1 9 9 7 G/EY

=$;NO@J8

2]Bj : ;vNc%Y!<%9JBNs%W%m%0%i%_%s%0

%7%9%F%`$N9=C[$HI>2A

;XF3650w	;3:j>!90 65<x

N) L?4[Bg3X Bg3X1! M}9) 3X8&5f2J

=$;N2]Dx >pJs%7%9%F%`3X @196 No. 6124960007-4

;aL>	0B F# >4 01

3 5MW

JBNs=hM}$OB??t$N9b@-G=%W%m%;%C%5$r%M%C%H%o!<%/$JIG@\B3$7, 3F%W%m%;%C%5$,3F!9$N7W;;$r9k3HKh$j, 9bB.$J=hM}$r<B8=$G$-$k. 7+$7, 3F%W%m%;%C%54V$G$NF14|!mutex, %P%j%d$J$I!K, %?%9%/J,3d!$Aj8_GS=|$d%9%1%C%I$J$IJBNs7W;;5!FCM-$NL?Na$r9M$(, $+$DIi2Y6Q9U$H>pJs<x<u$N%*!<%P!<%X%C%I$N7Z8:$r9MN8$7$J$/$F$O$$$1$J$$. $=$7$F, $=$l$r;H$&$?$aKO$"$kDxEYJY6/$7, JBNs%W%m%0%i%_%s%0$K4X9k@lLgE*CN<1$r3MF@$9kI,MW,$"$k!%

K\8&5fGO, ;vNc%Y!<%9?dO@$N9M$(J}rbHK, 2a5n$K:n@.$7$?JBNs%W%m%0%i%`$r:FMxMQ2DG=$J7A$G;vNc%Y!<%9$KC_@Q$7, ?7$?$KJBNs%W%m%0%i%`$r:n@.9k:]$K, $=$NLdBj$K:G$bN`;w$7$?;vNc$r;vNc%Y!<%9$+$i8!:w$9$k. $=$7$F, $=$l$r:FMxMQ$9$k. $D$^$j, 8!:w$7$?;vNc$N%9%1%l%H%s$KFyIU$1!&$@5$9$k$3$H$K$h$j, ?7$?$JJBNs%W%m%0%i%`$r:n@.$9$k. 3Nh&$JJ}K!$Khj, JBNs%W%m%0%i%_%s%0$NIiC4$r7Z8:$7, MF0W$KJBNs%W%m%0%i%`$r:n@.$G$-$k$h$&$K%5%]!<%H$9$k$3$H$rL\E*$H$7$F$$$k. 8=:_, ;vNc%Y!<%9$K$O#2#28D$N;vNc$,C_@Q$5$l$F$$$k. $=$7$F, $=$l$rMQ$$$F, ;vNc%Y!<%9JBNs%W%m%0%i%_%s%0%7%9%F%`$N9=C[$r9TC?. $^$?, 3N%7%9%F%`$rMxMQ$7$F, ;vNc8!:w$r$7, ;vNc=$@5Kh$kJBNs%W%m%0%i%_%s%0$r9T$$, %9%1%l%H%s$N:FMxMQEY$NI>2Ar7$F$$$k.

;vNc=$@5$KhkJBNs%W%m%0%i%_%s%0GO%W%m%0%i%`$r%9%1%C%I, F14|, %?%9%/J,3d, C10L7W;;, $=$NB>$KJ,$1$F, $=$l$>$l$N:FMxMQEY$r9TC10L$G?t$($?. %9%1%C%I, F14|$O:FMxMQEY$,9b$$. $3$l$O%$%s%G%C%/%9$N9`L\$N%"%k%4%j%:%`$d<B9T9=B$$,0lCW$7$?$+$i$G$"$k. %"%k%4%j%:%`$d<B9T9=B$$O9M$($ilk9=B$$rA4$FMQ0U$7$F$$$kNG, I,$:0lCW$9kh$&$KJC$F$$$k. %9%1%C%I, F14|$OJBNs%W%m%0%i%`$N9|3J$G$"$j, 0lHV=EMW$JItJ,$G$"$k. $3$NItJ,$N:FMxMQEY$r9b$a$k$3$H$OJBNs%W%m%0%i%_%s%0$NIiC4$r7Z8:$9$k$N$K:G$bLr$KN)$D. %?%9%/J,3d$O0lIt$O:FMxMQ$G$-$?$,, $"$^$j:FMxMQ$G$-$F$$$J$$. $3$l$O%$%s%G%C%/%9$N%?%9%/J,3d$N$H$3$m$,0lCW$7$J$$$3$H$,$R$H$D$"$k. $^$?, %?%9%/J,3d$OL\E*$N%W%m%0%i%`$K$+$J$j0MB8$7$F$$$F, ;vNc$r:FMxMQ$9kN$,Fq$7$$. $=$3$G, %?%9%/J,3d$NItIJ2=JIKh$j, %5%]!<%H$9kh$&$K9lPh$$. C10L7W;;$OC`<!%W%m%0%i%`$+$i, $=$N$^$^MxMQG-$k. $=$NB>$O include %U%!%$%k$d;~4V7WB,, 3F<oCM$NF~NOJI$NL?Na$G, $[$HsI%9%1%l%H%s$r:FMxMQ$G$-$?.

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I=L\<!

1 O8aK

6aG/, 7W;;5!$N?JJb$KOa6^$7$$$bN,$"$k$,, B.EY8~>e$K$O8B3&$,$"$k$H9M$(il$k.$=$N2r7hK!$N0lDH7F, JBNs=hM}$,5s$2il$k. JBNs=hM}$OB??t$N9b@-G=%W%m%;%C%5$r%M%C%H%o!<%/JI$G@\B3$7, 3F%W%m%;%C%5$,$*N*NN7W;;r9k3HKhj, 9bB.$J=hM}$,<B8=9k. 3N9bB.@-$H9b$$%3%9%H%Q%U%)!<%^%s%9$,, 5$>], 9R6u, 0eNE, 2=3X, J*M}, 650iJINJ,LnG4|BT5l$F$$$k. 7+$7, 8=<B$K$OC/$b$,4JC1$K<B8=G-kH$$$&o1GOJ/, 0lIt$N@lLg2H$K$@$1$7$+<B8=G-$J$$. $=$NM}M3$N0l$DH7$F, JBNs%W%m%0%i%_%s%0$H%G%P%C%0$N:$Fq5,5s2ilk. JBNs%W%m%0%i%`$r:n@.$9$k;~, %f!<%6$O%G!<%?$r$I$N$/$i$$$N7W;;C10L$G, $I$N$h$&$K3F%W%m%;%C%5$K?6$jJ,$1$k$+9M$( !&J?%9%/J,3d!K, 3F%W%m%;%C%5$,0l@F$K;O$^$G$?$j, A4$F$N%W%m%;%C%5$,7W;;$r=*$o$k$^$GBT$A>uBV$K$9$k$H$$$G$?@)8f!FJ14|!K$r$7$J$1$l$P$J$i$J$$. $^$?, F1;~$K6&M-JQ?t$K=q$-9~$`3H$,5/$-$J$$$h$&$K, 6&M-JQ?t$K=q$-9~$`;~$O, $=$N%G!<%?$r%m%C%/$7, B>$N%W%m%;%C%5$,%"%/%;%9G-$J$$$h$&$K$7, 7W;;$,=*N;7?$i, %"%s%m%C%/$7$F%"%/%;%92DG=$K9k$H$$$&h&$K, #1$D$N%W%m%;%9$@1,%"%/%;%9G-kh$&$K7J1lPJiJ$$!AJj8_GS=|!K $=$7$F, %9%l%C%I !JZ$$%W%m%;%9!K$N@8@., :o=|$JINJBNs7W;;5!FCM-$NL?Na$JIb$"$j, @lLgE*CN<1$r3MF@$9kI,MW,$"$k!%5i$K, B.EY8~>e$r9bak$?$aKO3F%W%m%;%C%5$K6QEy$K%?%9%/$rM?$(kI,MW,$"$j !JJi2Y6Q9U!K, $^$?, 3F%W%m%;%C%54VGN%G!<%?$NDL?.$r>/J/9kI,MW$,$"$k !>pJs<x<u$N%*!<%P!<%X%C%I$N7Z8:!K. $=$7$F, 3liN3H$r9M$(, %G%P%C%/9kNO5i$KBgJQ$J3HG"$k.

3liNIiC4$r7Z8:$9k?aK, JBNs%W%m%0%i%_%s%0$K4X$9$k8&5f$O, $$$m$$$mJH3m$G9T$olF$$$k. $=$7$F, MM!9$JJ}8~$+$i, %f!<%6$r;Y1g$9$kJ}K!$,9M$($ilk. JBNs%W%m%0%i%_%s%0;Y1g$N%"%W%m!<%A$H7F, <!$N#5$D$N9`L\$KJ,N`$7F_$k. :GE,2=%3%s%Q%$%i$O%?%9%/J,3d, 3F%?%9%/$NG[CV, %W%m%;%C%54V$N%G!<%?DL?.$dF14|JIJBNs2=$K4X$9$k:n6H$r%3%s%Q%$%i$,9T$&$H$$$&%"%W%m!<%AG"$k. 8@8l$N@_7W$H=hM}7O$O%f!<%6$,JBNs=hM}$rD>@\5-=RG-$kJBNs5-=R%W%m%0%i%_%s%08@8l$N3+H/$G$"$k. ItIJ2=, %i%$%V%i%j, OO $O%D!<%k$d%i%$%V%i%j$rItIJH7$FMQ0U$7F*$-, $=$lir;HMQ9k3HKhGF, JBNs%W%m%0%i%_%s%0$r;Y1g$9$k. %F%s%W%l!<%H, ;vNc$O%W%m%0%i%^!<$OL\E*$N%W%m%0%i%`$K9g$G$?M}O@, <jK!, ;q8;4IM}$J$I$r4^$`%$%G%#%*%`$N7?HD$K=q$-9~$`$3HKhj, JBNs%W%m%0%i%`$rMF0W$K@8@.9k. %G!<%?<}=8, 2D;k2=$O<B9T;~$N5^6^$J>pJs$r<}=8$7$F, $=$l$r2r@O$7, 8+d9$/I=<($9k3HKhj, %A%e!<%K%s%0$d, %G%P%C%/$KLrN)Fk.

$"$kLdBjKBP7$F, :G=i$K2r7h7??M$,CN<1$rC_@Q7F$$$l$P, 8e$N?MO=lr;29MK7$F, LdBj$rMF0W$K2r$/3H$,$G$-$k. 3Nh&K"$kCN<1$JIr:FMxMQ$7, LdBj$r2r7h7h$&$H9k5;=QH7$F, ;vNc%Y!]%9?dO@(Case-Based Reasoning: CBR) [1][2][3] $,$"$k. 3l$O2a5n$K7P83$7$?LdBj$r, :FMxMQ2DG=$J7A$G;vNc%Y!<%9$KC_@Q$7, ?7$?$JLdBj$r2r7h9k;~

$K, :G$bN `;w7?;vNc$r;vNc%Y!<%9$+$i8!:w$7, $=$l$r:FMxMQ$9k3HKhj, MF0W$KLdBj $r2r7h$9kH$$$&bNG"$k. 8e$N?M$,:G=i$K2r7h7??M$HF1$86lO+r9kNO?$$$X$s L5BL$G$"$j, 3Nh&J3HrHr1k$?$a$K9M$(=P5l$?. 3N;vNc%Y!<%9?dO@O9GK, %l%7%T:n@., 3F<o@_7W;Y1g, K!N'?dO@JI$K1~MQ$5lF$$$k[1].

K\8&5fGO, ;vNc%Y!<%9?dO@$N9M$(J}rbHK, 2a5n$K:n@.$7$?JBNs%W%m%0%i%`$r:FMxMQ 2DG=$J7A$G;vNc%Y!<%9$KC_@Q$7, ?7$?$KJBNs%W%m%0%i%`$r:n@.9k:]$K, $=$NLdBj$K:G$bN` ;w$7$?;vNc$r;vNc%Y!<%9$+$i8!:w$9$k. $=$7$F, $=$l$r:FMxMQ$9$k. $D$^$j, 8!:w$7$?;vNc $N%9%1%l%H%s$KFyIU$1!&$@5$9$k$3$H$K$h$j, ?7$?$JJBNs%W%m%0%i%`$r:n@.$9$k. 3Nh& $JJ}K!$Khj, JBNs%W%m%0%i%_%s%0$NIiC4$r7Z8:$7, MF0W$KJBNs%W%m%0%i%`$r:n@.$G$-$k$h $&$K%5%]!<%H$9$k$3$H$rL\E*$H$7$F$$$k. 8=:_, ;vNc%Y!<%9$K$O#2#28D$N;vNc$,C_@Q$5$l$F $$$k. $=$7$F, $=$l$rMQ$$$F, ;vNc%Y!<%9JBNs%W%m%0%i%_%s%0%7%9%F%`$N9=C[$r9TC?. $^ $?, 3N%7%9%F%`$rMxMQ7F, ;vNc8!:wr7, ;vNc=$@5Kh$kJBNs%W%m%0%i%_%s%0$r9T$$, %9 %1%l%H%s$N:FMxMQEY$NI>2Ar7$F$$$k.

K\%7%9%F%`$N;vNc%Y!<%9$K$O, %$%s%G%C%/%9, %9%1%l%H%s, %W%m%0%i%`, JBNs8z2L$,5-:\$5 l?3F%U%!%$%k$,, 0lDN;vNcH7$F;vNc%Y!<%9$KC_@Q5l$F$$$k. %$%s%G%C%/%9$K$O, $= $NJBNs%W%m%0%i%`$NFCD'$,5-:\$7$F$"$j, $3$l$r$b$H$KN`;w;vNc$r8!:w9k. 3NFCD'KO 1~MQ, ;EMM, %G!<%?9=B$, %?%9%/J,3d, =*N;>r7o, %H%]%m%8, %"%k%4%j%:%`, <B9T9=B$, JBNs2= <jK!, %$%s%?%i%/%7%g%s$N#1#09`L\$K$D$$$F5-:\$5lF$$$k. %9%1%l%H%sKOJBNs%W%m%0%i %`$N9|3J, $D$^$j, $=$NJBNs%W%m%0%i%`Cf$G;H$olk%G!<%?9=B$, %?%9%/J,3d, F14|, Aj8_GS =|, %9%1%C%IJI0lO"NbN,5-:\$5lF$$$k. %f!<%6O3$N%9%1%l%H%s$rFyIU$1!&$@5$9 k3HKhj, L\E*$NJBNs%W%m%0%i%`$r40@.$5$;$k. %W%m%0%i%`KO, $=$N;vNc$N%W%m%0%i %`K\BN$,5-:\$5$l$F$$$F, $$$D$G$b;2>H$G$-$k. JBNs8z2L$K$O, $=$N%W%m%0%i%`$r<B9T7? H-, INDxEY$NB.EY8~>e$,F@il$?$+$r%0%i%U$G<(7?bN$,5-:\$5lF$$$k.

N`;w;vNc$r8!:w$9$k>l9g, %$%s%G%C%/%9$rMQ$$$F8!:w$9$k$,, $3$3$G0lHV=EMW$K$J$C$F$/ $k$N$,, JBNs%"%k%4%j%:%`G"$k. 3NJBNs%"%k%4%j%:%`$,0[$J$k$H, A4$/;vNc$r:FMxMQ$9 $k$3$H$,$G$-$J$$. Rabhi $O7W;;%9%F!<%8$N@8@.%Q%?!]%s$H%G!<%?;2>H%Q%?!<%s$N5,B'@- $K$h$j, JBNs%"%k%4%j%:%`$rJ,3dE}<#K!, %W%m%;%C%5%U%!!<%`, %W%m%;%9%M%C%H%o!<%/, 7+$j JV$7JQ49$N#4$D$N%"%k%4%j%`$KJ,N`$7$F$$$k[9]. $^$?, %P!]%<%kBg3X$G3+H/$5$l$?#B#A#C #S (Basel Algorithm Classification Scheme) $O%"%k%4%j%:%`%H%]%m%8, %W%m%;%99=B$, %G!] %?J,;6, %$%s%?%i%/%7%g%s%a%+%K%:%`, <B9T9=B$, 5Z$S%G!]%?/%W%m%;%9N3EY$N4QE@$+$i, JB Ns%"%k%4%j%:%`$NJ,N`$r9T$$, 4JC1$J5-9f$GI=8=$9$kJ}K!$rDs0F$7$F$$$k[8]. $3$N#2$D$r 9MN8$7$F, %$%s%G%C%/%9$N3F9`L\$,A*Pl$k.

K\8&5fGO, 2>A[6&M-%a%b%j7?JBNs%^%7%s#K#S#R-#1>eGN%W%m%0%i%_%s%0$r;Y1g$9$k [14]. 2>A[6&M-%a%b%jJ}<0$OJ,;67?$N%a%b%j9=B$$G$"$k$,, 2>A[E*$J6&M-%a%b%j$r<B8=$7, 6&

M-%a%b%j7?%^%7%s>eGN>19g$HF1MM$K%f!<%6$OHf3SE*4JC1$J%W%m%0%i%_%s%0$,2DG=$HJk [11][12][13].

K\O@J8GOBh#2>O$G,JBNs%"%k%4%j%:%`$N0lHLE*J,N`$H#B#A#C#SKh$kJ,N`$K$D$$$F=R$Y,$5$i$K2>A[6&M-%a%b%j7?JBNs%^%7%s#K#S#R-#1$H$=$N%^%7%s>e$G$N%W%m%0%i%_%s%0$K$h$kJBNs<B9T9=B$$K$D$$$F@bL@$9$k. Bh#3>O$G$O,;vNc%Y!<%9JBNs%W%m%0%i%_%s%0%7%9%F%`$N35MW$H;vNc%Y!<%9,$=7F,%7%9%F%`$N;HMQK!$J$I$K$D$$$F=R$Y$k. Bh#4>O$G$O,JBNs2=$N2r@O$r$7,%$%s%G%C%/%9$r:n@.,$=$l$r4p$KN`;w;vNc$r8!:w!&$@5$9$kJ}K!KD$$$F=RYk. Bh#5>OGO,<B:]$K9T$C$?;vNc=$@5Kh$kJBNs%W%m%0%i%_%s%0$K$D$$$F=RYk. 6qBNE*KO:Y@~2=,%^!<%8!?%9%W%j%C%H%=!<%H,%J%C%W%5%C%/LdBjG"$k. 5i$K,$3liKD$$$F,Il$@$1%9%1%l%H%s$r:FMxMQ$G$-$?$+I>2A$r9T$$,$=$7$F,%W%m%0%i%_%s%0$NIiC4$,7Z8:$5l?$+9M;!$9$k.

2 JBNs%W%m%0%i%_%s%0<jK!$HJBNs%"%k%4%j%:%`$NJ,N`

2.1 JBNs%W%m%0%i%_%s%0<jK!

JBNs%W%m%0%i%_%s%0$OHs>o$K:FqG$"$k. $=$l$r%5%]!<%H$9k?aK, MM!9$JJ}8~$+$i, %f!<%6$r;Y1g9kJ}K!$,9M$(il$k. JBNs%W%m%0%i%_%s%0;Y1g$N%"%W%m!<%A$H7F, <!$N#5$D$N9`L\$KJ,N`$7$F@bL@$9$k.

- :GE,2=%3%s%Q%$%i

  JBNs=hM}KhCF9bB.2=$r?^$m$&$H9k>l9g, %?%9%/J,3d, 3F%?%9%/$NG[CV, %W%m%;%C%54V$N%G!<%?DL?.$dF14|$JIr9M$($J1lPJiJ$$. 3liN:n6H$r%f!<%6$,9T$&$NGOJ/, %3%s%Q%$%i$,9T$&$H$$$&%"%W%m!<%AG"$k. 3lKh$j, JBNs%W%m%0%i%`$N3+H/, %G%P%C%/$N;~4V$,C;=L5l$k. 7+$7, A4$F$NJBNs@-$r%3%s%Q%$%i$,8!=P9k3HOG$-$J$$.

- JBNs=hM}MQ8@8l$N@_7W$H=hM}7O

  %f!<%6$,JBNs=hM}$rD>@\5-=RG-$kJBNs%W%m%0%i%_%s%08@8l$N3+H/G"$k. =>Mh$NC`<!%W%m%0%i%0%i%_%s%08@8l$r3HD%$7$?$bN,$"$k. Nc$($P, High Performance Fortran $OJBNs8@8l$G, %G!<%?JBNs%W%m%0%i%_%s%0$r%5%]!<%H$7, MIMD, SIMD 7W;;5!$NG=NO$r:GBg8B$K0z$-=P$7, 5^6^$J%"!<%-%F%/%A%c$N7W;;5!$KE,MQ2DG=G"$k. 7+$7, %G!<%?$NJ,;6, DL?.JI$,J#;($KJk.

- ItIJ2=, %i%$%V%i%j, %*%V%8%'%/%H;X8~

  %D!<%k$d%i%$%V%i%j$rItIJ$H7FMQ0U7F$*$-, %W%m%0%i%`%i%$%V%i%j$H7F, $=$lir;HMQ9k3HKhCF, JBNs%W%m%0%i%_%s%0$r;Y1g$9$k.

- %F%s%W%l!<%H, ;vNc

  2a5n$K:n@.$7$?%"%k%4%j%:%`$d;q8;4IM}$J$I, JBNs%W%m%0%i%_%s%0$N7?HD$r:FMxMQ$9$k. %W%m%0%i%^!<$OL\E*$N%W%m%0%i%`$K9gC?M}O@, <jK!, ;q8;4IM}JI$r4^$`%$%G%#%*%`$N7?HD$K=q$-9~$`$3$H$K$h$j, JBNs%W%m%0%i%`$rMF0W$K@8@.9k.

