

## EE6313 – PROJECT 2

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```

#include <stdio.h>

#include "nr.h"

#include "nrutil.h"

#include <stdint.h>


//Max rows and columns of the matrix

#define MAX_ROWS 128

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//FILE *combinations;

double m[MAX_ROWS*MAX_ROWS]; //m is a pointer to a pointer


extern void init(uint8_t iwriteStrategy,uint8_t inWay,uint8_t ibl);
extern void sendReport(void);
extern void printReport(void);
extern void clearCounters(void);
extern void cFlush(void);


int main(void)
{
    uint8_t writestrategy,nWay,bl;
    for (writestrategy = 1; writestrategy <= 3; writestrategy++) {
        for (nWay = 1; nWay <= 16; nWay *= 2) {
            for (bl = 1; bl <= 8; bl *= 2) {

                init(writestrategy, nWay, bl);

                int i, j, nrot;


                int n = 128;

                /*

```

We need a Numerical Recipes-style "matrix" to use  
as an argument to call the jacobi function.

Here are the matrix values stored in row-major  
order in a 1-D array. This array name will be used  
as an argument for the convert\_matrix function.

\*/

```
//double m[] = { 8, -1, 3, -1, -1, 6, 2, 0, 3, 2, 9, 1, -1, 0, 1, 7 };
```

```
double m[] = {
```

```
85.11916139,0.45781468,0.461642093,0.721574948,0.422374452,0.431849027,0.491694323,0.746
754025,0.402753203,0.288700295,0.412122388,0.509424018,0.806616383,0.614135258,0.8292690
53,0.621524891,0.7338944,0.657567957,0.591333024,0.069707724,0.505189769,0.554033243,0.65
4322339,0.491870754,0.577144541,0.258018089,0.777075106,0.566136921,0.652301765,0.434336
91,0.546101259,0.449699475,0.348913475,0.696439196,0.632695512,0.751378519,0.196530424,0.
464968088,0.33532808,0.379468437,0.526518828,0.372200775,0.51011912,0.301730113,0.722830
192,0.21374269,0.482697561,0.38373544,0.843589817,0.735161078,0.8268688,0.476996994,0.802
13672,0.307732162,0.264512017,0.638487821,0.547029774,0.835382619,0.210455014,0.46378622
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22378,0.769228563,0.894734745,0.751782473,0.689474253,0.355284794,0.716230194,0.51391763
8,0.150095288,0.422213785,0.109287118,0.553094818,0.348433195,0.687520863,0.245635927,0.1
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0.577890892,
```

```
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76,0.601893335,0.403376126,0.315636142,0.23111851,0.511307612,0.670297173,0.649785446,0.2  
91702798,0.663683008,0.491228606,0.62101707,0.314599011,0.774126108,0.146063216,0.281077  
738,0.688824515,0.696266274,0.731555087,0.341400063,0.608547921,0.878282951,0.794149828,  
0.78858393,0.442248382,0.520633382,0.595720179,0.557006725,0.669152352,0.417730903,0.632  
862498,0.65005684,0.445834248,0.689205805,0.73741477,0.977449093,0.407392651,0.543205442  
,0.45223832,0.197811258,0.128673461,0.242439224,0.429174615,0.699054927,0.609138805,0.498  
531372,0.401331622,0.114160034,0.325563734,0.46757362,0.414587065,0.305328363,0.42908877  
1,0.204864281,0.768325042,0.611003625,0.360461067,0.240349079,0.515002016,0.44692877,0.55  
3386794,0.217004824,0.732534062,0.174482478,0.395440161,0.303560692,0.58056953,0.3676316  
75,0.81443792,0.132262055,0.450512111,0.613747247,0.65187721,0.191512558,0.450747898,0.73  
4804781,0.488205881,0.680410771,0.373773337,0.679189811,0.82411183,0.536966446,0.5132229  
26,0.447784651,0.805916244,0.911134337,0.619668526,0.494634541,0.866942798,0.666310679,0.  
553301248,0.247049837,0.29847217,0.865712151,0.773310462,0.37049853,0.685450558,0.474733  
258,0.55785732,0.416128172,0.605121266,0.356286875,0.78793822,0.233869719,0.495969252,0.6  
93699355,0.856461233,0.486513493,0.673358647,0.552765814,0.571195596,0.66351731,0.616363  
285,0.647366494,0.384377739,0.644307591,0.408739958,0.640413201,0.690130531,79.85060698,  
0.638704785,0.378017152,

