer call J. McCarthy at 4430 or 4971. If the answer is wrong, you may continue, but a penalty of one hour composite time will be charged for each wrong answer.

For the purposes of competition among machine language programmers, the last term in the composite time is changed to

\[50.0 \times (\text{computer time charged for the best of three runs of the final problem})\]

Comparison of the computer time charged by the 360/67 with that charged by the PDP-10 will be made according to the results of a calibration run with the same program written in SAIL and ALGOL W, running time only.
There are just four levels of line on each block. Apologies for xerox troubles.
STANFORD 4 05/31/71 14:17:36
NAME? knuth
KEYWORDS? none
COMMAND? set terse
? show time

05/31/71 14:17:57
ELAPSED TIME = 00:00:05
EDITING TIME = 0.00 SECONDS
COMPUTE TIME = 0.01 SECONDS
MEMORY USAGE = 0.01 PAGE-SECONDS
I/O ACTIVITY = 0 UNITS

? use env
VOLUME? sys14
? set vol sys14
? list
0.001 //DEKJOB JOB (K601,512,0.3,3),'KNUTH'
0.002 //JOBLIB DD DSN=SYS2.PROGLIB,DISP=OLD
0.003 // EXEC XALGOLW
0.004 //ALGOLW.SYSIN DD *
0.005 $ALGOL 0:15,3000
0.006 $DEBUG,4
999.9 $EOF
999.901 /*
? collect i
1. ? begin comment race problem;
2. ? integer array n(0:10),n(0:10),tally(0:10);
3. ? integer array c1,c2,c3,c4(1:8);
4. ? logical array easy(1:4);
5. ? procedure find(integer value k);
6. ? begin integer t1,t2;
7. ? t1:=5-p(a(c1(k))+c2(k));
8. ? t2:=5-p(a(c3(k))+c4(k));
9. ? for jj:=100 step 100 until 900 do
10. ? begin if p(jj)=0 then
11. ? begin for jj:=jj+1 until jj+4 do
12. ? if(p(jj)=t1) and (easy(k) or (p(jj-1)=t2))
13. ? then begin tally(k):=tally(k)+1;
14. ? if k<8 then begin p(jj-1)=1;a(k):=jj; find(k+1); p(jj):=0 end;
15. ? else if tally(8)<4 then write(a(0),a(1),a(2),a(3),a(4),a(5),a(6));
LINE NO. 13. CONTAINS 78 CHARACTERS.
16. ? a(4),a(7),a(8));
17. ? end end loop jj;
ERROR 2019 NEAR COORDINATE 0001 - ";" CANNOT FOLLOW "<ARRAY DCL>" HERE
CURRENT CONTEXT IS " ) ; "

ERROR 2002 NEAR COORDINATE 0007 - "A" IS UNDEFINED
CURRENT CONTEXT IS " A ( "

ERROR 2016 NEAR COORDINATE 0007 - SIMPLE TYPE ERROR NO. 53
CURRENT CONTEXT IS " ( C1 "

ERROR 2003 NEAR COORDINATE 0007 - SYNTAX ERROR
CURRENT CONTEXT IS " ) + "

ERROR 2002 NEAR COORDINATE 0008 - "A" IS UNDEFINED
CURRENT CONTEXT IS " A ( "

ERROR 2016 NEAR COORDINATE 0008 - SIMPLE TYPE ERROR NO. 53
CURRENT CONTEXT IS " ( C3 "

ERROR 2003 NEAR COORDINATE 0008 - SYNTAX ERROR
CURRENT CONTEXT IS " ) + "

ERROR 2002 NEAR COORDINATE 0012 - "TALLY" IS UNDEFINED
CURRENT CONTEXT IS " TALLY ( "

ERROR 2016 NEAR COORDINATE 0012 - SIMPLE TYPE ERROR NO. 53
CURRENT CONTEXT IS " ( K "

ERROR 2003 NEAR COORDINATE 0012 - SYNTAX ERROR
CURRENT CONTEXT IS " ) := "

ERROR 2002 NEAR COORDINATE 0015 - "A" IS UNDEFINED
CURRENT CONTEXT IS " A ( "

ERROR 2016 NEAR COORDINATE 0015 - SIMPLE TYPE ERROR NO. 53
CURRENT CONTEXT IS " ( K "