- %G!<%?<}=8, 2D;k2=

  <B9T;~N5$^$6$^$J>pJs$r<}=8$7$F, $=$l$r2r@O$7, 8+d9$/I=<($9$k. 3lKO%W%m%0%i%`$N3FItKh$N<B9T;~4V$HA4BN$K@j$a$kHfN($r=P$9$3$H$K$h$j, %W%m%;%C%54V$NIi2Y6Q9U$r7W$C$?$j, %f!<%6$,%A%e!<%K%s%0$9$k4p=`$KMxMQ$9k3Hd, %W%m%;%94V$N%$%Y%s%H$NBP1~4X78$rI=<(9k3HKh$j, %W%m%;%94V$N<B9T4X78$rGD0.7?$j, DL?.NL$N>pJs$rJ,@O7?j9k3HJI,$"$k.

2.2 JBNs%"%k%4%j%:%`$N0lHIE*$JJ,N`

JBNs%"%k%4%j%:%`$OJ#?t$N7W;;%9%F!<%8$,F1;~$K<B9T5l$k. $=$N%9%F!<%8$O<B9T;~ $K@8@.$5lk>l9g!FJ0E*!K$H, :G=i$K@8@.5l$k>l9g!@EE*!K$N#2%Q%?!<%s$,B8:_$9$k. $^$?, 3F7W;;%9%F!<%8$N%G!<%?;2>H%Q%?!<%s$O%D%j!<, %Q%$%W%i%$%sJI5,B'E*$JDL?.%Q %?!<%s$KJ,1ilk. %O%kBg3X$N#R#a#b#h#i$O7W;;%9%F!<%8$N@8@.%Q%?!<%s$H%G!<%?;2>H %Q%?!<%s$+$i, JBNs%"%k%4%j%:%`$rJ,3dE}<#K!(Divide and Conquer), %W%m%;%C%5%U%!!< %`(Processor Farms), %W%m%;%9%M%C%H%o!<%/(Process Networks), $/$jJV$7JQ49(Iterative Transfor mation) $N#4$D$KJ,N`$7$F$$$k.

1. J,3dE}<#K!(Divide and Conquer)

   M?$($il?LdBjKD$$$F2?i+$N7W;;$r9T$$, $"$k>r7oNbHK$=$l$rJ,3d$9$k. $= 7F, J,3d5l$?ItJ,KBP7, F1MM$K, 7W;;, J,3d$r9T$&. 3Nh&$K:F5/E*$K7W;;, J, 3d$r7+$jJV7J$,$i2r$+lk. $=$NLdBj$N2r$OJ,3d5l$?ItJ,2r$rE}9g9k3HKh $jF@$ilk. 3FItJ,LdBj$OFHN)$7$F7W;;$r9T$&$3H,G-, JBNs@-$,F@$ilk. $^$?, %G!<%?;2>H$NDL?.%Q%?!<%s$OLZ9=B$!%D%j!<!KG"$k.

2. %W%m%;%C%5%U%!!<%`(Processor Farms)

   M?$($il?LdBj$r=i4|$NCJ3,$GFHN)$7$?J#?t$N7W;;C10L$KJ,3d$7, J#?t$N%9%l!<%V$H %^%9%?!<$,$=l>$lFHN)$7$F7W;;$,9Tol$k. $=$7$F%^%9%?!<$,$=$liN7W;;7k2L$r 2s<}$7$F:G=*E*$J2r$rF@$k. $^$?, %G!<%?;2>H$NDL?.%Q%?!<%s$O%^%9%?!<!u%o!<%+!< G"$k. 3F%9%l!<%V$H%^%9%?!<$OFHN)$K7W;;$r9T$&$?$a, #4DN%"%k%4%j%:%`NCfG :G$b9b$$JBNs8z2L$rF@$k3H$,$G$-$k.

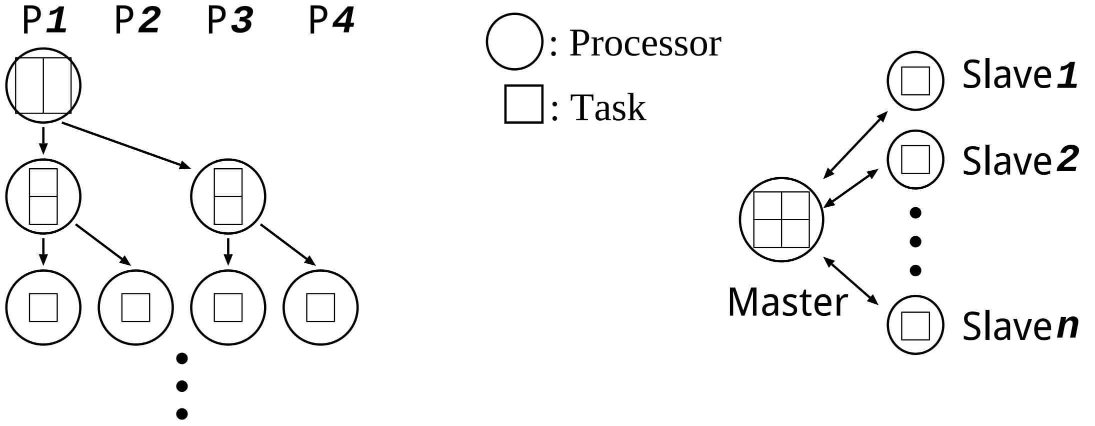
3. %W%m%;%9%M%C%H%o!<%/(Process Networks)

   M?$($i$lLdBj$K$D$$$F$=$N7W;;$rJ#?t$N7W;;%9%F!<%8$KJ,3d$9$k. 3F7W;;%9%F!<%8>e $rJ#?t$N%G!<%?$,N.$l$k. A08e$N%9%F!<%8GO%G!<%?$K0MB8@-$,$"$j, $^$?, 3F%9%F!< %8$OJB9T$K<B9T5l$k. A4%9%F!<%8$GF1$8L?Na$,<B9T5l$k>l9g$H, 3F%9%F!<%8$G0[JkL?Na$r<B9T9k>l9gH,$"$k. %G!<%?;2>H$NDL?.%Q%?!<%s$O%Q%$%W, %j%s%0JI $,$"$j, %Q%$%W%i%$%s=hM}$H8FPl$k.

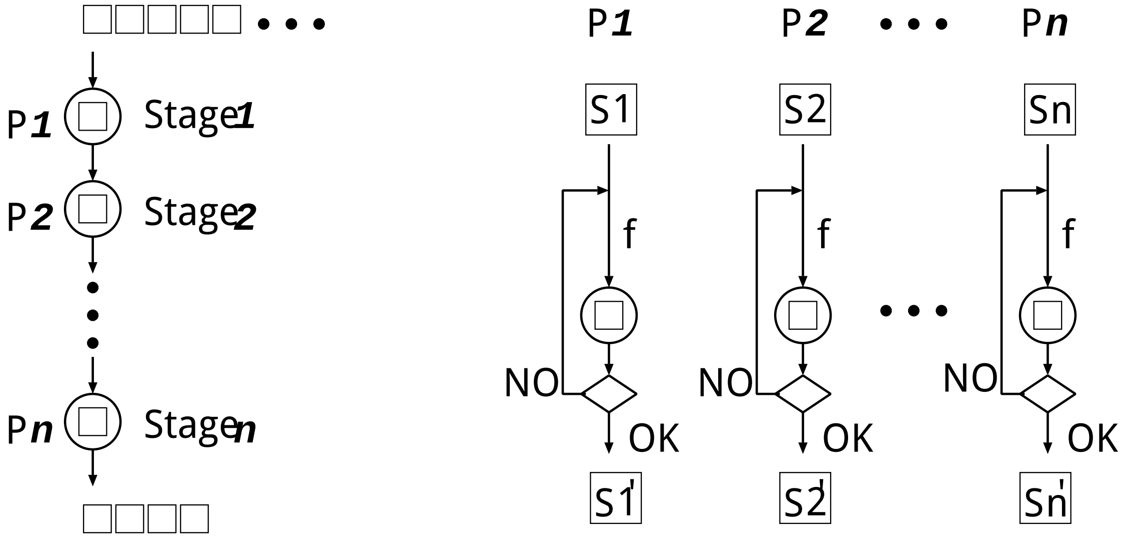
4. 7+jJV7JQ49(Iterative Transformation)

   M?$($il?LdBj$rJ#?t$N%*%V%8%'%/%H$KJ,3d$9$k. 3F%*%V%8%'%/%H$OJ#?t$N7+$jJV$7 $N7W;;$KhjCM$,JQ49$5lk. $=$N7+jJV7$O%*%V%8%'%/%H$NCM$,$"$kM?$(il$?>r 7o$rK~$?$9$^$G7+jJV5lk. $^$?, A0$N%9%F%C%W$G7W;;5l$?CM$O<+J,<+?H$^$?$O

JL$N%W%m%;%9>e$G;2>H5l$k ;2>H$NDL?.%Q%?!<%s$OItJ,E*$K%G!<%?$r;2>H$9$kItJ, >H9g$JI,$"$k.



(a) 分割統治法 (b) プロセッサファーム



(c) プロセスネットワーク (d) 繰り返し変換

?^1: JBNs%"%k%4%j%:%`$NU,N`

2.3 #B#A#C#S(Basel Algorithm Classification Scheme)

BACS $O%"%k%4%j%:%`$NJ,N`, J#;($5$N2r@O$JINJ}K!$rL@$i$+$K9k$?$a$K%P!<%<%k Bg3X$GDs0F5l$?. #B#A#C#S$O%"%k%4%j%:%`%H%]%m%8, %W%m%;%99=B$, %G!<%?$NJ,;6, %$%s%?%i%/%7%g%s%a%+%K%:%`, <B9T9=B$, 5Z$S%G!<%?!?%W%m%;%9N3EY$N4QE@$+$iJBNs%W%m%0%i%`$NJ,N`$r9TCF$$$k. $^$?, 4JC1$JN,8l$H5-9f$GJBNs%W%m%0%i%`$rI=8=G-$k.

2.3.1 %G!<%?$NJ,3d, J,;6

%G!<%?9=B$$G$O, 3F%W%m%;%C%5$,7W;;KI,MWJ%G!<%? !%J=!<%9%G!<%?!K$H7W;;7k2L%G!<%? !Jk2L%G!<%?!K$r<h$j>e2k. $=$7$F, %?%9%/J,3d$GO=$N%G!<%?$K$D$$$FJ,3dBP>], J,3dC10L, J,3dJ}K!KD$$$F>\=R9k. J,3dBP>]$O3F%W%m%;%C%5$KJ,3d9k%G!<%?$r, J,3dC10L$OC1FH$K7W;;$G$-$k:G>.$N7W;;C10L$r, J,3dJ}K!O=$N%G!<%?$r3F%W%m%;%C%5$K?6$jJ,1kJ}K!$r5-:\$9$k. %G!<%?$NJ,3d$OI i2Y6Q9U, DL?.$N%*!<%P!<%X%C%I, %"%k%4%j%:%`JI$K0MB8$9k,, 0lHIE*$K<!$N%Q%?!<%s$,B?$/MQ$$$ilk.

- %3%T!<!%G!<%?A4BN$N%3%T!<$r3F%W%m%;%C%5$K3d$j?6$k.
- %V%m%C%/!%G!<%?$r%W%m%;%C%5?t$HF1?t$N%V%m%C%/$KJ,$1, 3F%W%m%;%C%5$K#1BP#1$K Jkh&$K?6$jJ,1k.
- %5%$%/%j%C%/!$"$kJ,3dC10L$KJ,1il?%G!<%?$r<~4|E*$K3F%W%m%;%C%5$K?6$jJ,1k.

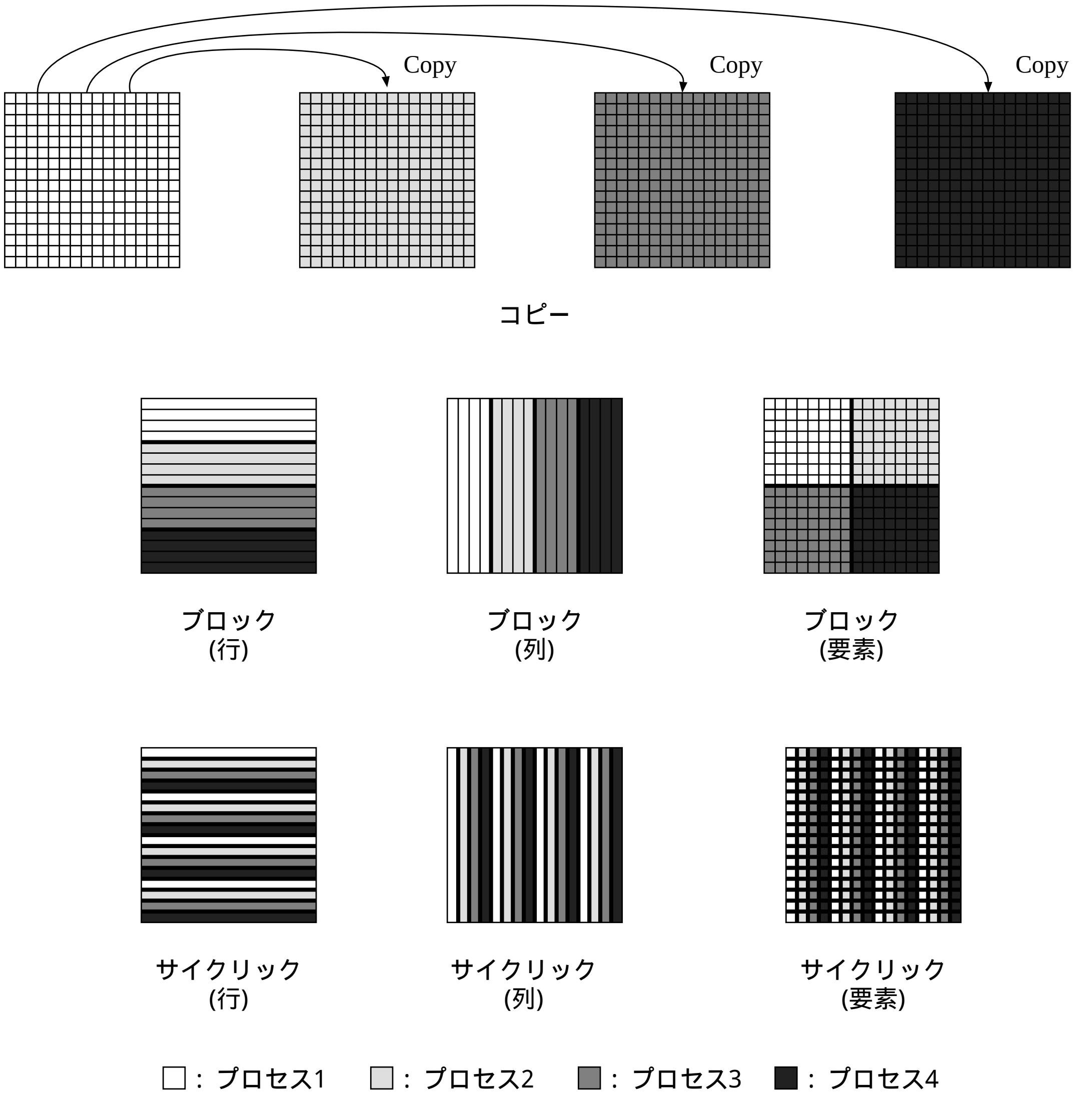
3liNJ,3d!&J,;6%Q%?!<%sO=l>$l#19T, #1Ns, #1MWAG, Kt$OJ#?t9T, J#?tNs, J#?tMWAG$NJ,3dC10L$KJ,1k3H$,$G$-$k. 3l$r?^2 $K<($9.

2.3.2 %$%s%?%i%/%7%g%s

%$%s%?%i%/%7%g%s$O%G!<%?$N0l4S@-$rJ]D?aK, %W%m%;%94V$GF14|$r<hk?aKMQ$$$ilk. 3N%$%s%?%i%/%7%g%s$O$=$NL\E*, %W%m%;%9?t, %W%m%;%94V$N4X78$KhC$FJ,N`$9k3H,G-$k.

1. L\E*
    - %G!<%?8r49

      <!$N=hM}9T$&;~$K, %W%m%;%9$,$"$k%G!<%?rI,MWH$7, $=$N%G!<%?$,B>$N%W%m%;%9$+$iDs6!5lJ1lPJi$J$$>l9g$O, %G!<%?8r49$N$?$a$N%$%s%?%i%/%7%g%s$,H/@8$9$k.



?^2: %G!<%?$NJ,3d,J,;6

- %G!<%?0l4S@- !&J3!<%I0l4S@-!K

  B>$N%W%m%;%9$rGSB>@)8f$d%7%0%J%kAw?.$JIKhC$F@)8f$9kH$-$KH/@8$9$k. 6&M-%G!<%?$K%"%/%;%9$7$?$j, B>$N%W%m%;%9$,9T$&=hM}$rBT$D;~$JIKMQ$$$k%$%s%?%i%/%7%g%s$G$"$k.

2. ;22C%W%m%;%9?t

   - D>@\%$%s%?%i%/%7%g%s

     #2DN%W%m%;%94V$GMQ$$$k%$%s%?%i%/%7%g%s$G$"$k. 3F%W%m%;%9O*8_$$$K%$%s%?%i%/%7%g%s$r9T$&Aj<j$r0U<1$7, $^$?, #1BP#1$N4X78$r;}$D.

- %0%m!<%P%k%$%s%?%i%/%7%g%s

  #3$D0J>e$N%W%m%;%94V$N%$%s%?%i%/%7%g%sG"$k.

3. %W%m%;%94V$N4X78

   - J,N%%$%s%?%i%/%7%g%s

     D>@\Aj<j$r;XDj$9kNGOJ/, 6&DL$K%"%/%;%9$G$-$kbN$r;XDj$7$F, $=$l$r MQ$$$k3HKh$j4V@\E*$J%$%s%?%i%/%7%g%s$r9T$&.

   - 7k9g%$%s%?%i%/%7%g%s

     %W%m%;%94V$N4X78$rDj5A7F, 3F%W%m%;%9$OD>@\;XDj$7$?%W%m%;%9$HN_, %$%s%?%i%/%7%g%s$r9T$&.

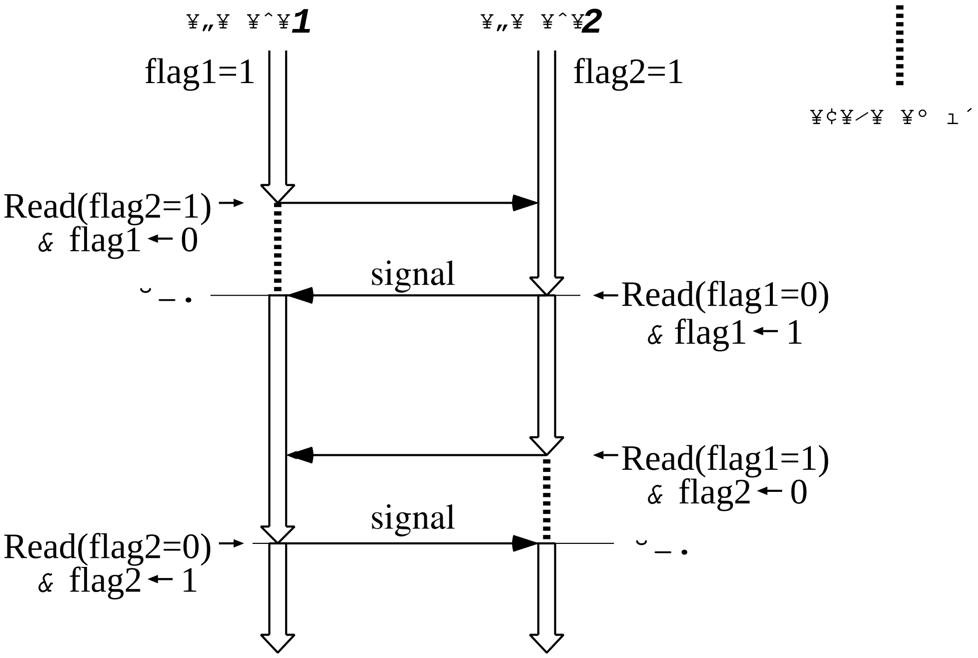
0J>eN3Hr$^$Hak$HI=1$K<($9#6$D$N%$%s%?%i%/%7%g%s$,9=@.$5lk. BP>]H9$kJBNs%^%7%s$N%"!<%-%F%/%A%c!<$d#O#S, JBNs8@8l=hM}$JIKhj, A4FN5!G=$r; }$DHO8BiJ$$. K\8&5f$GMQ$$$k2>A[6&M-%a%b%j7?JBNs%^%7%s#K#S#R!]#1>eGO%G!<%?8r49$N%$%s%?%i%/%7%g%s$OB8:_$;$:, %3!<%I0l4S@-$rJ]$D%$%s%?%i%/%7%g%s$,MQ0U$5lF$$$k. 3liN%$%s%?%i%/%7%g%s$K$D$$$F@bL@9k.