0.735868564,0.227622611,0.580852161,0.453222343,0.656974166,0.390266702,0.0752720  
26,0.647115584,0.452722502,0.775499997,0.487234429,0.579874589,0.44781942,0.313811687,0.3  
04838353,0.326701157,0.485182972,0.592153853,0.785053769,0.412622188,0.485761087,0.24043  
9843,0.57402824,0.296276767,0.288263626,0.454920266,0.317853223,0.477840003,0.719035866,  
0.585149186,0.508067045,0.320559143,0.234511979,0.691844539,0.408812541,0.204342873,0.58  
0206264,0.813397316,0.558265221,0.883606023,0.601942286,0.704823014,0.13557031,0.5100969  
76,0.522067959,0.681997943,0.791455311,0.335676201,0.36684077,0.6017385,0.609671137,0.475  
626004,0.304903403,0.7947866,0.601964632,0.608098118,0.584849063,0.653222033,0.466209669

,0.289026347,0.0735014,0.480755318,0.69491901,0.370670207,0.582943683,0.360651079,0.377570976,0.058489905,0.744437973,0.73030101,0.192381242,0.716700421,0.847622725,0.553229894,0.367141199,0.714743023,0.374898778,0.771384697,0.313408561,0.587872743,0.540802766,0.332661256,0.301137327,0.337585975,0.52278393,0.438422731,0.698924945,0.884113935,0.50534723,0.868246164,0.49552447,0.892248422,0.272412105,0.715417434,0.274682881,0.684325597,0.259263649,0.549590898,0.744046485,0.797243972,0.332042755,0.477716066,0.448426937,0.178257928,0.319215943,0.499479025,0.836115317,0.935424642,0.813097787,0.847659932,0.791840342,0.535276074,0.50389294,0.365895898,0.486122833,0.617737299,0.546046161,0.278080468,0.404949209,0.296639022,0.617966626,0.677930573,0.458299936,0.548315558,0.510619612,0.638704785,87.27902149,0.612280687,

0.577890892,0.243169102,0.65802807,0.437980808,0.514418322,0.398404371,0.668323089,0.337108416,0.698574567,0.645304047,0.538648109,0.492628789,0.224041416,0.729486817,0.017746172,0.448451515,0.737353186,0.621560514,0.683496281,0.617920373,0.316259999,0.48069006,0.616627857,0.111946231,0.389720138,0.454171459,0.854986524,0.160997177,0.509034972,0.760576639,0.657246309,0.294998158,0.460272063,0.571228407,0.396063273,0.546489057,0.84142197,0.616328537,0.788011002,0.486014746,0.676766948,0.703363296,0.400308095,0.609889305,0.204824623,0.492628036,0.735561743,0.458397453,0.455205938,0.903327903,0.27902481,0.395324903,0.527396395,0.515805413,0.673836036,0.713925878,0.218815556,0.190935145,0.772430086,0.286436821,0.385128218,0.351964559,0.318880788,0.705064073,0.836337642,0.666800433,0.767689018,0.29350187,0.704368184,0.386651421,0.580473629,0.380102817,0.693802496,0.182776419,0.520703347,0.700646253,0.444929776,0.761499066,0.302636706,0.482695455,0.750094346,0.887529985,0.705172743,0.311309619,0.131364101,0.334217355,0.483478329,0.214650264,0.349453684,0.248896887,0.717808774,0.731245463,0.511796044,0.097407551,0.498353399,0.237032756,0.575266683,0.548952562,0.369437012,0.713944645,0.745511998,0.398588215,0.372934286,0.465629194,0.325167858,0.088264453,0.389139346,0.095745779,0.497784874,0.329381071,0.51286321,0.604646822,0.879433089,0.757021727,0.727015943,0.48923179,0.443362398,0.502290956,0.210308675,0.278530287,0.888481398,0.292833945,0.311580908,0.403186838,0.695597828,0.378017152,0.612280687,79.9740116,