ERROR 2003 NEAR COORDINATE 0015 - SYNTAX ERROR
CURRENT CONTEXT IS " ) := "
? delete 2,
? run q hold
614 IS YOUR JOB NUMBER
? save source scr
"SOURCE" SCRATCHED & SAVED ON SYS14
? fetch 614 clear
DEKJOB (614) IS AWAITING EXEC , PRIORITY SS, CLASS Q
BACKLOGGED 3 JOB(S) 2.5 MINS.
? show time
05/31/71 14:38:20
ELAPSED TIME = 00:20:28
EDITING TIME = 1.22 SECONDS
COMPUTE TIME = 0.01 SECONDS
MEMORY USAGE = 0.01 PAGE-SECONDS
I/O ACTIVITY = 0 UNITS
? fetch 614
DEKJOB (614) IS AWAITING EXEC , PRIORITY SS, CLASS Q
BACKLOGGED 3 JOB(S) 2.5 MINS.
? set priority
SET: ILLEGAL.
? show time
05/31/71 14:43:11
ELAPSED TIME = 00:25:18
EDITING TIME = 1.25 SECONDS
COMPUTE TIME = 0.06 SECONDS
MEMORY USAGE = 0.06 PAGE-SECONDS
I/O ACTIVITY = 0 UNITS
? fetch 614
? Inst1
329. 0041 | END
? print 614
DEKJOB (614) WILL BE PRINTED
? ***
ARE YOU STILL THERE?
? use source clear
? modify "(k)+1"
13. THEN BEGIN TALLY(K) := TALLY(K) + 1; i(a)(k) := jj;
13. THEN BEGIN TALLY(K) := TALLY(K) + 1; a(K) := jj;
ALTERS ?
13. THEN BEGIN TALLY(K) := TALLY(K) + 1; a(K) := jj;
ALTERS ?
? dh "a(k) := jj;" to "" in 14
= TRACING (MAIN):
0032  2.---| EASY(K) := FALSE
       K := 5;  EASY(5) := FALSE; ...

= TRACING (MAIN):
0034  1.---| FOR I := 10 STEP 10 UNTIL 90 DO
0035  1.---|    I := 10;
0036  1.---|    A(0) := I + 1
0037  1.---|    I := 10;  P(10) := 1;
0037  1.---|    FIND(1)
       -> FIND;

= TRACING FIND:
0038  1.---| <PARAMETER ASSIGNMENT>
0039  1.---|    K := #;  # := 1;  K' := 1;
0040  1.---|    T1 := 5 - P(A(C1(K)) + C2(K))
0041  1.---|    K' := 1;  C1(1) := 1;  A(0) := 11;  K' := 1;  C2(1)
0042  1.---|    T2 := 5 - P(A(C3(K)) + C4(K))
0043  1.---|    K' := 1;  C3(1) := 0;  A(0) := 11;  K' := 1;  C4(1)
0044  1.---| FOR J := 10 STEP 10 UNTIL 90 DC
0045  1.---|    J := 10;
0046  1.---| IF P(J) = 0 THEN
0047  1.---|       J := 10;  P(10) := 1;  * = FALSE;
0048  1.---|    (FCR J)
0049  2.---|    J := 20;
0050  2.---| IF P(J) = 0 THEN
0051  2.---|       J := 20;  P(20) := ?;  * = FALSE;
0052  2.---|    (FCR J)
0053  2.---|    J := 30;  ...
0054  1.---| P(I) := 0
0055  1.---|    I := 10;  P(10) := 0;
0056  1.---|    (FOR I)
0057  1.---|    I := 20;
0058  2.---| A(0) := I + 1
0059  2.---|    I := 20;  A(0) := 21;
0060  2.---| P(I) := 1
0061  2.---|    I := 20;  P(20) := 1;
0062  2.---|    FIND(1)
       -> FIND:
Chromatology
1:09 looked at problem
Decided to place piece in middle, oriented as given, then place other & cyclically
Did Monte Carlo experiment indicating roughly 4,000 nodes in the search tree
Drafted program
2:17 Left office to look for a terminal
2:18 Logged on
2:34 Submitted first job to batch [Job 602, no backlog; 0.005 minutes execution
Fixed syntax error (multiple array declarations)
0.77 sec compile
0.0 sec exec.
2:38 Submitted second job [Job 614, backlogged]
Tried to find out how to change priority; never did find out
2:41 Job begins execution, 0.07 minutes complete time
3.6 sec exec.
2:43 I discover that the job was executed while I was inquiring about priority.
2:45 Begin reading listing of Job 614. Two errors (gave only solutions with pos 9 in center)
2:57 Corrected the errors, submitted third job [Job 650, no backlog, 0.26 min changed
15.00 sec exec
(Forgot to increase the expected run time from delay parameters. Noticed that 15 sec was
enough for about half the computation. Checked the first solution found.)
3:05 Submitted fourth job [Job 667, backlogged until 3:07:34. 0.45 min changed
24.71 sec exec
3:09 logoff changed 0.13 sec compile time
2.80 sec edit time
0.13 sec seconds memory
3:10 call McCarthy. Total computer time 45.3 sec execution
1.8 sec edit and compile.

Compile time

\[
\begin{array}{c|c}
\text{Compile time} & \text{Time} \\
1 \times 69 & 69 \\
2 \times 16 & 32 \\
4 \times 35 & 140 \\
20 \times 0.75 & 15 \\
\end{array}
\]

257 minutes.