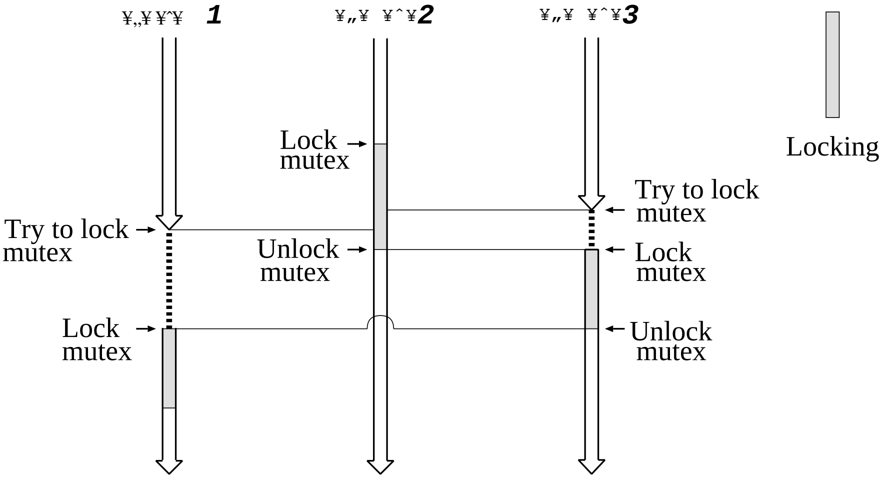
I=1: %$%s%?%i%/%7%g%s%Q%?!]%s

<table>
<tr><td colspan="2">D>@\%$%s%?%i%/%7%g%s</td><td colspan="4">%0%m!<%P%k%$%s%?%i%/%7%g%s</td></tr>
<tr><td colspan="2">7k9g%$%s%?%i%/%7%g%s</td><td colspan="2">J,N%%$%s%?%i%/%7%g%s</td><td colspan="2">7k9g%$%s%?%i%/%7%g%s</td></tr>
<tr><td>%G!<%?8r49</td><td>%3!<%I0l4S@-</td><td>%G!<%?8r49</td><td>%3!<%I0l4S@-</td><td>%G!<%?8r49</td><td>%3!<%I0l4S@-</td></tr>
<tr><td>exchange
send receive</td><td>signal, wait</td><td>read, write
(6&M-JQ?t)
put get (*mailbox*)</td><td>lock, unlock
(Aj8_GS=|)
PV(%;%^%U%))</td><td>broadcast
fan_in</td><td>barrier</td></tr>
</table>

I. %7%0%J%k!&%&%(%$%H

7k9g%$%s%?%i%/%7%g%s$H7F, %7%0%J%k!&%&%(%$%H$,$"$k. 3l$O?^3$Nh&$K#2$D$N%9%l%C%I4V$G9T$&$bNG, 6&M-JQ?tH7$F#f#l#a#g#1, #f#l#a#g#2$r; }$A, %U%i%0$NCM$,#1$N>l9g$O%S%8!<, #0$N>l9g$O%"%$%I%kHJ$k. @h$K=hM}$r=*$($?%9%l%C%I$OAj<j$N%9%l%C%I$N>uBV$r%U%i%0$+iFI_<h$j, b7, %S%8!<Ji<+J,$r%"%$%I%kK7$FAj<j$N%9%l%C%I$,=hM}$r=*N;9k$^GBTA, Aj<j$N%9%l%C%I$,%"%$%I%kJi, $=$l$r%S%8!<$K7F, <+J,$O=hM}$r?Jak.


¥„¥ ¥ˆ¥1
¥„¥ ¥ˆ¥2
¥¢¥⁄¥ ¥° ı´
flag1=1
flag2=1
Read(flag2=1)
& flag1 ← 0
signal
˘ – .
Read(flag1=0)
& flag1 ← 1
Read(flag1=1)
& flag2 ← 0
signal
Read(flag2=0)
& flag2 ← 1
˘ – .


¥„¥¥ˆ¥ 1
¥„¥ ¥ˆ¥2
¥„¥ ¥ˆ¥3
Locking
Lock mutex
Try to lock mutex
Try to lock mutex
Unlock mutex
Lock mutex
Lock mutex
Unlock mutex

%$%Y%s%H$K$O<!$N#3D,$"$k. $=$l$>$l%"%k%U%!%Y%C%H$NBgJ8;z$rMQ$$$FI=8=$7, %$%Y%s%H$NFbMF$,I,MW$J;~$O2<IU$-J8;z$G<($9.

- 7W;;%$%Y%s%H !#C!K

  %m!<%+%k$J7W;;$r<($9. B>$H$NAj8_:nMQ$O$J$$.

- %$%s%?%i%/%7%g%s%$%Y%s%H !#I!K

  F14 |, Aj8_GS= |, %G!<%?$N8r49$J$I%W%m%;%94V$NAj8_:nMQ$r<($9.

- %G!<%b%s%3!<%k%$%Y%s%H !#D!K

  %W%m%;%9$N@8@.$d=|5n$r9T$C$?$j, $=$N:]KG$-$?%G!<%?$N2s<}$d=hJ,$r9T$&. %W%m%;%9?t$H<dN`$r<1JL9k$?$a$K%Q%i%a!<%?$rIU1k3HbG$-$k.

2. %$%Y%s%H$H%W%m%;%9HN4X78

   #1DN%$%Y%s%H$KJ#?t$N%W%m%;%9$,;22C9k3HKh$j, JBNs=hM}$,9Tol$k. $=$N%W%m%;%9$N;22C$NI=8=J}K!$O<!$N#2DKJ,1ilk.

   - %H!<%?%k%$%Y%s%H !#t!K

     A4%W%m%;%9$,;22C$9$k.

   - %Q!<%7%c%k%$%Y%s%H !#p!K

     0lIt$N%W%m%;%9$,;22C9k. ;22C9k%W%m%;%9?t$rDj5A$7$?$j, %W%m%;%9%0%k!<%W$r;XDj$7$?$j9k.

3. %k!<%W

   %k!<%WKO%k!<%W$N2s?t$,%k!<%W$KF~$kA0$+$i7hailF$$$k>l9g !8GDj2s!K$H, %k!<%WFb$N<B9T>uBVKhCF%k!<%W$N2s?t$,7h$^$k>l9g !JIT8GDj2s!K$N#2$D$,$"$k.

   - 8GDj2s$N%k!<%W !#F#i#x!K

   - IT8GDj2s%k!<%W !#C#o#n#d!K

3lirbH$K#4$D$N%"%k%4%j%:%`$K$D$$$F, BeI=E*$J<B9T9=B$$rI=2 $K<($9. #4$D$N%"%k%4%j%:%`$N$&$A, J,3dE}<#K!, %W%m%;%C%5%U%!!]%`, 7+jJV7JQ49$O3F%W%m%;%C%5$,F10l$N7W;;$H%$%s%?%i%/%7%g%s$r9T$&$N$G, 0l$DK^Ha$FI=8=$9k3H,G-$k. %W%m%;%9%M%C%H%o!]%/$O%Q%$%W%i%$%s<0$K=hM}$,9TolkN$G, >e0L%9%l%C%I !tTop_thread!K$O<!$N%9%l%C%IHN$_F14 |$r<h$j, Cf0L%9%l%C%I !iInter_thread!K$O0l$DA0$N%9%l%C%I$H0l$D8e$N%9%l%C%I$NN>J}$HF14 |$r<h$j, 2<0L%9%l%C%I !tTail_thread!K$O0l$DA0$N%9%l%C%I$HN_F14 |$r<h$k. $=$N$?$a, 3N#3DNI=8=KJ$k.

I=2: #B#A#C#SKh$kJBNs%"%k%4%j%:%`

J,3dE}<#K!		$Cond\{I^p_{wait}, Cond(C^p, I^p_{search})\}$
%W%m%;%C%5%U%!!]%`		C^t
%W%m%;%9%M%C%H%o!]%/	top_thread	$Fix\{C, I^{p(lower\_thread)}\}$
	inter_thread	$Fix\{I^{p(upper\_thread)}, C, I^{p(lower\_thread)}\}$
	tail_thread	$Fix\{I^{p(upper\_thread)}, C\}$
7+jJV7JQ49		$Cond\{I^t_{barrier(A/B)}\{C^t\}\}$

2.4 2>A[6&M-%a%b%jJBNs%^%7%s#K#S#R-#1H=$NJBNs<B9T9=B$

2.4.1 2>A[6&M-%a%b%jJBNs%^%7%s#K#S#R!]#1

K\8&5fGO, 2>A[6&M-%a%b%j7?JBNs%^%7%s#K#S#R-#1>eGN%W%m%0%i%_%s%0$r;Y1g$9$k. 2>A[6&M-%a%b%jJ}<0$OJ,;67?$N%a%b%j9=B$$G$"$k$,, C101$N%"%I%l%96u4V, <+F0%"%I%l%9JQ49, %G!]%?4IM}$NF)2a@-$Khj, 2>A[E*$J6&M-%a%b%j$r<B8=$7, 6&M-%a%b%j7?%^%7%s>e$G$N>19g$HF1MM$K, %f!<%6$OHf3SE*4JC1$J%W%m%0%i%_%s%0$,2DG=HJ$k. $^$?, J,;6%a%b%j7?%^%7%s$HF1MM$N%9%1!]%i%S%j%F%#!]$r;}$A, N>J}$N%a%b%j9=B$$,;}$DFCD'$r7sMHw($?%^%7%s$G$"$k. $^$?, #K#S#R-#1>e$N%W%m%0%i%_%s%0$G$O, #K#S#R<R$,FH<+$K3+H/$7$?#C8@8lMQ$NJBNs=hM}4X?t$r4^$s$@#S#P#C !Simple Parallel C!K$Hpthread %7%9%F%`%3!<%k$r;HCF9T$&.

1. #S#P#C

   #S#P#C$Opthread JI$N?<$$CN<1$,$J$/$F$b, 4JC1$K#C$N%W%m%0%i%`$NJBNs2=$,$G$-$k. #S#P#CGO team $r;HMQ$7$FJBNs=hM}$r9T$&. team $N%a%s%P!<$G$"$k pthread $OF1;~$K$=$N=hM}$r=i$a, A4 pthread $N=hM}$N=*N;$,3NG'$5l?$i, <!$NL?Na$r<B9T$9$k.

   - team $N@8@.

     int pr_create_team(int numthreads);

     La$jCM: team_id

     #S#P#CGNJBNs=hM}$r9T$&H-$O, :G=i$K3N4X?t$r8F$S$@$7, JBNs=hM}$r9T$&team $r:n$k. numthreads $OJBNs2=$N?t !JBNs=hM}$K;22C$9$k pthread $N?t!K$G$"$k. 3N4X?tNLajCM$O@8@.$5l?team ID HV9fG"$k.

   - JBNs=hM}$N<B9T

pr_create_team() $G:n$il?team $rMxMQ$7$F, JBNs=hM}$r9T$&4X?t$,pr_pcall() G"$k.

```
#include !Rusr/numarg.h!S
pr_pcall(int team_id , int (*func_ptr)() , numar_t args_ptr);
```

pr_pcall() KhCF team_id $N team $K4X?t func_ptr() $NJBNs=hM}$,9Tol$k. 3N4X?t pr_pcall GO3FJBNs=hM}$NF14|$,Hi$l, A4$F$NJBNs=hM}$,=*N;7F$+$i, pr_pcall() $N<!$NL?Na$,<B9T$5lk.

- JBNs=hM}GNID HV9f$N<hF@

  JBNs=hM}$r9T$&4X?tGO, <+J,$N9T$&Y-=hM}$NHO0O$r;XDj9kI,MW$,$"$k. 3N;~, ;HMQ9kN, pr_mid() 4X?tG"$k.

  ```
  int     pr_mid();
  La$jCM!#0$+$i !nJumthreads-1!K$N@0?t
  ```

  4X?tNCfG pr_mid() $r8F$S=P9H, <+J,$N pthread ID $rF@$k3H$,$G$-$k.

- $=$NB>$N#S#P#C4X?t

  B>$K<!$Nh&$J4X?t$,$"$k.

```
_gspwt(lock_var); , _rsp(lock_var);      int pr_tid();
int pr_destroy_team(team_id);            int pr_in_parallel();
int pr_tsize();                          int pr_shutdown();
```

2. #p#t#h#r#e#d%7%9%F%`%3!<%k

pthread $O7Z$$%W%m%;%9G"$j, %9%l%C%I$N@8@.$KH<$&%*!<%P!<%X%C%I$OHs>o$K>.5/, 8zN($NNI$$JBNs=hM}$rC#@.$G$-$k. $^$?, pthread %7%9%F%`%3!<%k$r;H$C$FJBNs2=$9kH, Hs>o$K:Y$+$$@)8f$,2DG=$G$"$k.

- pthread $N@8@.

  ```
  int pthread_create(pthread_t *thread_id,pthread_attr_t attr,
                                   void *(*start_func),void *arg);
  ```

  thread_id(output) $O@8@.$5lk pthread $N ID. attr(input) $O pthread $NB0@-. start_func(input) $O@8@.$7$?pthread $G<B9T$5lk4X?t. arg $O function XN0z?t. 4X?tNLajCM$O pthread_create NLajCM @5$7$1lP#0. pthread_create KhCF pthread $,@8@.$5$l, $=$N pthread GO0z?t start_func $G;XDj$5l?4X?t$,<B9T$5lk.

- $=$NB>$Npthread $NA`:n

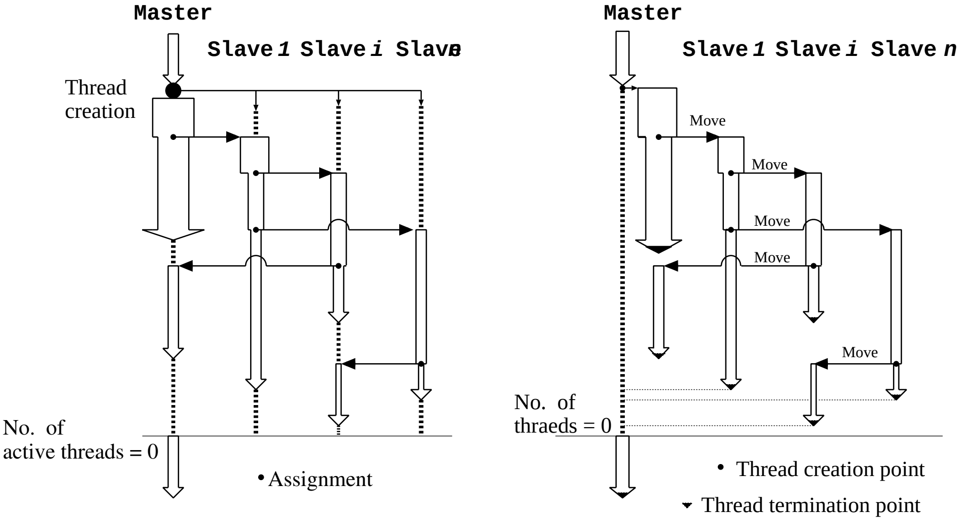
  pthread $NA`:n$O3NB>$Kpthread $r>C5n$7$?$j, 0\F0$5$;$?$j, 7k9g7?j9k3H,G-$k. $^$?, 3F<o%$%s%?%i%/%7%g%s$b$"$k.

pthread_exit	pthread_mutex
pthread_move	pthread_cond
pthread_join	pthread_barrier

2.4.2 JBNs<B9T9=B$

2>A[6&M-%a%b%jJBNs%^%7%s#K#S#R!]#1>eGNJBNs<B9T9=B$$r<($9. 3NJBNs<B9T9=B$$O%9%1%C%I$N>uBV!@J8@., :o=|!K$dF14|9=B$$r?^$GI=8=$9k3HKhj, ;k3PE*KJai$(, %"%k%4%j%:%`$rM}2r$9$k$3$H$r=u$1$k. 0J2<$KJBNs%"%k%4%j%:%`Kh$KJBNs<B9T9=B$$r@bL@9k.

1. J,3dE}<#K!



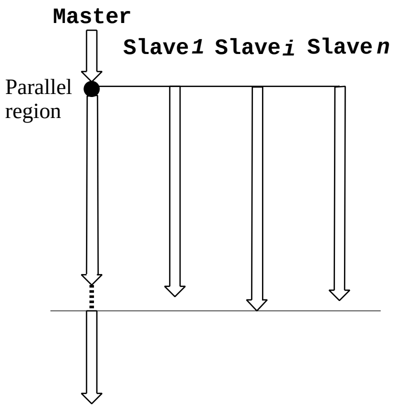
(a) ¥¥Ø¥¥º¥Œ¡…¥‚¥¥•¿

(b) ¥„¥¥ˆ¥ , fi•¿

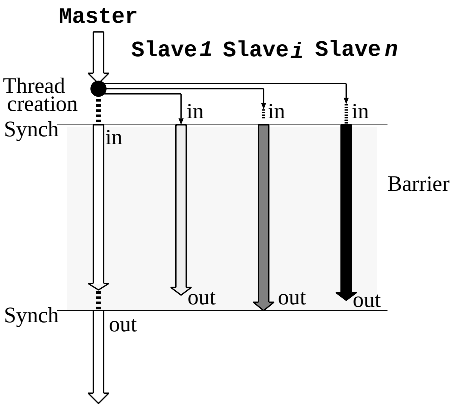
@8@.7F, $=$N%9%l%C%I$KJ,3d%?%9%/$rM?$(, %"%$%I%k%W%m%;%C%5$K=hM}$r9To;$k.
=hM}$,=*N;$7$?$i, %9%l%C%I$r:o=|$9$k. %9%l%C%I?t$,#0KJC?$i=*N;$9$k.

2. %W%m%;%C%5%U%!!<%`

?^7$K%W%m%;%C%5%U%!!<%`$NJBNs<B9T9=B$$r<($9. %Q%i%l%k%j!<%8%g%s7?$O<+F0E*$K3+;O$H=*oj$K%P%j%dF14|$,<hil, 3F%9%l%C%I$OF1$8=hM}$r9T$&. %9%l%C%I@8@.7?$O%9%l%C%I$N@8@., :o=|, 5Z$S, %P%j%dF14|$N3+;O$H=*N;$r<+M3$K;XDj$G$-$k. $^$?, 3F%9%l%C%I$OO[$JC?=hM}$r9T$&3HbG$-, LdBj$K1~8F%9%l%C%I$r:Y$+$/;XDj$G$-$k.

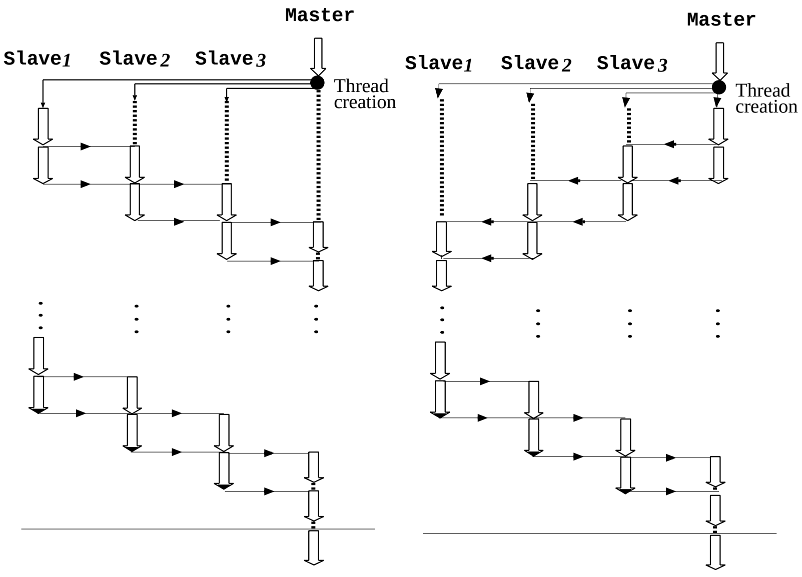


(a) ¥¥Ø¥¥º¥Œ¡…¥,¥¥•¿



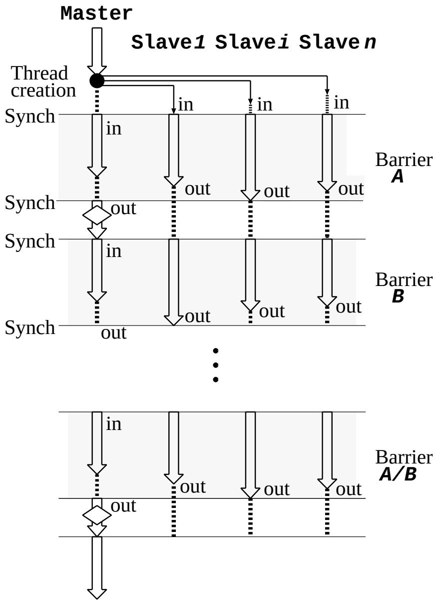
(b) ¥„¥¥ˆ¥ , fi•¿

%9%?!<$,%A%'%C%/%$%s7F$$$k%P%j%dKO%9%l!<%V$b2?2s$b%A%'%C%/%$%s$9k3H,G-, F14 |$r<h$k3H$,$G$-$J$$. $=$3$G, #2<cN`$N%P%j%d$r;H$&3HKhCF, %^%9%?!<$,%P%j%d#A$KF~CF$$$k4V, %9%l!<%V$O%P%j%d#B$K$OF~$k3H$,$G$-$:, BTAN>uBVKJ$k. $3$3$GF14 |$r<hk3H,G-$k.