};

double \*d = dvector(1, n);

double \*r = dvector(1, n);

double \*\*v = dmatrix(1, n, 1, n);

double \*\*a = convert\_dmatrix(&m[0], 1, n, 1, n);

/\*printf("Matrix:\n");

for (i = 1; i <= n; i++) {

for (j = 1; j <= n; j++) {

printf(" %f", a[i][j]);

}

```

        printf("\n");
    }
    printf("\n");*/

clearCounters();
jacobi(a, n, d, v, &nrot);
cFlush();
sendReport();
printReport();
printf("Eigenvalues:\n");
for (i = 1; i <= n; i++) {
    printf("%d : %f\n", i, d[i]);
}
printf("\n");

printf("Eigenvectors:\n");
for (i = 1; i <= n; i++) {
    printf("%d:", i);
    for (j = 1; j <= n; j++) {
        printf("%f ", v[j][i]);
    }
    printf("\n");
}
printf("\n");

printf("Number of Jacobi rotations = %d\n", nrot);

free_convert_matrix(a, 1, n, 1, n);
free_dmatrix(v, 1, n, 1, n);
free_dvector(r, 1, n);
free_dvector(d, 1, n);

```



```

        }

    }

}

return 0;

}

//JACOBI.C

#include <math.h>

#include "nrutil.h"

#include <stdint.h>

#define NRANSI

#define ROTATE(a,i,j,k,l) g=a[i][j];h=a[k][l];a[i][j]=g-s*(h+g*tau);\
    a[k][l]=h+s*(g-h*tau);

extern void writeMemory(void *p, uint32_t size);
extern void readMemory(void *p, uint32_t size);
extern void printReport(void);

void jacobi(double **a, int n, double d[], double **v, int *nrot)
{
    int j, iq, ip, i;

    double tresh, theta, tau, t, sm, s, h, g, c, *b, *z;

    readMemory(&n, sizeof(n));
    writeMemory(&b, sizeof(b));

    b = dvector(1, n);

    readMemory(&n, sizeof(n));
    writeMemory(&z, sizeof(z));

    z = dvector(1, n);

    writeMemory(&ip, sizeof(ip));
    readMemory(&ip, sizeof(ip));
    readMemory(&n, sizeof(n));

```

```

for (ip = 1; ip <= n; ip++) {
    writeMemory(&iq, sizeof(iq));
    readMemory(&iq, sizeof(iq));
    readMemory(&n, sizeof(n));
    for (iq = 1; iq <= n; iq++) {
        readMemory(&ip, sizeof(ip));
        readMemory(&iq, sizeof(iq));
        writeMemory(&v[ip][iq], sizeof(v[ip][iq]));
        v[ip][iq] = 0.0;
        readMemory(&iq, sizeof(iq));
        writeMemory(&iq, sizeof(iq));
        readMemory(&iq, sizeof(iq));
        readMemory(&n, sizeof(n));
    }
    readMemory(&ip, sizeof(ip));
    readMemory(&ip, sizeof(ip));
    readMemory(&v[ip][ip], sizeof(v[ip][ip]));
    v[ip][ip] = 1.0;
    readMemory(&ip, sizeof(ip));
    writeMemory(&ip, sizeof(ip));
    readMemory(&ip, sizeof(ip));
    readMemory(&n, sizeof(n));
}

writeMemory(&ip, sizeof(ip));
readMemory(&ip, sizeof(ip));
readMemory(&n, sizeof(n));
for (ip = 1; ip <= n; ip++) {
    readMemory(&ip, sizeof(ip));
    readMemory(&ip, sizeof(ip));
    readMemory(&a[ip][ip], sizeof(a[ip][ip]));
    readMemory(&ip, sizeof(ip));
}