(a)FSFE (b)LSFE

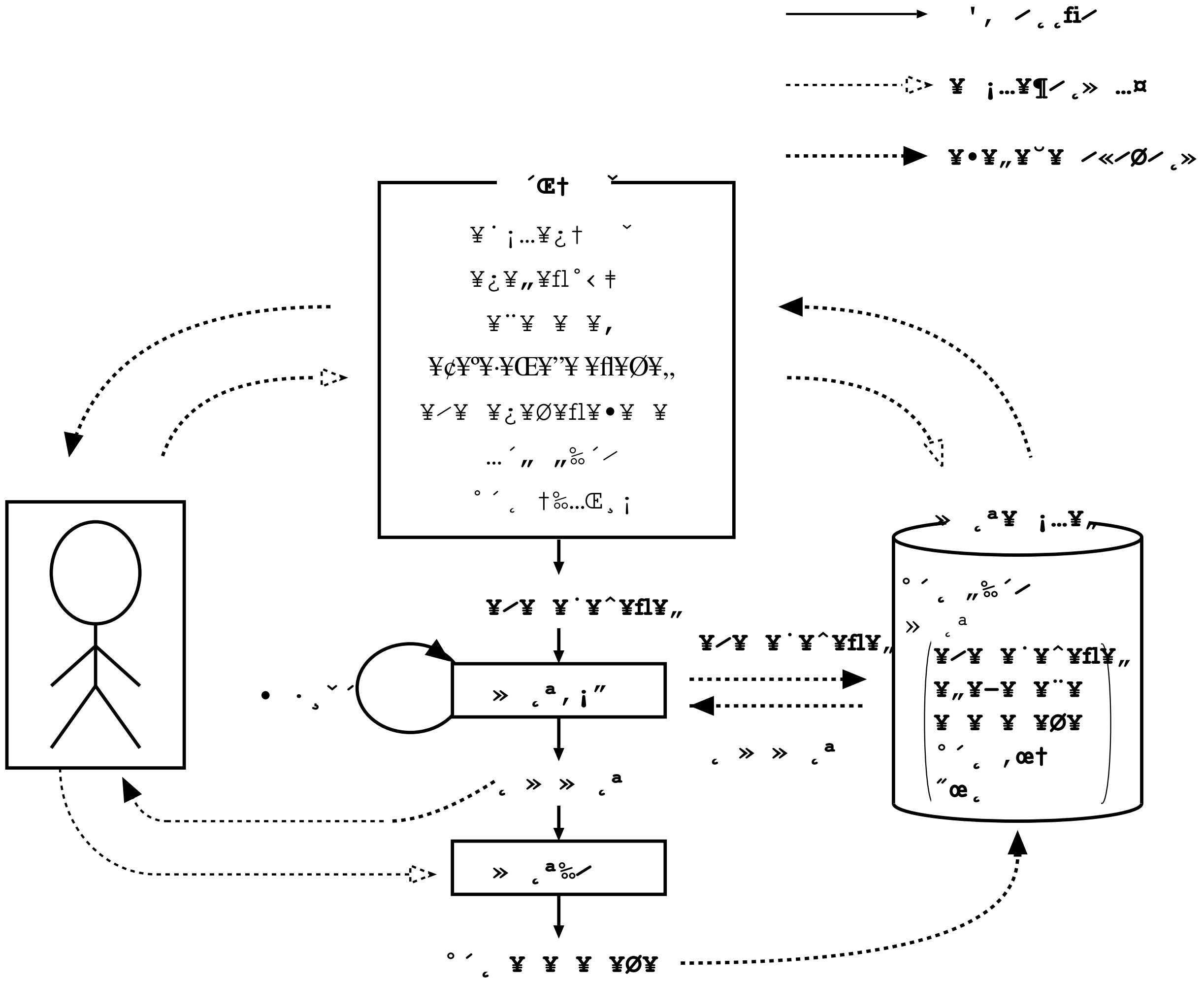
?^8: JBNs9=B$(%W%m%;%9%M%C%H%o!]%/)



?^9: JBNs9=B$(7+$jJV$7JQ49)

3 ; vNc% Y! <% 9JBN s% W% m% 0% i%_% s% 0% 7% 9% F% '

3.1 ; vNc% Y! <% 9JBN s% W% m% 0% i%_% s% 0$ N3 5MW



Kh$j, L\E*$NJBNs%W%m%0%i%‘$r40@.$5$;$k. %W%m%0%i%‘KO, $=$N;vNc$N%W%m%0%i%‘K\BN$,5-:\$5lF$$$F, $$$DGb;2>HG-$k. JBNs8z2L$O, $=$N%W%m%0%i%‘$r<B9T$7$?$H$-, INDxEY$NB.EY8~>e$,F@il$?$+$r%0%i%U$G<(7?bNG"$k.

$^$:, %f!<%6$O%$%s%G%C%/%9$N3F9‘L\Kh$KLdBj2r@O$r9T$&. 3N%$%s%G%C%/%9$N:n@.$O3F9‘L\$K$D$$$F=gHV$K5-:\$9$k. 3F9‘L\$O?^$d@bL@$,$"$j, %f!<%6$,E,Ev$@$H;W$&bN$rA*Br$9k@1G$h$$$N$G, 4JC1$K:n@.G-$k. %7%9%F%‘$O3N%$%s%G%C%/%9$rMQ$$$F, N‘;w;vNc$r8!:w$9$k. N‘;w;vNc$N8!:w$O%$%s%G%C%/%9$N3F9‘L\$,40A4$K%^%C%A$9kbN,$"$l$P, $=$N;vNc$r, $=$&GJ1l$P, >r7o$r4KOB !&J$%s%G%C%/%9$N9‘L\$r0lD:$D:o=|$7$F$$$/!K7F, :G$bN‘;w$7$?;vNc$r8!:w7F$/$k. %f!<%6O=$&$7$F8!:w$5l?;vNc$N%9%1%l%H%s$KFyIU$1!&$@5$9$k3HKh$j, ?7$?$JJBNs%W%m%0%i%‘$r:n@.9k. 3N;~, N‘;w;vNc$N%W%m%0%i%‘K\BN$dJBNs8z2LJI$r;2>H$9k3H,G-, B.EY8~>e$N4|BTEY$d%W%m%0%i%_%s%0$NMF0W$5$rM=B,$9k3H,G-$k. 3Nh&$JJ}K!$Khj, JBNs%W%m%0%i%_%s%0$NIiC4$r7Z8:$7, MF0W$KJBNs%W%m%0%i%‘$r:n@.G-$kh&$K%5%]!<%H9k.

3.2 ;vNc%Y!<%9$N9=C[

3.2.1 ;vNc$NI=8=

0lDN;vNcH7$F, %$%s%G%C%/%9 !*J.index!K, %9%1%l%H%s !*J.skel!K, %W%m%0%i%‘ !*J.pg!K, JBNs8z2L !*J.gif!K$N3F%U%!%$%k$,MQ0U$5lF$$$k.

1. %$%s%G%C%/%9

1~MQ	LdBj$N1~MQJ,Ln
;EMM	LdBj$NDj5A
%"%k%4%j%:%‘	J,3dE}<#K!, %W%m%;%C%5%U%!!]%‘, %W%m%;%9%M%C%H%o!]%/, 7+jJV7JQ49
=*N;>r7o	%"%k%4%j%:%‘$N=*N;>r7o
%G!]%?9=B$	%=!]%9%G!]%?, 7k2L%G!]%?
%?%9%/J,3d	(J,3dBP>], J,3dC10L, J,;6J}K!)
%H%]%m%8	%H%j!], %o!]%+!], %^%9%?!]&%o!]%+!], %Q%$%W, %j%s%0, %a%C%7%e, %O%$%Q!]%-%e!]%V, ...
%$%s%?%i%/%7%g%s	%7%0%J%k·%&% (%$%H, %_%e!]%F%C%/%9, %P%j%d
JBNs2=<jK!	%Q%i%l%k%j!]%8%g%s, %Q%i%l%k%;%/%7%g%s, %9%l%C%I%i%$%V %i%j
<B9T9=B$	$BACS$

2. %9%1%l%H%s

   JBNs%W%m%0%i%`$N9|3J!&J?%9%/J,3d, Aj8_GS=|, F14|, %9%l%C%I@8@.!&o=|!K

3. %W%m%0%i%`K\BN

4. JBNs8z2L

   JBNs=hM}Kh$kB.EY8~>eHf$rIA$$$?%0%i%U

3.2.2 ;vNc%Y!<%9$N:n@.

3l$^$G, %"%k%4%j%:%`Kh$K#2#28D$N;vNc$r:n@.$7$?. $3$l$rI=3$K<($9. 3F;vNc$N:n@.<j=g$O$^$:, $"$kLdBj$K$D$$$FC`<!=hM}$N%W%m%0%i%`$r%o!<%/%9%F!<%7%g%s>e$G:n$j!$$=$3$+$i, JBNs2=$NJ}K!$r9M$(!$JBNs%W%m%0%i%`$r:n@.!$$=7F, JBNs%^%7%sG"$k#K#S#R-#1>e$G<B9T, 5i$K, %G%P%C%/$,=*N;7?$i, JBNs8z2L$,IN$/$i$$$G$F$$$kN+$rD4$Y!$#1$D$N;vNc$H7F$^$Hak. $^$?, $=$NCf$G, JBNs%W%m%0%i%`$r:n@.$9$k:], N`;w;vNc$r;}$CF-$F, $=$N%9%1%l%H%s$KFyIU$1!&=$@5$r9T$$, %W%m%0%i%`$r:n@.$7$?$b$N$rI=4$K<($9. Lp0u$N:8B&$,;29M$K$7$?%W%m%0%i%`(%9%1%l%H%s) $G, 1&B&$,:n@.7?%W%m%0%i%`G"$k.

I=3: ;vNc%Y!<%9$N:n@.

J,3dE}<#K!	%/%$%C%/%=!<%H, @QJ,7W;;, =d2s%;!<%k%9%^%sLdBj C_@QK!
%W%m%;%C%5%U%!!]%`	%^%s%G%k%V%m, #K#M#PK!, %l%$%H%l!<%7%s%0, %(%C%8Cj=P #H#o#u#g#hJQ49, #3<!%9%W%i%$%s, #B#MK! %S%8%M%k0E9f, %i%s%l%s%0%905=L
%W%m%;%9%M%C%H%o!]%/	#L#UJ,2rK!, %P%V%k%=!<%H, :Y@~2=, %J%C%W%5%C%/LdBj
7+jJV7JQ49	#D#K#AK!, %o!<%7%c%k%"%k%4%j%:%`, JqAu%"%k%4%j%:%` %^!<%8!?%9%W%j%C%H%=!<%H, %m%s%P!<%0@QJ,K!

I=4: ;vNc=$@5$KhkJBNs%W%m%0%i%`$N:n@.

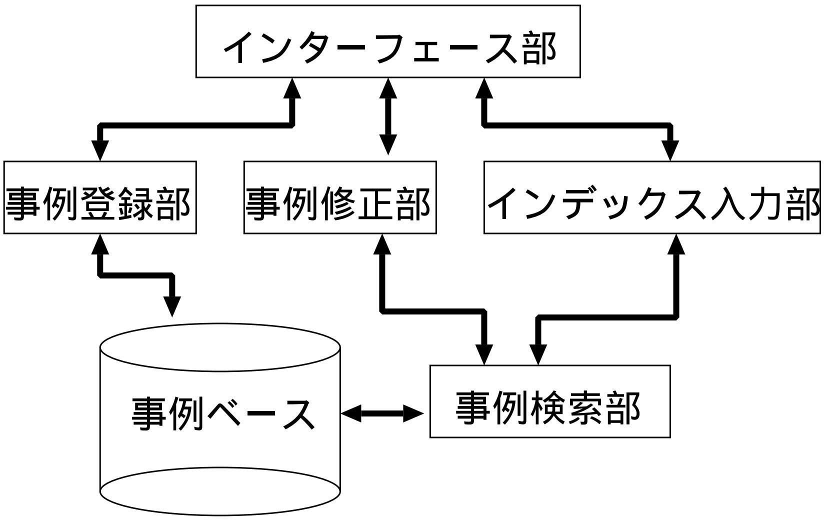
#K#M#PK!	$\Longrightarrow$	#3<!%9%W%i%$%s	#3<!%9%W%i%$%s	$\Longrightarrow$	%(%C%8Cj=P
#D#K#AK!	$\Longrightarrow$	JqAu%"%k%4%j%:%`	%/%$%C%/%=!<%H	$\Longrightarrow$	=d2s%;!<%k%9%^%sLdBj
#K#M#PK!	$\Longrightarrow$	#H#o#u#g#hJQ49	%P%V%k%=!<%H	$\Longrightarrow$	:Y@~2=
#D#K#AK!	$\Longrightarrow$	%^!<%8!?%9%W%j%C%H%=!<%H	#L#UJ,2rK!	$\Longrightarrow$	%J%C%W%5%C%/LdBj
#K#M#PK!	$\Longrightarrow$	%S%8%M%k0E9f	#K#M#PK!	$\Longrightarrow$	%i%s%l%s%0%905=L
#K#M#PK!	$\Longrightarrow$	#B#MK!	%/%$%C%/%=!<%H	$\Longrightarrow$	C_@QK!
#D#K#AK!	$\Longrightarrow$	%m%s%P!<%0@QJ,K!			

3.3 %7%9%F%`9=@.$H;HMQK!

3.3.1 %7%9%F%`9=@.

K\%7%9%F%`$O Tck/Tk Kh$j, %W%m%0%i%_%s%0$5lF$$$k. Tck/Tk $OJ8K!5,B'$,C1=c, 7?@k8@$,ITMW, K-IY$J@)8f9=B$, %b%8%e!<%k2=$,<+M3<+:_, 3HD%@-, ?t3X4X?t$N%5%]!<%H, %j%9%H=hM}5!G=$N6/2=, O"A[G[Ns5!G=, $=$7$F, GUI %$%s%?!<%U%'!<%9$rDs6!$7$F$$$k.

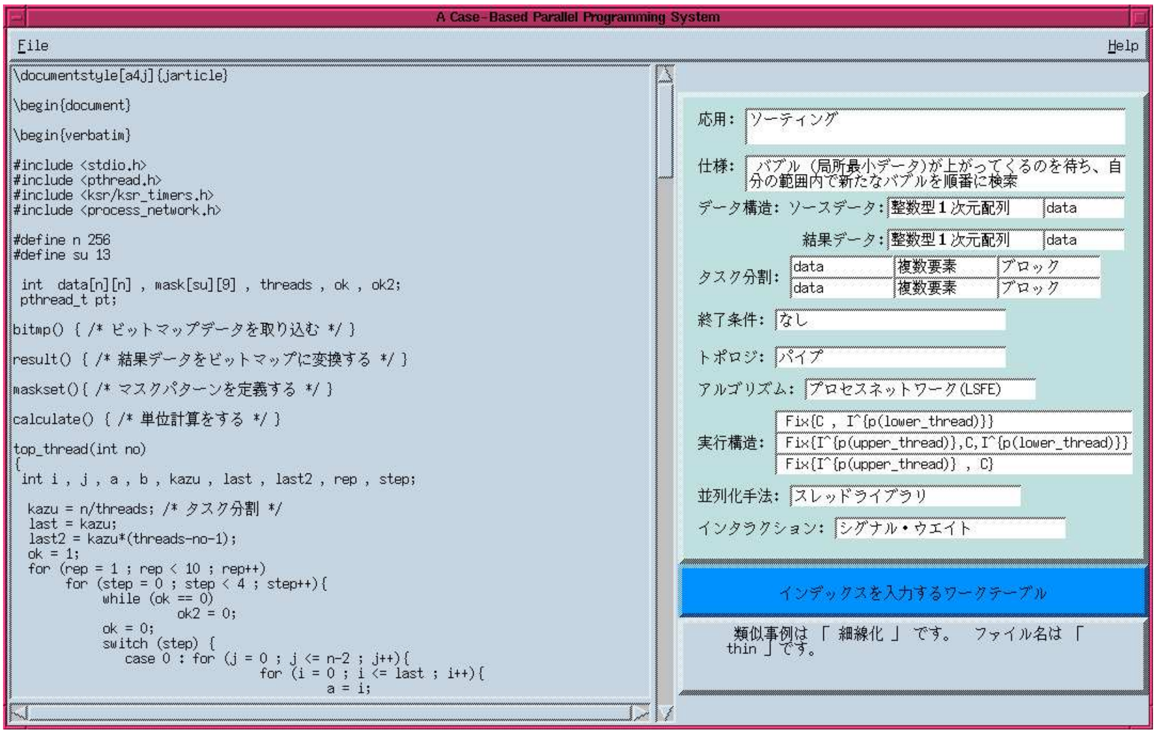
K\%7%9%F%`$N%7%9%F%`9=@.$r?^11$K<($9. K\%7%9%F%`$O%$%s%?!<%U%'!<%9It, %$%s%G%C%/%9F~NOIt, ;vNc8!:wIt, ;vNc=$@5It, ;vNcEPO?It, ;vNc%Y!<%9$+$i$J$k. %$%s%?!<%U%'!<%9It$O%f!<%6$H$N$d$j<h$j$r$9$k$H6&$K, %$%s%G%C%/%9$HN`;w;vNc$N8!:wKh$k%9%1%l%H%s$NI=<($,$G$-$k. %$%s%G%C%/%9F~NOIt$O%f!<%6HNBPOCKh$j, %$%s%G%C%/%9$N3F9`L\$r=gHV$K5-=R$9$k$3$H$r%5%]!<%H$9$k. ?^$d@bL@$rMQ$$$, $^$?, 3F9`L\$OI=<(5l$?$bN+$iA*Br$9$k. ;vNc8!:wIt$OF~NO5l$?%$%s%G%C%/%9$r4p$KN`;w;vNc$r8!:w$7, $=$N%9%1%l%H%s$rI=<($9$k. ;vNc=$@5It$O8!:w$5$l$?%9%1%l%H%s$NJT=8$H$=$N%U%!%$%k$N%;!<%V$r9T$&. ;vNcEPO?It$O?7$?$J;vNc$rEPO?$9$k. ;vNc%Y!<%9$K$O:#$^$G:n$C$?;vNc$,EPO?$5$l$F$$$k. 3F;vNc$O%$%s%G%C%/%9, %9%1%l%H%s, %W%m%0%i%`, JBNs8z2L$KJ,N`$5$l, $=$7$F, $=$N%U%!%$%kL>$OE}0l, 3HD%;R$,0[$Jkb$NF1;N$,01DN;vNcG"$k.



?^11: %7%9%F%`9=@.

3.3.2 %7%9%F%`$N;HMQK!

%f!<%6$OmainPG $H$$$&%U%!%$%k$r<B9T9lPh$$. 3NmainPG $O<B9T%U%!%$%k7A<0KJCF$$$F, %3%^%s%I$r<B9T$9kH, %7%9%F%`$,5/F0$9$k. $^$:, JBNs%W%m%0%i%`$r:n@.$9k+, ;vNc$rEPO?$9k+J9$$$F$/$k. JBNs%W%m%0%i%`$r:n@.$9$k$rA*$V$H, %$%s%G%C%/%9$N:n@.$r;O$a$k. $3$l$O%f!<%6$HBPOCE*$K9T$$, 019`L\$:$DM?$(il$?$bN+$iA*Br$7$F$$$/(IUO?;2>H). %$%s%G%C%/%9$N:n@.$,=*N;$9kH, %7%9%F%`$ON`;w;vNc$r8!:w$7F/$k. ?^12$O%P%V%k%=!<%H$N%$%s%G%C%/%9$r:n@.$7, N`;w;vNc$H$7$F, :Y@~2=$N;vNc$,8!:w$5$l$?>lLL$G$"$k. $3$N%$%s%?!<%U%'!<%9$O1&2<$NItJ,$G, %7%9%F%`$H%f!<%6$H$,$d$j<h$j$r9T$$, $=$N7k2LG-$?%$%s%G%C%/%9$r1&>eItJ,$KI=<(9k. $=$7$F, 8!:w$5l?N`;w;vNc$N%9%1%l%H%s$r:8ItJ,$KI=<($9$k. $3$NItJ,$G%9%1%l%H%s$rFyIU$1!&$@5$9$k$3$H$K$h$j, JBNs%W%m%0%i%`$r:n@.$9k3HKJk. $3$3$GJT=8$7$?JBNs%W%m%0%i%`$O:8>e$NFile $r%/%j%C%/$7$Fsave $rA*$V$H, %U%!%$%k$KJ]B8$9$k$3$H$,$G$-$k. $^$?, $3$NFile $r%/%j%C%/$7$F, 8!:w$5$l$?N`;w;vNc$NJBNs%W%m%0%i%`$dJBNs8z2L$r8+k3H,G-$k.



```
\documentstyle[a4j]{jarticle}

\begin{document}

\begin{verbatim}

#include <stdio.h>
#include <pthread.h>
#include <ksr/ksr_timers.h>
#include <process_network.h>

#define n 256
#define su 13

 int  data[n][n] , mask[su][9] , threads , ok , ok2;
 pthread_t pt;

bitmp() { /* ビットマップデータを取り込む */ }

result() { /* 結果データをビットマップに変換する */ }

maskset(){ /* マスクパターンを定義する */ }

calculate() { /* 単位計算をする */ }

top_thread(int no)
{
 int i , j , a , b , kazu , last , last2 , rep , step;

  kazu = n/threads; /* タスク分割 */
  last = kazu;
  last2 = kazu*(threads-no-1);
  ok = 1;
  for (rep = 1 ; rep < 10 ; rep++)
       for (step = 0 ; step < 4 ; step++){
            while (ok == 0)
                      ok2 = 0;
            ok = 0;
            switch (step) {
               case 0 : for (j = 0 ; j <= n-2 ; j++){
                                   for (i = 0 ; i <= last ; i++){
                                            a = i;
```

応用: ソーティング

仕様: バブル（局所最小データ)が上がってくるのを待ち、自分の範囲内で新たなバブルを順番に検索

データ構造: ソースデータ: 整数型1次元配列 | data

結果データ: 整数型1次元配列 | data

タスク分割: data | 複数要素 | ブロック
data | 複数要素 | ブロック

終了条件: なし

トポロジ: パイプ

アルゴリズム: プロセスネットワーク(LSFE)

実行構造:
Fix{C , I^{p(lower_thread)}}
Fix{I^{p(upper_thread)},C,I^{p(lower_thread)}}
Fix{I^{p(upper_thread)} , C}

並列化手法: スレッドライブラリ

インタラクション: シグナル・ウエイト

類似事例は「 細線化 」です。 ファイル名は「 thin 」です。

?^12: %7%9%F%`$N%$%s%?!<%U%'!<%9

4 JBNs2=$N2r@O$H;vNc8!:w!&=$@5

4.1 JBNs2=$N2r@O$Khk%$%s%G%C%/%9$N:n@.

%f!<%6$,:n@.$7$?$$%W%m%0%i%`$K$D$$$FJBNs2=$N2r@O$r9T$$, %$%s%G%C%/%9$r:n@.$9$k. %$%s%G%C%/%9$O3F9`L\$K$D$$$F=gHV$K5-:\$9$k. 3N=gHV$O0lHL$K%f!<%6$,JBNs%W%m%0%i%`$r:n@.$9$k$H$-$K9M$($k=gHV$K$7$F$"$k. =i$a$K1~MQ, ;EMM, <!$K%G!<%?9=B$, %?%9%/J,3d, =*N;>r7o, $=$7$F, %H%]%m%8, %"%k%4%j%:%`, :G8e$K<B9T9=B$, JBNs2=<jK!, %$%s%?%i%/%7%g%s$r5-=R9k. :G8e$N#3DO0MB8$7$F$$$kNG, #1D,7h$^$k$H, #3$DHb7hDj9k. 3F9`L\$H$b?^$d@bL@$rF~$l, $J$k$Y$/%f!<%6$,E,Ev$@$H;W$&$b$N$rA*Br$9$k$@$1$G%$%s%G%C%/%9$r5-=R$G$-$k$h$&$K$7, 4JC1$K%$%s%G%C%/%9$,:n@.$G$-$k$3$H$rL\;X$7$?. $^$?, Nc$NCf$KEv$F$O$^$k$b$N$,$J$+$C$?>l9g$O, %f!<%6$,9M$($F5-=R$9$k. 6qBNE*$K$O0J2<$N=gHV$G3F9`L\$rA*Br7F$$$/.

1. 1~MQ

   %=!<%F%#%s%0, 7PO)C5:w, %0%i%ULdBj, 2hA |=hM}, J8;zNs>H9g, ?tCM=hM}, $=$NB>$N#7$D$+$iA*Br9k.

2. ;EMM

   J8>O$^$?$O<0$GF~NO9k.

3. %G!<%?9=B$

   7W;;$N4p$KJk%=!<%9%G!<%?$H7W;;8e$N7k2L%G!<%?$r0J2<$N<j=g$GA*Br$9$k.

   (a) G[Ns or $=$NB>
   (b) #1<!85 or #2<!85 or #3<!85
   (c) @0?t7? or <B?t7? or J8;z7? or 9=B$BN

4. %?%9%/J,3d

   %=!<%9%G!<%?, 7k2L%G!<%?Hb$KJ,3dBP>], J,3dC10L, J,;6J}K!$rF~NO$9$k. J,3dBP>]$O%f!<%6$,FH<+$KF~NO9k. J,3dC10L, J,;6J}K!$O0J2<$NA*Br;h$+$i$=$l$>$lA*Br9k.

J,3dC10L	J,3dJ}K!
#1MWAG #19T #1Ns J7 J#?tMWAG J#?t9T J#?tNc	%V%m%C%/ %3%T!< %5%$%/%j%C%/

5. =*N;>r7o

   %k!<%W$N7+$jJV7,2DJQ2sNH$-$K, $=$N=*N;>r7o$r;XDj$9$k. 8GDj2s$NH-OJ7H9k.

6. %H%]%m%8

   %o!<%+!<, %D%j!<, %Q%$%W, %a%C%7%e, %j%s%0, %^%9%?!<!u%o!<%+!<, %O%$%Q!<%-%e!<%V, $=$NB>$N#8$D$+$iA*Br9k. 3N:], ?^$H@bL@$r2hLL>e$KI=<($9$k.

7. %"%k%4%j%:%`

   %W%m%;%C%5%U%!!<%`, J,3dE}<#K!, %W%m%;%9%M%C%H%o!<%/, 7+jJV7JQ49$N#4$D$+$iA*Br9k. 3N:], ?^$H@bL@$r2hLL>e$KI=<($9$k.

8. <B9T9=B$

   A*Br7?%"%k%4%j%:%`KBP9$kBeI=E*$J<B9T9=B$$N?^$H, BACS I=8=$r2hLL>e$KI=<($9$k. $=$NCf$+$i:G$bE,@Z$J9=B$$rA*Br9k. %W%m%;%9%M%C%H%o!<%/$N;~$O, 5i$K FSFE(First Start First End) $H LSFE(Last Start First End) NIAi$+$rA*Br9k.

9. JBNs2=<jK!

   <B9T9=B$$,7h$^$C$F$$$kNG, 3liO<+F0E*$K%Q%i%l%k%j!<%8%g%s, %Q%i%l%k%;%/%7%g%s, %9%l%C%I%i%$%V%i%j$N#3D+$iA*Br$5lk.

10. %$%s%?%i%/%7%g%s

    %7%0%J%k!&&%(%$%H, %P%j%d, mutex, J7$N#4D+$iA*Br9k. 3N:], ?^$H@bL@$r2hLL>e$KI=<(9k. <B9T9=B$$,7h$^$C$F$$$kNG, A*Br;h$,9J$ilk.

4.2 ;vNc8!:wK!

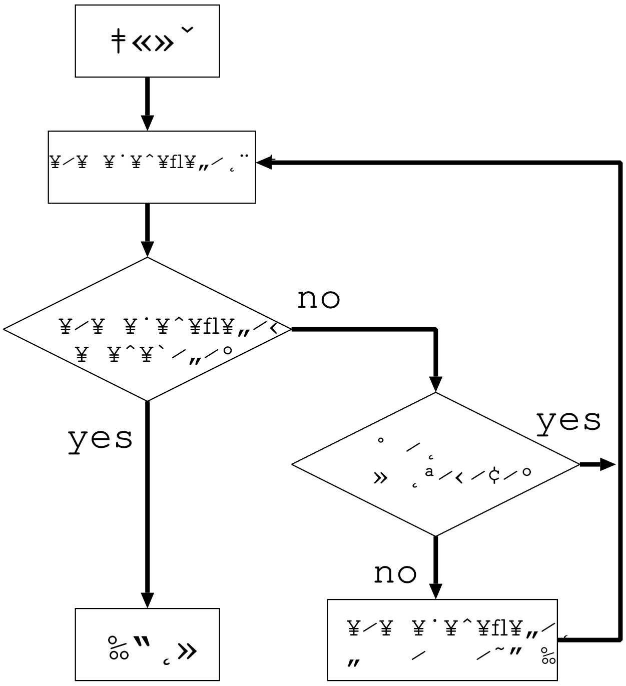
%$%s%G%C%/%9$rMQ$$$FN`;w;vNc$r8!:w$9$k. %f!<%6$,F~NO$7$?%$%s%G%C%/%9$H;vNc%Y!<%9$KC_$($F$"$k%$%s%G%C%/%9$rHf3S$9$k$?$a$K, 3F;vNc$N%$%s%G%C%/%9$OI=5$N$h$&$K$=$l$>$l$KBP1~$9$k?t;z$GI=8=$7$F$"$k. $3$&$9$k$3$H$K$h$j, 3F9`L\$rHf3S7d$9$$$h$&$K9k. ;EMM, =*N;>r7o, JBNs2=<jK!$OJ8;zNs$G5-=R9k. JBNs2=<jK!$H<B9T9=B$$O%;%C%HJN$G, 8!:w$N;~$O<B9T9=B$$NJ}NCMr;H$&. $^$?, 019TL\$K;vNcL>$r5-=R$7, 8!:w5l$?;~$K$=$l$rI=<($9$k. 3F9`L\$OA*Br;hKE,EvJbN$,$J$+$C$?>l9g$OJ8;zNs$G5-=R$9$k.

N`;w;vNc$N8!:w%"%k%4%j%:%`$r?^13$K<($9. %$%s%G%C%/%9$N3F9`L\$r0l$D$:$DD4$Y, 40A4$K%^%C%A$7$?;vNc$,B8:_$7$?$i, $=$N;vNc$r8!:w$7$F$/$k. A4$F$N;vNc$K$D$$$F9T$$, 40A4$K%^%C%A$9$k;vNc$,$J$$>l9g$O, >r7o$r4KOB$7$F:G$bN`;w$7$?;vNc$r8!:w7F$/$k.

>r7o4KOB$O%$%s%G%C%/%9$N9`L\$r0l$D$:$D:o=|$9$k$3$H$K$h$j9T$&. %f!<%6$,F~NO$7$?%$%s%G%C%/%9$N9`L\$r0l$D:o=|$7, ;DjN9`L\$,0lCW$9$k;vNc$r8!:w$9$k. $3$l$rN`;w;vNc$,8!:w$5lk$^$G7+jJV9. 3N:o=|$N=gHV$rI=6$K<($9. JQ?t$O<B:]$KHf3S9kJQ?tG"$k. 3N=gHV$O%9%1%l%H%s!&%W%m%0%i%`!K$N9=B$$K1F6A$,>.$5$$9`L\$+$i:o=|$9kh$&$K9M$($?. 3&9k3HKh$j, %9%1%l%H%s$NMxMQEY$r9b$a, %W%m%0%i%_%s%0$NI iC4$,7Z8:5l$k. $^$?, :G0-$N>l9g$G$b, :G8e$N9`L\$N%"%k%4%j%:%`$O#4$D$NA*Br;h$NCf$+$iA*Pl, $+$D, $=$N#4DN%"%k%4%j%:%`Kh$K;vNc$,B8:_$9$k$N$G, I,$:F1$8%"%k%4%j%:%`$N;vNc$,8!:w5l$k. 3l$O:G$b=EMW$G, %"%k%4%j%:%`$,0[$J$k$H, $[$H$s$I:FMxMQ$9$k$3$,$G$-$:, 5U$K%"%k%4%j%:%`$,0lCW9k$H, %a%$%sItJ,O[HsI=N^$^:FMxMQG-, %W%m%0%i%`%_%s%0$,Hs>o$K3Z$KJk.

I=5: 3F;vNc$N%$%s%G%C%/%9$N5-=R

9TL\	9`L\	A*Br;h
#1.	;vNcL>	;vNcL>$r=q$/
#2.	1~MQ	1(?tCM7W;;) 2(%=!<%F%#%s%0) 3(7PO)C5:w) 4(%0%i%ULdBj) 5(2hA|=hM}) 6(J8;zNs>H9g) J8;zNs($=$NB>)
#3.	;EMM	;EMM$r=q$/
#4.	=*N;>r7o	=*N;>r7o$r=q$/
#5.	%G!<%?9=B$(7k2L%G!<%?)	1(G[Ns) 2($=$NB>)
#6.		1(#1<!85) 2(#2<!85) 3(#3<!85) 4($=$NB>)
#7.		1(@0?t7?) 2(<B?t7?) 3(J8;z7?) 4(9=B$BN) 5($=$NB>)
8!A10.	%G!<%?9=B$(%=!<%9%G!<%?)	%G!<%?9=B$(7k2L%G!<%?) $KF1$8
#1#1.	%?%9%/J,3d(7k2L%G!<%?)	1(#1MWAG) 2(#19T) 3(#1Ns) 4(J7) 5(J#?tMWAG) 6(J#?t9T) 7(J#?tNs)
#1#2.		1(%V%m%C%/) 2(%5%$%/%j%C%/) 3(%3%T!<)
13!A14.	%?%9%/J,3d(%=!<%9%G!<%?)	%?%9%/J,3d(7k2L%G!<%?) $KF1$8
#1#5.	%$%s%?%i%/%7%g%s	1(mutex) 2(%7%0%J%k!&%(%$%H) 3(%P%j%d) 4($J$7)
#1#6.	JBNs2=<jK!	%Q%i%l%k%j!<%8%g%s, %9%l%C%I%i%$%V%i%j, %Q%i%l%k%;%/%7%g%s
#1#7.	<B9T9=B$	1(J,3dE}<#K!(%Q%i%l%k!A)) 2(%9%l%C%I!A) 3(%W%m%;%C%5%U%!!<%`(%Q%i%l%k!A)) 4(%9%l%C%I!A) 5(%W%m%;%9%M%C%H%o!<%/(FSFE)) 6(LSFE) 7(7+jJV7JQ49)
#1#8.	%H%]%m%8	1(%o!<%+!<) 2(%D%j!<) 3(%Q%$%W) 4(%a%C%7%e) 5(%j%s%0) 6(%^%9%?!<!u%o!<%+!<) 7(%O%$%Q!<%-%e!<%V) J8;zNs($=$NB>)
#1#9.	%"%k%4%j%:%`	1(%W%m%;%C%5%U%!!<%`) 2(J,3dE}<#K!) 3(%W%m%;%9%M%C%H%o!<%/) 4(7+jJV7JQ49)


no
yes
yes
no

4.3 ;vNc=$@5K!

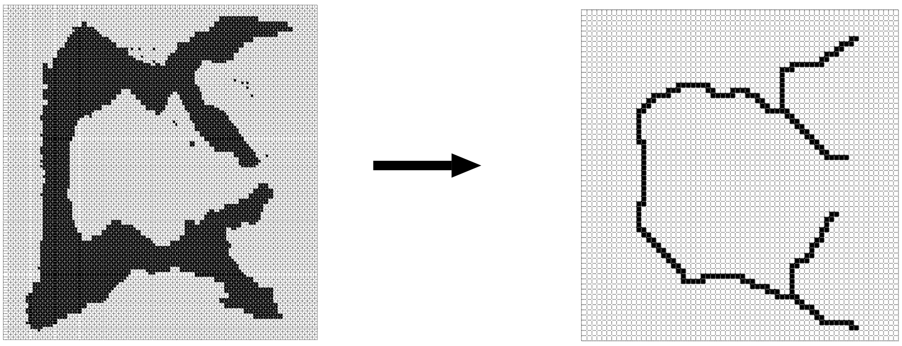
;vNc=$@5$O%f!<%6$,<jF0$G9T$& 8!:w$5$1$?;vNc$N%9%1%1%H%s$OJBNs%W%m%0%i%`$N9|3J
G"$j, BgItJ,$r:FMxMQG-$k. 7+$7, %f!<%6$,L\E*H9$kJBNs%W%m%0%i%`$K9k$?aK
$O=$@5r7J1lPJi$J$$. $3$3$G, JBNs%W%m%0%i%`$r%9%l%C%I, F14|, %?%9%/J,3d, C10L
7W;;$N#4$D$NItJ,$KJ,N`7F$_$k$H, %9%l%C%I, F14|$O%9%1%1%H%sr[Hs$I:FMxMQ$G$-$k
$@$m$&. $=$1$O8!:w$5$1$?;vNc$NJBNs%"%k%4%j%:%`$d<B9T9=B$$,0lCW9k$+$iG"$k. $$
$m$$$m$J<oN`$NJBNs%"%k%4%j%:%`$d<B9T9=B$$r;}$D;vNc$,MQ0U7F$"$kNG, 0lCW9k;v
Nc$,I,$:8+D+kh$&$KJC$F$$$k. $=$N$?$a, 9|3J$NItJ,$O$=$N$^$^:FMxMQG-$k. %?%9
%/J,3d$O%$%s%G%C%/%9$N9`L\$,0lCW7F$$$l$P, $"$kDxEY:FMxMQG-k,, $=$1Gb=$@5$,
I,MWG"$k. 0lCW$7$J$$>l9g$O, BgItJ,$r=$@5$9k+?75,$K9M$(kI,MW,$"$k. 3NItJ,$O
%f!<%6$,0lHV6lO+$9kH3mG"$k. C10L7W;;$O$[$HsIC`<!%W%m%0%i%`$+$i, :FMxMQ9k
3H$,$G$-$k. $$$:1K7F$b, =$@5ItJ,$O%f!<%6$,FH<+$K9M$(J1lPJi$J$$. $^$?,
3N;~, 8!:w$5$1$?;vNc$N%W%m%0%i%`K\BN$dJBNs8z2L$r;2>H9k3H$,$G$-, IN$/$i$$$N
JBNs8z2L$,F@$i1k$+M=A[$G$-$k.

5 ;vNc=$@5$KhkJBNs%W%m%0%i%_%s%0

5.1 :Y@~2=

5.1.1 LdBj$NDj5A$H2r@O

:Y@~2=$OI}$N$"$k@~?^7A$+$i, I}N[$\Cf?4$NItJ,$KI}#1$NCf?4@~$r<h$j=P9?aN#1DNJ}K!G"$k(?^14). $=$N4pK\E*$J9M$(J}$O?^15$K<(9h$&$J%^%9%/%Q%?!<%s$rMQ$$$F, $=$N>r7o$KE,9g$9$k?^7AItJ,$,$"$l$PCf?4E@$r#1$+$i#0KJQ($k. :o$jJ}H7F"if$kJ}8~$N$"$ifk>l9g$r9M$($F, %Q%?!<%s$rB?$/MQ0U$9$k. MQ0U$7$?%^%9%/%Q%?!<%s$O3l$r#9#0!k, #1#8#0!k, #2#7#0!k2sE>7?%^%9%/$b4^$a, A4It$G#1#78D$"$k. $^$?, :oCFf/=g=xH7$F, >e$+$i2<$X, :8$+$i1&$X, 2<$+$i>e$X, $=$7$F, 1&$+$i:8$X$H#4J}8~$+$i=gHV$K#1%a%C%7%e$:$D:oCFf/. 3l$r2?EY$b7+jJV7$FI}#1$N@~$,F@$ilk$^$G9T$&.



¥‰¡…¥„¥˙¡…¥¿

•°† ¥˙¡…¥¿

?^14: :Y@~2=

0		1
0	1	1
0		1

x4

	0	
0	1	0
	0	

x1

0	0	
0	1	1
0	0	

x4

	0	0
1	1	0
1	1	

x4

?^15: %^%9%/%Q%?!<%s

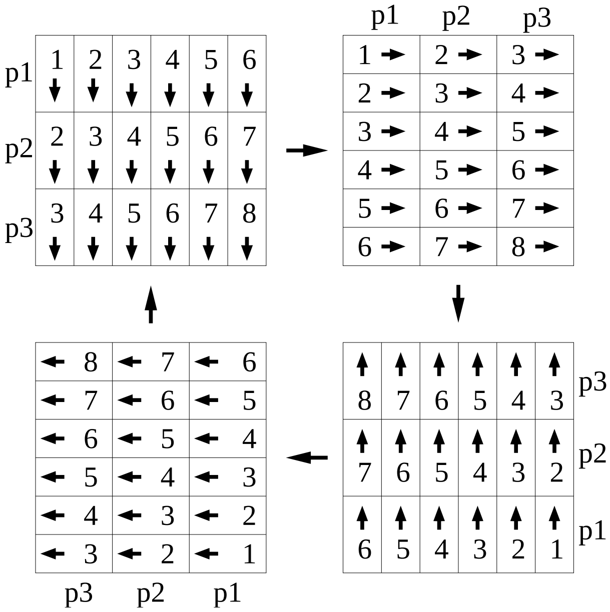
5.1.2 %?%9%/J,3d$HJBNs2=

C1FH$K7W;;$G$-$k:G>.$N7W;;C10L!OJ10IMWAG!K$O2hA|J?LL>e$N#9$D$NE@$N%G!<%?data[n][n] !nJ = i,i+1,i+2!KG"$k.

%=!<%9%G!<%?!'2hA|J?LL>e$N#9$D$NE@$N%G!<%?data[n][n] !nJ = i,i+1,i+2!K

7k2L%G!<%?!'2hA|J?LL>e$N#9$D$NE@$N%G!<%?data[n][n] !nJ = i,i+1,i+2!K

?^16Nh$&$K, 2hA|J?LL$r%V%m%C%/$KJ,1k. 3N#1DN%V%m%C%/$NI}$O#3%S%C%HG"$k. 3F%9%l%C%I$,M?$($il?ItJ,KD$$$F%^%C%A%s%0$r9T$&. #1DNNs$,=*$oC?$i, #1%S%C%H1&$K$:$i7F9T$&. $^$?, A0$N%^%C%A%s%0$GF@il$?CM$,<!$N%^%C%A%s%0$r9T$&$H$-$KI,MWHJ$j, $3$3$GF14|$r<hkI,MW,$"$k. 3N$?$a, %Q%$%W%i%$%s=hM}$,E,Ev$G$"$j, JBNs%"%k%4%j%:%`$H$7$F%W%m%;%9%M%C%H%o!<%/$rMQ$$$, %&%(!<%V%U%m%s%H>u$K=hM}$,?J$`.