```

```

writeMemory(&d[ip], sizeof(d[ip]));
readMemory(&ip, sizeof(ip));
writeMemory(&b[ip], sizeof(b[ip]));
b[ip] = d[ip] = a[ip][ip];
readMemory(&ip, sizeof(ip));
writeMemory(&z[ip], sizeof(z[ip]));
z[ip] = 0.0;
readMemory(&ip, sizeof(ip));
writeMemory(&ip, sizeof(ip));
readMemory(&ip, sizeof(ip));
readMemory(&n, sizeof(n));
}
writeMemory(&nrot, sizeof(*nrot));
*nrot = 0;
writeMemory(&i, sizeof(i));
readMemory(&i, sizeof(i));
for (i = 1; i <= 50; i++)
{
    writeMemory(&sm, sizeof(sm));
    sm = 0.0;
    writeMemory(&ip, sizeof(ip));
    readMemory(&ip, sizeof(ip));
    readMemory(&n, sizeof(n));
    for (ip = 1; ip <= n - 1; ip++) {
        readMemory(&ip, sizeof(ip));
        writeMemory(&iq, sizeof(iq));
        readMemory(&ip, sizeof(ip));
        readMemory(&n, sizeof(n));
        for (iq = ip + 1; iq <= n; iq++){
            readMemory(&ip, sizeof(ip));
            readMemory(&iq, sizeof(iq));

```

```

        readMemory(&a[ip][iq], sizeof(a[ip][iq]));
        readMemory(&sm, sizeof(sm));
        writeMemory(&sm, sizeof(sm));
        sm += fabs(a[ip][iq]);
        readMemory(&iq, sizeof(iq));
        writeMemory(&iq, sizeof(iq));
        readMemory(&iq, sizeof(iq));
        readMemory(&n, sizeof(n));
    }
    readMemory(&ip, sizeof(ip));
    writeMemory(&ip, sizeof(ip));
    readMemory(&ip, sizeof(ip));
    readMemory(&n, sizeof(n));
}
readMemory(&sm, sizeof(sm));
if (sm == 0.0) {
    readMemory(&z, sizeof(z));
    readMemory(&n, sizeof(n));
    free_dvector(z, 1, n);
    readMemory(&b, sizeof(b));
    readMemory(&n, sizeof(n));
    free_dvector(b, 1, n);
    return;
}
readMemory(&i, sizeof(i));
if (i < 4){
    readMemory(&n, sizeof(n));
    readMemory(&sm, sizeof(sm));
    writeMemory(&tresh, sizeof(tresh));
    tresh = 0.2*sm / (n*n);
}

```

```

else{

    writeMemory(&tresh, sizeof(tresh));

    tresh = 0.0;

}

writeMemory(&ip, sizeof(ip));
readMemory(&ip, sizeof(ip));
readMemory(&n, sizeof(n));

for (ip = 1; ip <= n - 1; ip++) {

    readMemory(&ip, sizeof(ip));

    writeMemory(&iq, sizeof(iq));

    readMemory(&iq, sizeof(iq));

    readMemory(&n, sizeof(n));

    for (iq = ip + 1; iq <= n; iq++) {

        readMemory(&ip, sizeof(ip));

        readMemory(&iq, sizeof(iq));

        readMemory(&a[ip][iq], sizeof(a[ip][iq]));

        writeMemory(&g, sizeof(g));

        g = 100.0*fabs(a[ip][iq]);

        readMemory(&i, sizeof(i));

        readMemory(&ip, sizeof(ip));

        readMemory(&d[ip], sizeof(d[ip]));

        readMemory(&g, sizeof(g));

        readMemory(&ip, sizeof(ip));

        readMemory(&d[ip], sizeof(d[ip]));

        readMemory(&iq, sizeof(iq));

        readMemory(&d[iq], sizeof d[iq]);

        readMemory(&g, sizeof(g));

        readMemory(&iq, sizeof(iq));

        readMemory(&d[iq], sizeof d[iq]);

        if (i > 4 && (double)(fabs(d[ip]) + g) == (double)fabs(d[ip])

            && (double)(fabs(d[iq]) + g) == (double)fabs(d[iq])){