?^16: :Y@~2=$N%?%9%/J,3d

5.1.3 ;vNc=$@5$KhkJBNs%W%m%0%i%_%s%0

1. %$%s%G%C%/%9

:Y@~2=$N%$%s%G%C%/%9$rI=7$K<($9. LdBj2r@O$r9TC?7k2L$r%$%s%G%C%/%9$K=q$-9~sG$$$k. $^$?, I=8$KN`;w;vNc$H$7$F8!:w$5$l$?%P%V%k%=!<%H$N%$%s%G%C%/%9$r<($9. %P%V%k%=!<%H$On 8D$N%G!<%?$r>:=g$K%=!<%H$9$k. NY$j9g$o$;$N%G!<%?$r=g$KHf3S, 8r49$9$k. $3$l$r7+$jJV$7JQ49$,5/$3$i$J$/$J$C$?$i=*N;$H$J$k. :Y@~2=$H%P%V%k%=!<%H$NAj0cE@$O%G!<%?9=B$, %?%9%/J,3d, =*N;>r7o, %"%k%4%j%:%`$G$"$k. %G!<%?9=

I=7: :Y@~2=$N%$%s%G%C%/%9

	1~MQ	2hA |=hM}	
	;EMM	%^%9%/%Q%?!<%s$rMQ$$$F, M?$($il?ItJ,KD$$$F%^%C%A%s%0$r9T$$, I}#1$NCf?4@~$r<h$j=P$9	
"$	%G!<%?9=B$	%=!<%9%G!<%?: @0?t7?Fs<!85G[Ns data 7k2L%G!<%? : data	
"$	%?%9%/J,3d	%=!<%9%G!<%?: data , 9T!&Ns%V%m%C%/ , %V%m%C%/ 7k2L%G!<%? : data , 9T!&Ns%V%m%C%/ , %V%m%C%/	
"$	=*N;>r7o	J7	
!{	%H%]%m%8	%Q%$%W	
"$	%"%k%4%j%:%`	%W%m%;%9%M%C%H%o!<%/ !FSFE!K	
!{	<B9T9=B$	top_thread	$Fix\{C, I^{p(lower\_thread)}\}$
		inter_thread	$Fix\{I^{p(upper\_thread)}, C, I^{p(lower\_thread)}\}$
		tail_thread	$Fix\{I^{p(upper\_thread)}, C\}$
!{	JBNs2=<jK!	%9%l%C%I%i%$%V%i%j	
!{	%$%s%?%i%/%7%g%s	%7%0%J%k!&%&%(%$%H	

I=8: %P%V%k%=!]%H$N%$%s%G%C%/%9

1~MQ	%=!<%F%#%s%0	
;EMM	%P%V%k(6I=j:G>.%G!]%?) $,>e$,CF$/$kNrBT$A, <+J,$N HO0OFb$G?7$?$J%P%V%k$r=gHV$K8!:w	
%G!<%?9=B$	%=!<%9%G!<%?: @0?t7?0l<!85G[Ns data 7k2L%G!<%? : data	
%?%9%/J,3d	%=!<%9%G!<%?: data , MWAG%V%m%C%/ , %V%m%C%/ 7k2L%G!<%? : data , MWAG%V%m%C%/ , %V%m%C%/	
=*N;>r7o	%=!<%9%G!<%?!a#0	
%H%]%m%8	%Q%$%W	
%"%k%4%j%:%`	%W%m%;%9%M%C%H%o!<%/ !LSFE!K	
<B9T9=B$	top_thread	$Fix\{C, I^{p(lower\_thread)}\}$
	inter_thread	$Fix\{I^{p(upper\_thread)}, C, I^{p(lower\_thread)}\}$
	tail_thread	$Fix\{I^{p(upper\_thread)}, C\}$
JBNs2=<jK!	%9%l%C%I%i%$%V%i%j	
%$%s%?%i%/%7%g%s	%7%0%J%k!&%&%(%$%H	

B$$H%?%9%/J,3d$NAj0c$G, 3NItJ,O+Jj=$@5$,I,MWG"$k. 7+$7, J,3dJ}K!$,F1$8%V%m%C%/$JNG, $"$kDxEY:FMxMQG-k@m&. %"%k%4%j%:%`$OF1$8%W%m%;%9%M%C%H%o!<%/$G$O$"$k$,, <B9T7ABV$,0[$J$k$N$G0lIt=$@5$,I,MW$G$"$k. $=$NB>$N9`L\$O0l=oJN$G, F14|$JIO:FMxMQG-k@m&. $^$?, I=Cf$N!{$O0lCW7?9`L\$G, "$$OIT0lCW$N9`L\$G$"$k.

2. ;vNc$N=$@5

%P%V%k%=!<%H$N%9%1%l%H%s$KFyIU$1!?=$@5r9k3HKhj, :Y@~2=$N%W%m%0%i%`$r:n@.$9$k. 0J2<$K$=$N%W%m%0%i%`$r0lIt>JN,7F5-:\$9$k. $^$?, :8C<$N5-9f$Khj, INh&K7$F:n@.$5l?$+$r<($9. $=$N5-9f$OI=9$KBP1~9k. $^$?, 6uGr9T$OC`<!%W%m%0%i%`$+iNMxMQG"$k. S $O%9%1%l%H%s$+iNMxMQG"$k.

I=9: ;vNc=$@5$N5-9f

	%9%1%C%I(T)	F14|(S)	%?%9%/J,3d(D)
:FMxMQ(S)	ST	SS	SD
=$@5(M)	MT	MS	MD
?75,(N)	NT	NS	ND

!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2

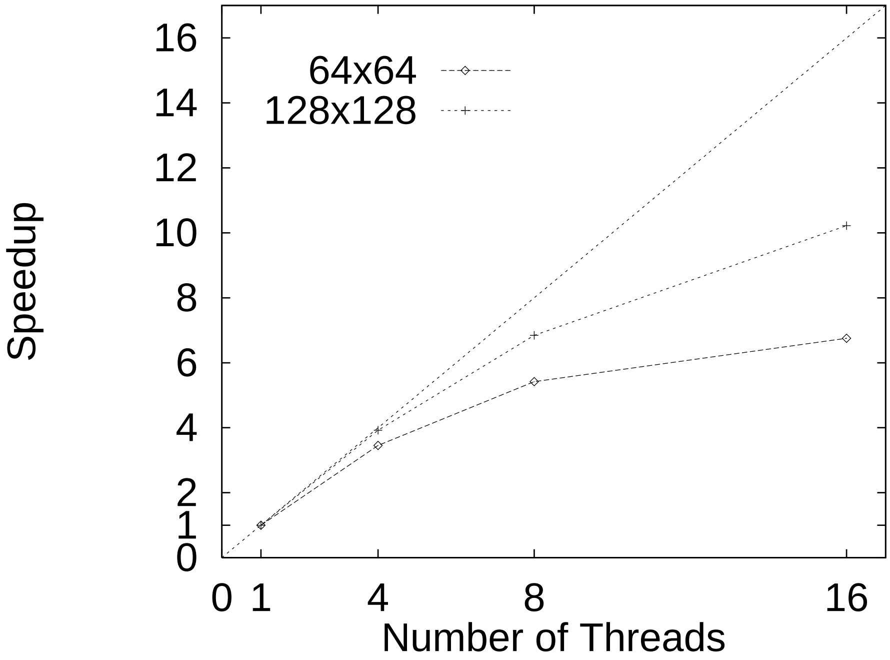
```
S !’ 3F<o include %U%!%$%k
     bitmp(){ %=!<%9%U%!%$%k$r<h$j9~$`!}   result(){ 7k2L$N=PNO!}
     maskset(){ %^%9%/%Q%?!<%s$N@_Dj!}  calculate(a,b,step){ C10L7W;;!}

S  !’top_thread(int no)
     {
MD !’  kazu = n/threads;  last = kazu;  last2 = kazu*(threads-no-1);
       for (rep = 1 ; rep < 10 ; rep++)
            for (step = 0 ; step < 4 ; step++){
NS !’            tail %9%1%C%I$HF14|$r<h$k
                 switch (step) {
                    case 0 : for (j = 0 ; j < n-2 ; j++){
MD !’                                for (i = 0 ; i <= last ; i++)
                                               C10L7W;;
SS !’                                top_lower1(no);
SS !’                                top_lower2(no);  }  break;
                    case 1 : for (i = 0 ; i < n-2 ; i++)  case 0 $KF1$8
                    case 2 : for (j = n-1 ; j > 1 ; j--)  case 0 $KF1$8
                    case 3 : for (i = n-1 ; i > 1 ; i--)  case 0 $KF1$8  }
```

```
S !' middle_thread(int no)
     {
MD !'  kazu = n/threads;  fast = kazu*no;  last = kazu*(no+1);
MD !'  fast2 = kazu*(threads-no);  last2 = kazu*(threads-no-1);
       for (rep = 1 ; rep < 10 ; rep++)
            for (step = 0 ; step < 4 ; step++)
                 switch (step) {
                    case 0 : for (j = 0 ; j < n-2 ; j++){
ND !'                                 i = fast;
SS !'                                 inter_upper1(no);
                                               C10L7W;;
SS !'                                 inter_upper2(no);
MD !'                                 for (i = fast+1 ; i <= last ; i++)
                                               C10L7W;;
SS !'                                 inter_lower1(no);
SS !'                                 inter_lower2(no);  }  break;
                    case 1 : for (i = 0 ; i < n-2 ; i++)  case 0 $KF1$8
                    case 2 : for (j = n-1 ; j > 1 ; j--)  case 0 $KF1$8
                    case 3 : for (i = n-1 ; i > 1 ; i--)  case 0 $KF1$8
     }

S !' tail_thread(int no)
     {
MD !'  kazu = n/threads;  fast = kazu*no;  last = n-2;
MD !'  fast2 = kazu*(threads-no);
       for (rep = 1 ; rep < 10 ; rep++)
            for (step = 0 ; step < 4 ; step++){
                 switch (step) {
                    case 0 : for (j = 0 ; j < n-2 ; j++){
ND !'                                 i = fast;
SS !'                                 tail_upper1(no);
                                               C10L7W;;
SS !'                                 tail_upper2(no);
MD !'                                 for (i = fast+1 ; i < last ; i++)
                                               C10L7W;;
SS !'                                 tail_lower(no);  }  break;
                    case 1 : for (i = 0 ; i < n-2 ; i++)  case 0 $KF1$8
                    case 2 : for (j = n-1 ; j > 1 ; j--)  case 0 $KF1$8
                    case 3 : for (i = n-1 ; i > 1 ; i--)  case 0 $KF1$8
NS !'            ok = 1;  }
     }
```

```
S !′ main()
     {
       bitmp();  maskset();
S !′   printf(‘‘input num of threads = ‘‘);  scanf(‘‘%d’’,&threads);
ST !′  allocate(threads);
S !′   as = all_seconds();  us = user_seconds();
MD !′  pthread_create(&pt,pthread_attr_default,top_thread,(void *)0);
MD !′  for (i = 1 ; i < (threads -1) ; i++)
MD!′           pthread_create(&pt,pthread_attr_default,inter_thread,(void *)i);
MD !′  tail_thread(i);
S !′   printf(‘‘CPU time = %f \n’’,user_seconds()-us);
S !′   printf(‘‘Elapsed time = %f \n’’,all_seconds()-as);
       result();
     }
```

3. <B9T7k2L

<B9T7k2L$r?^17$K<($9. %5%$%:H7$F#6#4x#6#4$H, #1#2#8x#1#2#8$G9T$C$?. #1#2#8x#1#2#8$G#1#6Bf$N;~, Ls#1#0G\$NB.EY8~>e$,F@$il?.

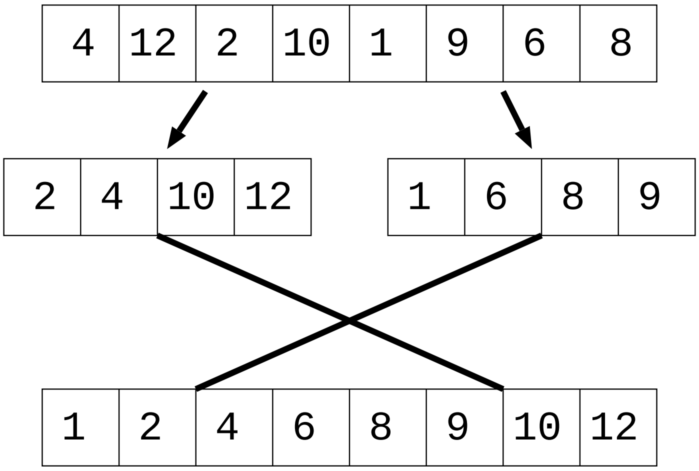


?^17: :Y@~2=$N<B9T7k2L

5.2 %^!<%8!?%9%W%j%C%H%=!<%H

5.2.1 LdBj$NDj5A$H2r@O

$^$:, M?$($il?%G!<%?$r#2$D$KJ,$1, A0=hM}H7$F, $=$l$>$l$r>:=g$K%=!<%H7F$*$/. $=$7$F, $=$N%G!<%?$r0l$D$:$D=gHV$K;}$CF-$F, Hf3S$r9T$&(?^18).



?^18: %^!<%8!?%9%W%j%C%H%=!<%H

5.2.2 %?%9%/J,3d$HJBNs2=

C1FH$K7W;;$G$-$k:G>.$N7W;;C10L !V10IMWAG!K$O%^!<%8$9$k%G!<%?#28DG"$k.

%=!<%9%G!<%? !%^!<%8$9$k%G!<%?#28D !data[i],data[i+1] !K

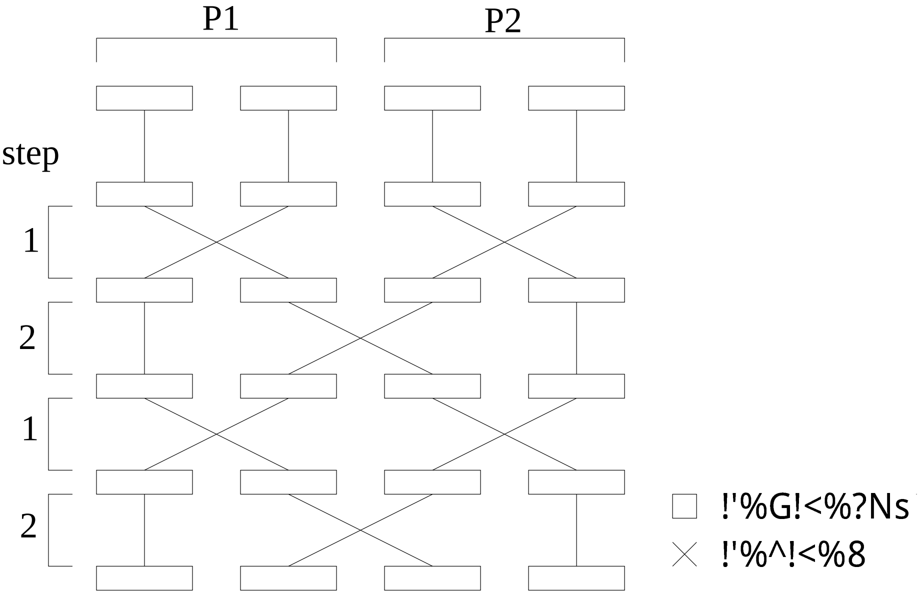
7k2L%G!<%? !%^!<%8$7$?%G!<%?#28D !data[i],data[i+1] !K

#PBf$N%W%m%;%C%5$, n (%G!<%??t)/ p $NItJ,Ns$r;}$D. A0=hM}$G, <+J,$NJ];}$9$kItJ,Ns $r#2$D$KJ,$1, $=$l$>$l, 6I=jE*$K%=!<%H$9$k. Bh#1$N%9%F%C%WO=lr$=$l$>$l%^!<%8$9$k. $=$7$F, Bh#2$N%9%F%C%W$O%^!<%8$9$kItJ,$r#1%V%m%C%/1&K:i7%^!<%8$9$k. 3N;~, #1HV1&$N%W%m%;%C%5$O2?b7$J$$. <!$OBh#1$N%9%F%C%W$N>l=j$r%^!<%8$9$k. 3liN%9%F%C%W$r8r8_$K7+jJV7, p 2s$N%9%F%C%W$N7+jJV7$N8e, =*N;$9$k !J?^19!K.

%^!<%8$9$k%G!<%?$r3F%W%m%;%C%5$K6QEy$K%V%m%C%/$KJ,1k. 3F%W%m%;%C%5$OM?$(il$?%V%m%C%/$N%G!<%?KD$$$F%^!<%8$9$k. J,3dBP>], J,3dC10L, J,3dJ}K!$O

!data , MWAG%V%m%C%/, %V%m%C%/!K

G"$k. $^$?, ?^19Nh$&$K, Bh#1%F%C%W$HBh#2%9%F%C%W$N7+jJV7<B9T7F$$$/NG, %"%k%4%j%:%`$O7+$jJV$7JQ49$,K>$^$7$$.



?^19: %^!<%8!?%9%W%j%C%H%=!<%H$N%?%9%/J,3d

5.2.3 ;vNc=$@5$KhkJBNs%W%m%0%i%_%s%0

1. %$%s%G%C%/%9

%^!<%8!?%9%W%j%C%H%=!<%H$N%$%s%G%C%/%9$rI=10$K<($9. $^$?, I=11$KN`;w;vNc$H$7 $F8!:w$5$l$?#D#K#AK!$N%$%s%G%C%/%9$r<($9. #D#K#AK!$O<B:,$r;}$D $n$ <!$NB?9`<0

$$f(x) = x^n + \alpha_1 x^{n-1} + \text{!D} + \alpha_{n-1} x + \alpha_n$$

$N n 8D$N2r$r5aakbNG"$k. 3NJ}K!$O n 8D$N2r $X_1, X_2, \text{!D}, X_n$ $rF1;~$K5a$a kbNG, %"%k%4%j%:%`$O X_i $N k HVL\$N6a;wCM$r $X_i^{(k)} (i = 1, 2, \text{!D}, n)$ H7,

$$X_i^{(k+1)} = X_i^{(k)} - \frac{f(X_i^{(k)})}{\displaystyle\prod_{j=1, j \neq i}^{n} (X_i^{(k)} - X_j^{(k)})}$$

Kh$jC`<!6a;wCM$r5aak. 3l$r, X_i^{k+1} $H X_i^k HN:9$,>.5/$Jk^$GB3$1$k. %^!<%8!?%9%W%j%C%H%=!<%H$H#D#K#AK!$NAj0cE@$O%G!<%?9=B$, %?%9%/J,3d, =*N;>r7o, <B9T9=B$$G$"$k. %G!<%?9=B$$O;w$F$$$k$,, %?%9%/J,3d$,A4$/0[$JkN$G, ?75,$G9M $($J1lPJiJ$$. $^$?, =*N;>r7o$O%9%1%1%H%s$O:FMxMQG-$J$$$,, C`<!%W%m%0 %i%`$+$i;}CF3l$k. <B9T9=B$$N0c$$$O3N=*N;>r7o$NH=Dj$NH3m@1JNG, A4BNE*$J9|3JItJ,$O$=$N$^$^:FMxMQG-kG$"$m$&.

I=10: %^!<%8!?%9%W%j%C%H%=!<%H$N%$%s%G%C%/%9

	1~MQ	%=!<%F%#%s%0
	;EMM	<+J,$NHO0OFb$N%G!<%?KD$$$F%^!<%8$9$k
"$	%G!<%?9=B$	%=!<%9%G!<%?: @0?t7?1<!85G[Ns data 7k2L%G!<%? : @0?t7?1<!85G[Ns data
"$	%?%9%/J,3d	%=!<%9%G!<%?: data , MWAG%V%m%C%/ , %V%m%C%/ 7k2L%G!<%? : data , MWAG%V%m%C%/ , %V%m%C%/
"$	=*N;>r7o	P !%W%m%;%C%5?t!K2s$N7+$jJV$7
!{	%H%]%m%8	40A4>H9g
!{	%"%k%4%j%:%`	7+jJV7JQ49
"$	<B9T9=B$	$Fix\{I^t_{Barrier(A/B)}\{C^t\}\}$
!{	JBNs2=<jK!	%Q%i%l%k%j!]%8%g%s
!{	%$%s%?%i%/%7%g%s	%P%j%d

I=11: #D#K#AK!$N%$%s%G%C%/%9

1~MQ	?tCM7W;;
;EMM	$X_i^{(k+1)} = X_i^{(k)} - \dfrac{f(X_i^{(k)})}{\prod\limits_{j=1, j \neq i}^{n} (X_i^{(k)} - X_j^{(k)})}$
%G!<%?9=B$	%=!<%9%G!<%?: <B?t7?1<!85G[Ns data 7k2L%G!<%? : <B?t7?1<!85G[Ns data
%?%9%/J,3d	%=!<%9%G!<%?: data , %3%T!] 7k2L%G!<%? : data , 1 MWAG , %5%$%/%j%C%/
=*N;>r7o	8m:9$(X_i^{(k+1)} - X_i^{(i)}) < 10^{-6}KtQJQ49%9%F%C%W?t$=5000$
%H%]%m%8	40A4>H9g
%"%k%4%j%:%`	7+jJV7JQ49
<B9T9=B$	$Cond\{I^t_{Barrier(A/B)}\{C^t\}, C^{p(master)}\}$
JBNs2=<jK!	%Q%i%l%k%j!]%8%g%s
%$%s%?%i%/%7%g%s	%P%j%d

2. ;vNc=$@5

#D#K#AK!$N%9%1%l%H%s$KFyIU$1!?=$@5r9k3HKhj,%^!<%8!?%9%W%j%C%H%=!<%H$N%W%m%0%i%`$r:n@.$9$k. 0J2<$K$=$N%W%m%0%i%`$r5-:\$9$k. 5-9f$OI=9$KBP1~$9$k.

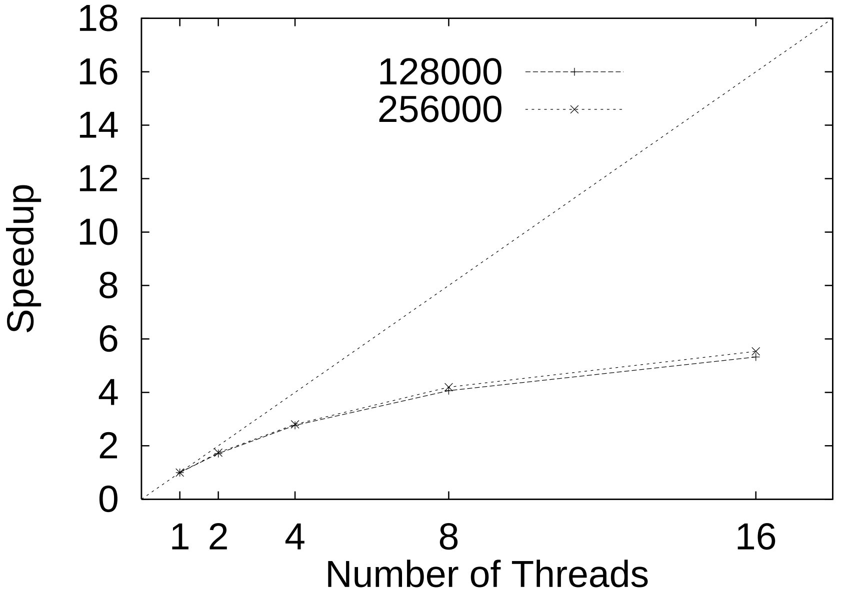
!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2

```
S:  #include <stdio.h>             #include <ksr/numarg.h>
S:  #include <ksr/ksr_timers.h>     #include <pthread.h>
    #include <stdlib.h>            #include <fcntl.h>

    dataget()    {%G!<%?$NF~NO$N4X?t}
    result()     {7k2L$N=PNO$N4X?t}
    calculate() {C10L7W;;$r9T$&4X?t}

    marge()
    {
ST:  thread_no = pr_mid();
ND:  kazu = n/threads;   fast = kazu*thread_no;   last = kazu/2;
     pt = &data[fast];   qsort(pt,last,sizeof(int),intcompare);
MD:  fast2 = fast + last;
     pt = &data[fast2];  qsort(pt,last,sizeof(int),intcompare);
MD:  fast3 = fast2 + last;

MD:  for (count = 0 ; count < threads ; count++){
SS:             pthread_barrier_checkin(&barrierA,thread_no);
                        calculate(fast,fast2,last,kazu);
SS:             pthread_barrier_checkout(&barrierA,thread_no);

SS:             pthread_barrier_checkin(&barrierB,thread_no);
ND:                     if (fast3 < n)
ND:                             calculate(fast2,fast3,last,kazu);
SS:             pthread_barrier_checkout(&barrierB,thread_no);
    }  }
S:  main()
    {
```

```
     dataget();
S:   printf(``input num of threads = ``);   scanf(``%d'',&threads);

SS:  pthread_barrier_init(&barrierA,pthread_barrierattr_default,threads);
SS:  pthread_barrier_init(&barrierB,pthread_barrierattr_default,threads);
ST:  team_id = pr_create_team(threads);
S:   as = all_seconds();   us = user_seconds();

SS:  pr_pcall(team_id,marge,copyargs());

S:   printf(``CPU time = %f \n'',user_seconds()-us);
S:   printf(``Elapsed time = %f \n'',all_seconds()-as);
     result();
    }
```

3. <B9T7k2L

%=!<%H%G!<%?$,#2#5#6#0#0#0$G,%W%m%;%C%5$,#1#6Bf$NH-,#5.#5G\$NB.EY8~>e$,F@$il?.

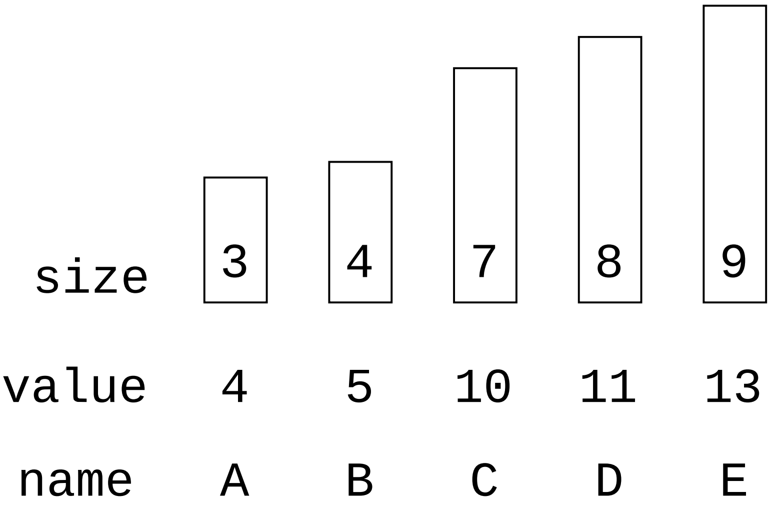


?^20: %^!<%8!?%9%W%j%C%H%=!<%H$N<B9T7k2L

5.3 %J%C%W%5%C%/LdBj

5.3.1 LdBj$ND j5A$H2r@O

Bg$-$5$b2ACM$b0[Jk#N<dN'$NIJJ*$rMFNL#M$N>.$5$J%J%C%W%5%C%/$KF~lkH-, :G$b2ACM$,9b$/$Jkh$&$JAH9g$;$r8+D1$k. 3Nh&$JLdBj$r%J%C%W%5%C%/LdBj !Knapsack problem!K$H$$$&. Nc$($P, ?^21Nh$&$K#5<dN'NBg-5H2ACM$N0c$&IJJ*$,$"$j, %J%C%W%5%C%/$NMFNL$,#1#7$G$"$kH9$k. $3$3$G, #A$r#58D !#J68D$OF~$i$J$$!KF~lF2ACM$r#2#0$H9k$+, #D$H#E$r#18D$:$DA*$s$G2ACM$r#2#4H9k+, $^$?, B>$NB??t$NAH9g$;$r;n$9$3H,G-$k. $=$NCf$G2ACM$N:G$b9b$$AH9g$;$rC5$9. %J%C%W%5%C%/LdBj$O%S%8%M%9>e$G, M"Aw2q<R$,2YJ*$r%H%i%C%/$dHt9T5!$K@Q$`$N$K:GE,$J@Q2Y$NAH9g$;$r5a$a$?$j, $5$i$K, @Q$_9~$`IJJ*$N?t$r@)8B9k$H$$$C$?LdBj$^$G9-$/;Hol$F$$$k.



?^21: %J%C%W%5%C%/LdBj

F0E*7W2hK!$rMQ$$$?%J%C%W%5%C%/LdBj$N2rK!$O, Bg$-$5#M0J2<$NA4$F$N%J%C%W%5%C%/$KF~$k:GE,$JIJJ*$NAH9g$;$r5a$a$k. cost[k] $,MFNL k $N%J%C%W%5%C%/$KF~$kIJJ*$N:GBgCM$rI=$7, best[k] $,$=$N:GBgCM$r<B8=9kAH9g$;$N:G8e$K2C$($?IJJ*$rI=$9. :G=i$K, M 0J2<$NA4$FNBg-5N%J%C%W%5%C%/KBP7$FIJJ* A $@$1$r5M$a$?;~$N2ACM$N:GBgCM$r7W;;$7, <!$K, A $H B HNAH9g$;$r9M$($F5Ma?;~$N7W;;$r9T$$, 0J2<F1MM$K?J$a$k. 3N;~, 7W;;ESCf$N3F;~E@K*1k:GE,2r$r cost[k] $KC_$(F*$/. ?^21$NNcKBP9$k7W;;$N2aDx$rI=12$K<($9. Bg$-$5#1#7$N%J%C%W%5%C%/$K5M$ail$kIJJ*$N2ACM$N:GBgCM$O#2#4G"$k. $=$7$F, :GE,$J%J%C%W%5%C%/$NCf?H$O<!Nh$&$KG[Ns best $+$i:F8=G-$k. $^$:, Dj5A$+$i best[M] NCfK$OF~$C$F$$$k. $=$7$F, $=$N;DjOBg$-$5 M - size[best[M]] $N%J%C%W%5%C%/$N:GE,$J

AH9g$;$HF1$8$G$"$k$+$i, best[M - size[best[M]]] NCfK$OF~$C$F$$$k. 0J2<F1MM$K9M$(lP NI$$. ?^21NNcG$O best[17] = C , best[10] = C , best[3] = A HJ$k.

I=12: %J%C%W%5%C%/LdBj$N2r

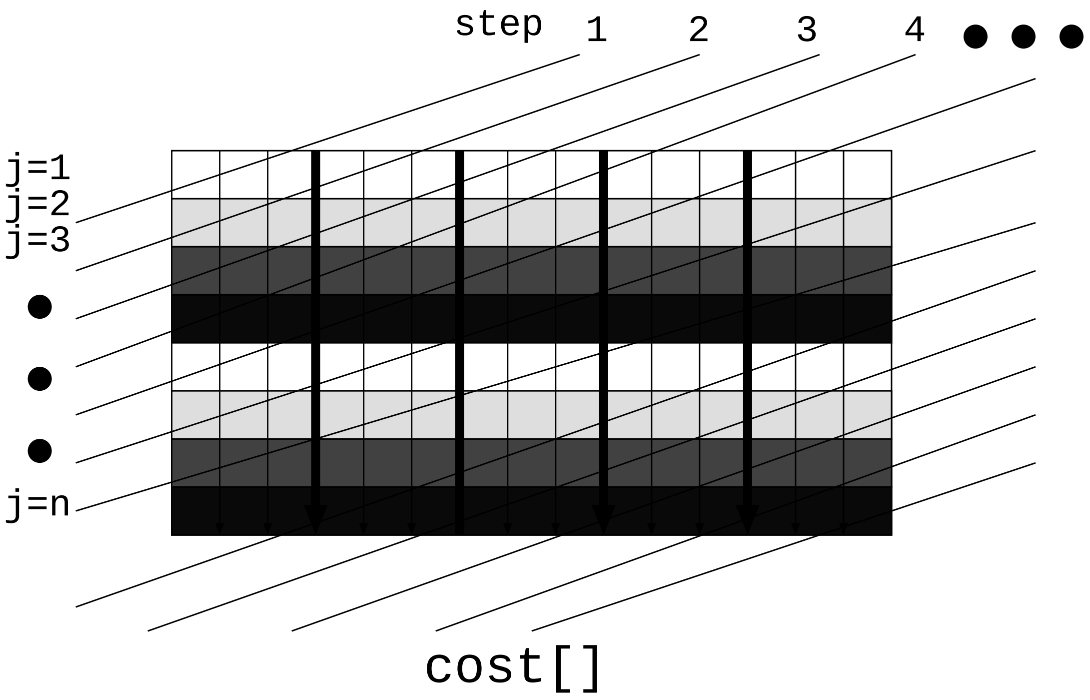
	k	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
j=1	cost[k]	0	0	4	4	4	8	8	8	12	12	12	16	16	16	20	20	20
	best[k]			A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
j=2	cost[k]	0	0	4	5	5	8	9	10	12	13	14	16	17	18	20	21	22
	best[k]			A	B	B	A	B	B	A	B	B	A	B	B	A	B	B
j=3	cost[k]	0	0	4	5	5	8	10	10	12	14	15	16	18	20	20	22	24
	best[k]			A	B	B	A	C	B	A	C	C	A	C	C	A	C	C
j=4	cost[k]	0	0	4	5	5	8	10	11	12	14	15	16	18	20	21	22	24
	best[k]			A	B	B	A	C	D	A	C	C	A	C	C	D	C	C
j=5	cost[k]	0	0	4	5	5	8	10	11	13	14	15	17	18	20	21	23	24
	best[k]			A	B	B	A	C	D	E	C	C	E	C	C	D	E	C

5.3.2 %?%9%/J,3d$HJBNs2=

Bg$-$5#M0J2<$NA4$F$N%J%C%W%5%C%/$KF~$k:GE,$JIJJ*$NAH9g$;$r5a$ako1@$,, Nc$($P, $j = 2$, $k = 5$ $r7W;;$9$k>l9g, $j = 1$, $k = 5$ $N cost[k] NCMHHf3S9kI,MW$,$"kN$G, $3$3$GF14|$r<hkI,MW,$"$k. D^$j, $j = a$, $k = b$ $N7W;;$r9T$&$H$-$O $j = a - 1$, $k = b$ $N cost[b] NCM,I,MWG"$j, 9G$K, $3$3$N7W;;$r=*N;7F$$$kI,MW$,$"$k. hC$F, JBNs%"%k%4%j%:%`$O%W%m%;%9%M%C%H%o!<%/$,;H$($k. $=$7$F, $j = 1$ $+$i $j = n$ $^$G$r3F%W%m%;%C%5$K%5%$%/%j%C%/$KM?$(, %&%(!<%V%U%m%s%H>u$K7W;;7F$$$/3HKJ$k. C1F|H$K7W;;G-$k:G>.$N7W;;C10L$O#1MWAG$G$"$k. 7+$7, $=$&9k$H, 7W;;;~4V$h$jDL?.;~4V$N$[$&$,$+$+$CF7$^$$, B.EY8~>e$,F@$ilJ$$. $=$3$G, %J%C%W%5%C%/$NMFNL$K9g$o$;$FJ#?t$NMWAG$r0l2tH_$F, =hM}$r9T$&$h$&$K9k. J,3dBP>], J,3dC10L, J,3dJ}K!$O

!cost[ ], J#?tMWAG, %5%$%/%j%C%/!K

G"$k. $=$7$F, 7W;;$O?^22Nh$&$K9T$&.



?^22: %J%C%W%5%C%/LdBj$N%?%9%/J,3d

5.3.3 ;vNc=$@5$KhkJBNs%W%m%0%i%_%s%0

1. %$%s%G%C%/%9

   %J%C%W%5%C%/LdBj$N%$%s%G%C%/%9$rI=13$K<($9. $^$?, I=14$KN`;w;vNc$H7F8!:w$5 1?#L#UJ,2rK!$N%$%s%G%C%/%9$rI=14<($9. #L#UJ,2rK!$O@5J}9TNs A $r $A = LU$ $N h&$K, 2<;03Q7A9TNs$H, >e;03Q7A$N@Q$N7A$KJ,2r$9k3HG$"$k. @5J}9TNs$r#L, #U $KJ,2r$9$k;~, (i , j) @.J,$O

$$U_{ij} = (A_{ij} - \sum_{k=1}^{i-1} l_{ik} U_{ki}) / l_{ii} \qquad (i < j)$$

$$L_{ij} = A_{ij} - \sum_{k=1}^{j-1} l_{ik} U_{ki} \qquad (i >= j)$$

   $H$$$&7W;;$G, #L, #U$NCM$,$G$k. %J%C%W%5%C%/LdBj$H#L#UJ,2rK!$NAj0cE@$O%G!<%?9=B$, %?%9%/J,3d, =*N;>r7o$G$"$k. %G!<%?9=B$$H=*N;>r7o$O0[$JkN$G, C`<!%W%m%0%i %`$+$i;}$CF/k+, ?75,$G9M$($k. %?%9%/J,3d$O7k2L%G!<%?$NJ,3dC10L$@1,0[$J $j, J,3dJ}K!$JIOF1$8$JNG, $"$kDxEY%9%1%l%H%s$rMxMQ$G$-$k$@$m$&. $=$NB>$N 9`L\$O0lCW7F$$$kNG, A4BNE*$J9=B$$O$=$N$^$^;H$($k$H;W$&.

I=13: %J%C%W%5%C%/LdBj$N%$%s%G%C%/%9

	1~MQ	F0E*7W2hK!
	;EMM	#N<dN`$NIJJ*$rMFNL#M$N%J%C%W%5%C%/$K, :G$b2ACM$,9b $/$Jkh$&$KF~lk
"$	%G!<%?9=B$	%=!<%9%G!<%?: @0?t7?0l<!85G[Ns value 7k2L%G!<%? : @0?t7?0l<!85G[Ns best
"$	%?%9%/J,3d	%=!<%9%G!<%?: value , J7 , %3%T!< 7k2L%G!<%? : best , J#?tMWAG , %5%$%/%j%C%/
"$	=*N;>r7o	J7
!{	%H%]%m%8	%Q%$%W
!{	%"%k%4%j%:%`	%W%m%;%9%M%C%H%o!<%/ !ESFE!K
!{	<B9T9=B$	top_thread $Fix\{C, I^{p(lower\_thread)}\}$ inter_thread $Fix\{I^{p(upper\_thread)}, C, I^{p(lower\_thread)}\}$ tail_thread $Fix\{I^{p(upper\_thread)}, C\}$
!{	JBNs2=<jK!	%9%l%C%I%i%$%V%i%j
!{	%$%s%?%i%/%7%g%s	%7%0%J%k !&&% (%$%H

I=14: #L#UJ,2rK!$N%$%s%G%C%/%9

1~MQ	?tCM7W;;
;EMM	$U_{ij} = (A_{ij} - \sum_{k=1}^{i-1} l_{ik} U_{ki}) / l_{ii} \quad (i < j)$ $H $L_{ij} = A_{ij} - \sum_{k=1}^{j-1} l_{ik} U_{ki} \quad (i >= j)$ $r;H$$!$ @5J}9TNs$rL $HU $KJ,2r$9$k
%G!<%?9=B$	%=!<%9%G!<%?: @0?t7?Fs<!85G[Ns data 7k2L%G!<%? : @0?t7?Fs<!85G[Ns data
%?%9%/J,3d	%=!<%9%G!<%?: data , J7 , %3%T!< 7k2L%G!<%? : data , 0lNs , %5%$%/%j%C%/
=*N;>r7o	%9%F%C%W $= 2n - 1$
%H%]%m%8	%Q%$%W
%"%k%4%j%:%`	%W%m%;%9%M%C%H%o!<%/ !ESFE!K
<B9T9=B$	top_thread $Fix\{C, I^{p(lower\_thread)}\}$ inter_thread $Fix\{I^{p(upper\_thread)}, C, I^{p(lower\_thread)}\}$ tail_thread $Fix\{I^{p(upper\_thread)}, C\}$
JBNs2=<jK!	%9%l%C%I%i%$%V%i%j
%$%s%?%i%/%7%g%s	%7%0%J%k !&&% (%$%H

2. ;vNc=$@5

#L#UJ,2rK!$N%9%1%l%H%s$KFyIU$1!?=$@5$9$k3HKh$j, %J%C%W%5%C%/LdBj$N%W%m%0%i%`$r:n@.$9$k. 0J2<$K$=$N%W%m%0%i%`$r5-:\$9$k. 5-9f$OI=9 $KBP1~$9$k.

!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2!2

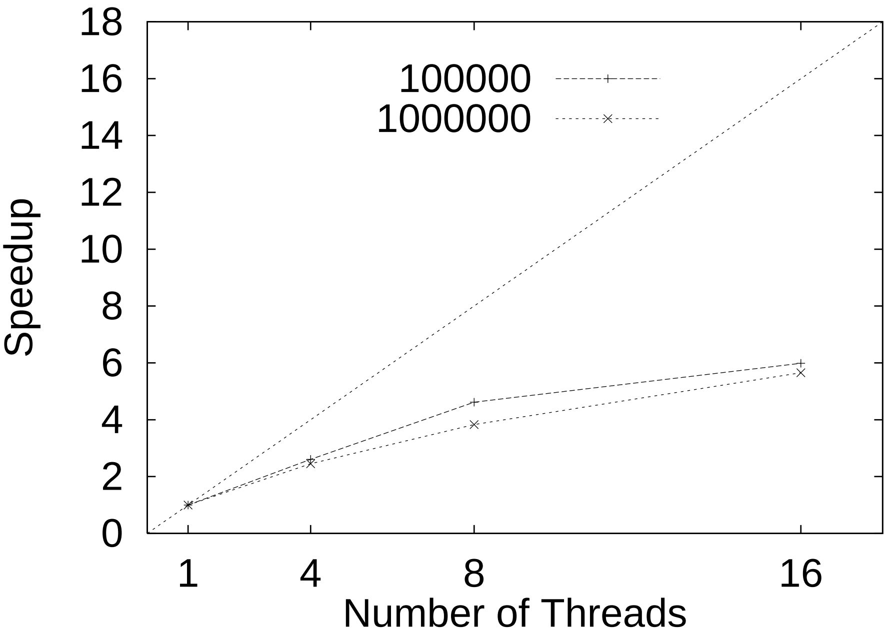
```
S:   3F<o include %U%!%$%k
     work(i,j){ 2ACM$rHf3S$9$k }

S:   top_thread(int no)
     {
MD:   i = 1;  j = no+1;
M:    while (i > 0){
SD:           a = i;  b = j;
ND:           while ( (a>0) && (b<=n) ){
ND:                   for (k = 0 ; k < divi ; k++){
                               if (a <= M)  work(a, b);
ND:                            a += 1;  }
MD:                   a -= (divi*(threads+1));
SD:                   b += threads;  }
SS:           top_lower1(no);
ND:                   i += divi;
SS:           top_lower2(no);
     }  }

S:   middle_thread(int no )
     {
MD:   i = 1;  j = no+1;
M:    while (i > 0){
SS:           inter_upper1(no);
SS:           inter_upper2(no);
SD:           a = i;  b = j;
ND:           while ( (a>0) && (b<=n) ){
ND:                   for (k = 0 ; k < divi ; k++){
                               if (a <= M)  work(a, b);
```

```
ND:                         a += 1;  }
MD:                a -= (divi*(threads+1));
SD:                b += threads;  }
SS:         inter_lower1(no);
ND:                  i += divi;
SS:         inter_lower2(no);
    }  }

S:  tail_thread(int no)
    {
MD:  i = 1;  j = no+1;
M:   while (best[M] == 0){
SS:         tail_upper1(no);
SS:         tail_upper2(no);
SD:         a = i;  b = j;
ND:         while ( (a>0) && (b<=n) ){
ND:                for (k = 0 ; k < divi ; k++){
                            if (a <= M)  work(a, b);
ND:                         a += 1;  }
MD:                a -= (divi*(threads+1));
SD:                b += threads;  }
ND:         i += divi;
SS:         tail_lower(no);
    }  }

S:  main()
    {
     fp = fopen(``data'',''r'');
     for (i = 1 ; !feof(fp) ; i++){
          fscanf(fp,''%c\n'',&name[i]);  fscanf(fp,''%d\n'',&value[i]);
          fscanf(fp,''%d\n'',&size[i]);  };
     name[i] = '\0';  value[i] = '\0';  size[i] = '\0';  fclose(fp);
S:   printf(``input num of threads = ``);  scanf(``%d'',&threads);
     printf(``%J%C%W%5%C%/$NMFNL$rF~NO$7$F$/$@$5$$. ``);  scanf(``%d'',&M);
```

```
          for (i = 1 ; i <= M ; i++)  cost[i] = 0;    best[M] = 0;
     S:   as = all_seconds();   us = user_seconds();
     ST:  allocate(threads);
     ST:  pthread_create(&pt,pthread_attr_default, top_thread, (void *)0 );
     ST:  for (i = 1 ; i < (threads - 1) ; i++)
     ST:     pthread_create(&pt,pthread_attr_default, inter_thread, (void *)i );
     ST:  tail_thread(i);
     S:   printf(``CPU time = %f \n'',user_seconds()-us);
     S:   printf(``Elapsed time = %f \n'',all_seconds()-as);
          printf(``:GBgCM$O %d \n'',cost[M]);
         }
```

3. <B9T7k2L

%J%C%W%5%C%/$NMFNL$,#1#0K|$N;~, %W%m%;%C%5$,#1#6Bf$GLs#6G\$NB.EY8~>e$,F@$il?.



?^23: %J%C%W%5%C%/LdBj$N<B9T7k2L

5.4 I>2A$H9M;!

;vNc$N:FMxMQEY$r, :Y@~2=, %^!<%8!?%9%W%j%C%H%=!<%H, %J%C%W%5%C%/LdBjKD$$$F=RYk. 3FI=$O%W%m%0%i%`$r%9%l%C%I, F14|, %?%9%/J,3d, C10L7W;;, $=$NB>$KJ,$1$F9T$&. I=$N?t;z$NC10L$O9T$G$"$k. $^$?, C10L7W;;$OC`<!%W%m%0%i%`$+$i:NMQ7?bN$r:FMxMQ$H9k. I=KO$J$$$,, $=$NB>$K include %U%!%$%k$d;~4V7WB,, 3F<oCM$NF~NOJI$NL?Na$b:FMxMQ7F$$$k.

5.4.1 :Y@~2=

%P%V%k%=!<%H$N%9%l%l%H%s$KFyIU$1!?=$@5r9k3HKhj, :Y@~2=$N%W%m%0%i%`$r:n@.7?. I=15O=$N:FMxMQEY$r<($9. $^$:, %9%l%C%I$O=$@5$,I,MW$G$"$C$?. $=$l$O%P%V%k%=!<%H$N<B9T9=B$$, LSFE $G, :Y@~2=$N<B9T9=B$$, FSFE $H0[$Jk+iG$"$k. $=$N$?$a, %^%9%?!<$,=hM}$9kO$:$@C? tail %9%l%C%I$H top %9%l%C%I$rH?BP$K3d$jEvFJ1lPJiJ$$. F14|O[Hs$I:FMxMQ$G$-$?. 3l$O%"%k%4%j%:%`$,F1$8%W%m%;%9%M%C%H%o!<%/$G$"$k$?$aG"$k. $^$?, ?75,$NF14|$,#5DI,MWJNO, :Y@~2=$O?^7A$r#4DNJ}8~$+$i=gHV$K:o$C$F$$$/$?$a, $"$kJ}8~$+$i$N=hM}$,A4It=*N;9kNrBT$?$J1lPJi:, top %9%l%C%I$H tail %9%l%C%I$N4V$GF14|$r<hk+iG$"$k. %?%9%/J,3d$O, 3F%W%m%;%C%5$,INItJ,rdkN$+, $^$?, %G!<%?$N?6$jJ,1NH3mO=$@5$d?75,$G%f!<%6$,:n@.$7, %9%l%l%H%s$O:FMxMQG-J+C?. C10L7W;;$OA4$FC`<!%W%m%0%i%`$+$i:FMxMQ7?.

A4BNH7FO, F14|JIO[Hs$I:FMxMQ$G$-$F, %W%m%0%i%`$N9|3JItJ,$O$9$0$K40@.$7$?. 7+$7, %?%9%/ItJ,$OA4$/:FMxMQG-$:, %f!<%6$,A4$F9M$($J1lPJiJ$$$N$G, $+$J$j6lO+$7$?.

I=15: ;vNc$N:FMxMQEY$NI>2A !JY@~2=!K

	%9%l%l%H%s			C`<!%W%m%0%i%`
	%9%l%C%I(T)	F14|(S)	%?%9%/J,3d(D)	
:FMxMQ(S)	7	36	0	222
=$@5(M)	4	0	24	0
?75,(N)	0	5	8	0

5.4.2 %^!<%8!?%9%W%j%C%H%=!<%H

#D#K#AK!$N%9%l%l%H%s$KFyIU$1!?=$@5r9k3HKhj, %^!<%8!?%9%W%j%C%H%=!<%H$N%W%m%0%i%`$r:n@.$7$?. I=16$O$=$N:FMxMQEY$r<($9. %9%l%C%I$HF14|$O%"%k%4%j%:%`$,F1

$87+$jJV$7JQ4 9$G$"$k3H$+$i%9%1%l%H%sr=N^$^:FMxMQ$G$-$?. %$%s%G%C%/%9$N<B9T9=B$$,0[JkH3mO#D#K#AK!$,0l$D$N7W;;$,=*N;7?8e, =*N;>r7o$NH=Dj$r9kNKBP$7, %^!<%8!?%9%W%j%C%H%=!<%H$O8GDj2s$N7+jJV7Kh$k7W;;$G$"$k$?$a, =*N;>r7o$NH=Dj$r7J$$$+iG$"$k. A4BNE*$J9=B$$KO"$^$j1F6AOJ$$. %?%9%/J,3d$OA4$/:FMxMQG-J+C?. %^!<%8!?%9%W%j%C%H%=!<%H$O7W;;ItJ,$,%9%F%C%W#1$H%9%F%C%W#2$KJ,$+$l$F$$$F, 3N#2DN7+jJV7KhCF:G=*E*$J2r$rF@$k. $=$7$F, 3N%9%F%C%W#1$H%9%F%C%W#2GO7W;;9k>l=j$,0[Jk$?$a, FC<l$J%?%9%/J,3d$r9T$&. $=$N$?$a$K, =$@5$d?75,$G9M$($kI,MW$,$"C?. C10L7W;;$OA4$FC`<!%W%m%0%i%`$r:FMxMQ$7$?.

A4BNH7FO, %9%l%C%I$dF14|$JIOA4$F:FMxMQ$G$-$F, %W%m%0%i%`$N9|3JItJ,$O$9$0$K40@.$7$?. 7+$7, %?%9%/J,3d$O%9%1%l%H%s$b;H$($:, $^$?, %9%F%C%W#1$H%9%F%C%W#2$G7W;;ItJ,$,0[$Jk?$a, $=$NItJ,$N3d$jEv$FJ}$,$+$J$j6lO+$7$?.

I=16: ;vNc$N:FMxMQEY$NI>2A !J%^!<%8!?%9%W%j%C%H%=!<%H!K

	%9%1%l%H%s			C`<!%W%m%0%i%`
	%9%l%C%I(T)	F14|(S)	%?%9%/J,3d(D)	
:FMxMQ(S)	9	7	0	57
=$@5(M)	0	0	3	0
?75,(N)	0	0	5	0

5.4.3 %J%C%W%5%C%/LdBj

#L#UJ,2rK!$N%9%1%l%H%s$KFyIU$1!?=$@5r9k3HKhj, %J%C%W%5%C%/LdBj$N%W%m%0%i%`$r:n@.$7$?. I=17$O$=$N:FMxMQEY$r<($9. $^$:, %9%l%C%I$HF14|$O%"%k%4%j%:%`$,F1$8%W%m%;%9%M%C%H%o!<%/!JFSFE!KG"k3H+$i, %9%1%l%H%s$r$=$N$^$^:FMxMQG-$?. %?%9%/J,3d$O0lIt:FMxMQG-$?. 3l$O%$%s%G%C%/%9$N%?%9%/J,3d$NH3mGJ,3dC10L$O0[$JCF$$$k$,, J,3dJ}K!$,0lCW7F$$$k$?$aG"$k. %9%l%C%I?t$K9go;$F, %5%$%/%j%C%/$K7W;;$7$F$$$/H3mr$=$N$^$^:FMxMQ7?. =$@5$d?75,NH3m$O, J,3dC10L$,#L#UJ,2rK!$O#1Ns$G, %J%C%W%5%C%/LdBj$,J#?tMWAG$G0[JC$F$$$k$?$aG"$k. J#?tMWAG$r7W;;9k$?$a$K, C10L7W;;$r while J8$d for J8$G$/$/C?$j, JQ?t$r$=$l$K9g$o$;$kh&K7$?$j9kH3mr?75,$G:n@.$7$?$j=$@5$7$?. C10L7W;;$OA4$FC`<!%W%m%0%i%`$r:FMxMQ7?.

A4BNH7FO, %9%l%C%I$dF14|$JIOA4$F:FMxMQ$G$-, %W%m%0%i%`$N9|3JItJ,O9$0$K40@.7?. %?%9%/J,3d$O%5%$%/%j%C%/$K7W;;$r9kH3mO%9%1%l%H%s$r:FMxMQ$G$-, 3Z$K:n@.9k3H$,$G$-$?. 7+$7, J#?tMWAG$r7W;;5;k?aK, ?75,$G9M$($?$H3m$d=$@5$7

$?$H3m$O<+J,$G9M$($J1lPJi:, >/$76lO+$7$?.

I=17: ;vNc$N:FMxMQEY$NI>2A !%J%C%W%5%C%/LdBj!K

	%9%1%l%H%s			C`<!%W%m%0%i%`
	%9%1%C%I(T)	F14|(S)	%?%9%/J,3d(D)	
:FMxMQ(S)	11	9	9	32
=$@5(M)	0	0	9	0
?75,(N)	0	0	12	0

5.4.4 %"%k%4%j%:%`Kh$N:FMxMQEY$NI>2A

#4DN%"%k%4%j%:%`Kh$KBeI=E*$J;vNc$N:FMxMQEY$NI>2A$rI=18 $K<($9. J,3dE}<#K!$O=d2s%;!<%k%9%^%sLdBj, %W%m%;%C%5%U%!!<%`$O#3<!%9%W%i%$%s, %W%m%;%9%M%C%H%o!<%/$O%J%C%W%5%C%/LdBj, 7+$jJV$7JQ4 9$O%^!<%8!?%9%W%j%C%H%=!<%HG"$k.

I=18: %"%k%4%j%:%`Kh$N;vNc$N:FMxMQEY$NI>2A

		%9%1%l%H%s			C`<!%W%m%0%i%`
		%9%1%C%I(T)	F14|(S)	%?%9%/J,3d(D)	
=d	:FMxMQ(S)	28	8	0	75
	=$@5(M)	0	0	0	15
2s	?75,(N)	0	7	8	7
#3	:FMxMQ(S)	8	1	0	107
	=$@5(M)	0	0	11	3
<!	?75,(N)	0	0	12	0
%J	:FMxMQ(S)	11	9	9	32
%C	=$@5(M)	0	0	9	0
%W	?75,(N)	0	0	12	0
%^	:FMxMQ(S)	9	7	0	57
!<	=$@5(M)	0	0	3	0
%8	?75,(N)	0	0	5	0

3F%"%k%4%j%:%`$H$b, %9%1%C%I$OA4$F:FMxMQ$G$-$F$$$k. %9%1%C%I@8@.$O%"%k%4%j%:%`Kh

$KBgBN7h$^CF$$$kNG, 3N7k2LKJ$k. F14|$O=d2s%;!<%k%9%^%sLdBj0J30$OA4$F:FMxMQG-$F$$$k. 3l$b%"%k%4%j%:%`Kh$KBgBN7h$^$C$F$$$k. =d2s%;!<%k%9%^%sLdBj$,?75,$rI,MW$H$7$?$N$O6&M-JQ?t$X$NFI$_=P$7!?=q$-9~$_$N$?$a$G$"$k. %?%9%/J,3d$O3F%"%k%4%j%:%`$H$b, $[$HsI=$@5$d?75,G"C?. %J%C%W%5%C%/LdBj$O%9%1%1%H%s$N%$%s%G%C%/%9$N%?%9%/J,3d$N9`L\$,N`;w$7$F$$$?$?$a, 0lIt:FMxMQG-$?$H3mb"$k. A4BN$H7F, =d2s%;!<%k%9%^%sLdBj$,0lHV=$@5$9$kI,MW$,$"C?. 3l$OJ,3dE}<#K!$,#4DN%"%k%4%j%:%`NCfG, 0lHVJ#;($J9=B$$r;}D?aG$"$k.

5.5 %?%9%/J,3d$NItIJ2=

;vNc=$@5$KhkJBNs%W%m%0%i%_%s%0$O, %9%1%C%I$dF14|JI$NItJ,$O:FMxMQEY$,9b$/, JBNs%W%m%0%i%_%s%0$NIiC4$r7Z8:9kNK, :GbLrKN)CF$$$k. 7+$7, %?%9%/J,3d$O$[$HsI:FMxMQG-$F$$$J$$. 3l$O%$%s%G%C%/%9$N%?%9%/J,3d$NH3m,, 0lCW7J$$$3H,RHD"$k. $^$?, %?%9%/J,3d$O, L\E*$N%W%m%0%i%`K+Jj0MB8$7$F$$$F, ;vNc$r:FMxMQ$9kN$,Fq$7$$. $=$3$G, %?%9%/J,3d$NL?Na$r, $"$i$+$8$a, ItIJ$H7FMQ0U7F$*$-, %f!<%6$,%9%1%1%H%s$KFyIU$1!&=$@5$9$k:]$K, $=$l$rMQ$$$k3HKhCF, %?%9%/J,3dItJ,$N%W%m%0%i%_%s%0$r%5%]!<%H9kh&K9$k. Nc$($P, $"$k%G!<%?$r%V%m%C%/$KJ,3d9k;~$O,

$block = N/threads;$ (N : A4%G!<%??t, $threads$: %9%1%C%I?t)

Nh$&$K, $block$ $KA4%G!<%??t$r%9%1%C%I?t$G3d$C$?CM$rF~lkL?NaKhCF, 3F%W%m%;%C%5$K $block$ $:$D%G!<%?rEO9$3$HKJ$k. $^$?,

$start = block * threads\_no;$ ($threads\_no$: %9%1%C%IHV9f)

$NL?Na$Khj, $start$ KO3F%W%m%;%C%5$,7W;;$9$k@hF,$NHVCO$,3JG<$5lk. $^$?, $"$k%G!<%?$r%5%$%j%C%/$KJ,3d$9$k;~,

$i \ = threads\_no;$ ($threads$: %9%1%C%IHV9f)

$i \ += threads;$ ($threads$: %9%1%C%I?t)

$NL?Na$r3F%W%m%;%C%5$G9T$($P, %5%$%j%C%/$K i NCMrM?$($k3H$,G-$k. 3Nh&$K, $"$i$+$8$aM=A[$G$-$kL?Na$rJ,3dC10L$dJ,3dJ}K!KhCF, 9M$($ilkbN$rA4$FMQ0U7F$*$-, %f!<%6$,$=lrMxMQ9k3H$,$G$-$kh&K7$?$i, %?%9%/J,3d$N%W%m%0%i%_%s%0$NIiC4$r7Z8:$G$-$k.

6 $*$ojK

;vNc%Y!<%9JBNs%W%m%0%i%_%s%0%7%9%F%`$N9=C[$r9T$C$?. $^$?, ;vNc=$@5$K$h$kJBNs%W%m%0%i%_%s%0$H$7$F, :Y@~2=, %^!<%8!?%9%W%j%C%H%=!<%H, %J%C%W%5%C%/LdBj$K$D$$$F, <B:]$K, N`;w7?;vNc$N%9%1%1%H%s$rbH$K%W%m%0%i%_%s%0$r9T$$, $=$N:FMxMQEY$NI>2A$r9TC?. 3N%7%9%F%`$N9=C[$G$O, $^$:, ;vNc%Y!<%9$N:n@.$r9T$$, :#$^$G:n@.$7$?;vNc$r%7%9%F%`$G;H$(kh$&$J7A$KD>$7$?. $=$7$F, %7%9%F%`9=@.$r9M$($?. %$%s%G%C%/%9$N:n@.J}K!$O%f!<%6$,F~NO$7$d$9$$$h$&$K, $^$?, ;vNc8!:wK!$O%9%1%1%H%s$K1F6A$,$J$$$9`L\$+$i:o=|$9k3HKhj, :FMxMQEY$r9b$akh$&$K9)IW7?. ;vNc=$@5$KhkJBNs%W%m%0%i%_%s%0GO%W%m%0%i%`$r%9%1%C%I, F14|, %?%9%/J,3d, C10L7W;;, $=$NB>$KJ,$1$F, $=$1$>$1$N:FMxMQEY$r9TC10L$G?t$($?. %9%1%C%I, F14|$O:FMxMQEY$,9b$$. $3$1$O%$%s%G%C%/%9$N9`L\$N%"%k%4%j%:%`$d<B9T9=B$$,0lCW$7$?$+$i$G$"$k. %"%k%4%j%:%`$d<B9T9=B$$O9M$($i1k9=B$$rA4$FMQ0U$7$F$$$kNG, I,$:0lCW$9kh$&$KJC$F$$$k. %9%1%C%I, F14|$OJBNs%W%m%0%i%`$N9|3J$G$"$j, 0lHV=EMW$JItJ,$G$"$k. $3$NItJ,$N:FMxMQEY$r9b$a$k$3$H$OJBNs%W%m%0%i%_%s%0$NIiC4$r7Z8:$9$k$N$K:G$bLr$KN)$D. %?%9%/J,3d$O$[$H$s$I:FMxMQ$G$-$F$$$J$$. $3$1$O%$%s%G%C%/%9$N%?%9%/J,3d$N$H$3$m$,0lCW$7$J$$$3$H$,$R$H$D$"$k. $^$?, %?%9%/J,3d$OL\E*$N%W%m%0%i%`$K$+$J$j0MB8$7$F$$$F, ;vNc$r:FMxMQ$9kN$,F|$7$$. C10L7W;;$OC`<!%W%m%0%i%`$+$i, $=$N$^$^MxMQG-$k. B>$K$O include %U%!%$%k$d;~4V7WB,, 3F<oCM$NF~NOJI$NL?Na$G, $[$HsI%9%1%1%H%s$r:FMxMQ$G$-$?.

:#8e$N2]Bj$H7F$O, %?%9%/J,3d$N%5%]!<%HrINh$&$K9k$+$G$"$k. 0lDO;vNc$rA}$d$9$3HG$"$k. %$%s%G%C%/%9$N%"%k%4%j%:%`$d<B9T9=B$$N9`L\$+$i%?%9%/J,3d$N9`L\$^$GA4$F$N9`L\$,0lCW9kh&$K, MM!9$J9=B$$r;}C?;vNc$rC_$(k3HKhC$F, %9%1%1%H%s$N:FMxMQEYrh$j9b$ak3H,G-k@m&. b&0lDO%?%9%/ItJ,$NL?Na$rItIJH7$F$$$/D+MQ0U7F$*$-, I,MWJbNr%f!<%6$,MxMQ$9k3HG$"$k. %$%s%G%C%/%9$N%"%k%4%j%:%`$d<B9T9=B$$N9`L\$O%^%C%A9k;vNc$,I,$:8+D+kN$G, JBNs%W%m%0%i%`$N9|3J$O;H$($k. $"$H$O%?%9%/J,3d$G$"$k. $=$Nh&JH$-, $"$i$+$8$a, $$$m$$$m$JJ,3dJ}K!$K1~8?L?Na$rMQ0U$7F*1P, %f!<%6O=lrMxMQ9k$@$1$G%?%9%/J,3dItJ,$b%W%m%0%i%_%s%0G-k@m&.

<U<-

K\8&5f$N5!2q$rM?$($F2<5j,F|:",5.=E$J8f;XF3$rD:$-$^7?;3:j>!9065<x$K?4$h$j?<$/46<U$N0U$rI=7^$9.$^$?,K\8&5f$K$"$?$j,;vNc=$@5Kh$kJBNs%W%m%0%i%_%s%0$K7HoC$FD:$$$?JFED7rFs;a,FA;3H~9a;a,JBSKF|:"hj5.=E$J8f0U8+$rD:$-$^7?K\8&5f<<$N3'MM$K?4hj46<UCW7^$9!%

$=$7$F,KSR-#1$r;HMQ5;$FD:$$$F$$$k%-%c%N%s!&9!<%Q!<%3%s%T%e!<%F%#%s%0S.I.3t<02q<R$K46<UCW$7$^$9.

;29MJ88%

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