```

```

        readMemory(&ip, sizeof(ip));
        readMemory(&iq, sizeof(iq));
        writeMemory(&a[ip][iq], sizeof(a[ip][iq]));
        a[ip][iq] = 0.0;
    }
else if (fabs(a[ip][iq]) > tresh) {
    readMemory(&ip, sizeof(ip));
    readMemory(&iq, sizeof(iq));
    readMemory(&a[ip][iq], sizeof(a[ip][iq]));
    readMemory(&tresh, sizeof(tresh));
    readMemory(&ip, sizeof(ip));
    readMemory(&iq, sizeof(iq));
    readMemory(&d[ip], sizeof(d[ip]));
    readMemory(&d[iq], sizeof(d[iq]));
    writeMemory(&h, sizeof(h));
    h = d[iq] - d[ip];
    readMemory(&h, sizeof(h));
    readMemory(&g, sizeof(g));
    readMemory(&h, sizeof(h));
    if ((double)(fabs(h) + g) == (double)fabs(h)){
        readMemory(&ip, sizeof(ip));
        readMemory(&iq, sizeof(iq));
        readMemory(&a[ip][iq], sizeof(a[ip][iq]));
        readMemory(&h, sizeof(h));
        writeMemory(&t, sizeof(t));
        t = (a[ip][iq]) / h;
    }
else {
    readMemory(&ip, sizeof(ip));
    readMemory(&iq, sizeof(iq));
    readMemory(&a[ip][iq], sizeof(a[ip][iq]));

```

```

        readMemory(&h, sizeof(h));
        writeMemory(&theta, sizeof(theta));
        theta = 0.5*h / (a[ip][iq]);
        readMemory(&theta, sizeof(theta));
        readMemory(&theta, sizeof(theta));
        writeMemory(&t, sizeof(t));
        t = 1.0 / (fabs(theta) + sqrt(1.0 + theta*theta));
        readMemory(&theta, sizeof(theta));
        if (theta < 0.0){

                readMemory(&t, sizeof(t));
                writeMemory(&t, sizeof(t));
                t = -t;
        }
}

readMemory(&t, sizeof(t));
readMemory(&t, sizeof(t));
writeMemory(&c, sizeof(c));
c = 1.0 / sqrt(1 + t*t);
readMemory(&t, sizeof(t));
readMemory(&c, sizeof(c));
writeMemory(&s, sizeof(s));
s = t*c;
readMemory(&s, sizeof(s));
readMemory(&c, sizeof(c));
writeMemory(&tau, sizeof(tau));
tau = s / (1.0 + c);
readMemory(&ip, sizeof(ip));
readMemory(&iq, sizeof(iq));
readMemory(&a[ip][iq], sizeof(a[ip][iq]));
readMemory(&t, sizeof(t));

```

```
writeMemory(&h, sizeof(h));  
h = t*a[ip][iq];  
readMemory(&ip, sizeof(ip));  
readMemory(&z[ip], sizeof(z[ip]));  
readMemory(&h, sizeof(h));  
readMemory(&ip, sizeof(ip));  
writeMemory(&z[ip], sizeof(z[ip]));  
z[ip] -= h;  
readMemory(&iq, sizeof(iq));  
readMemory(&z[iq], sizeof(z[iq]));  
readMemory(&h, sizeof(h));  
readMemory(&iq, sizeof(iq));  
writeMemory(&z[iq], sizeof(z[iq]));  
z[iq] += h;  
readMemory(&ip, sizeof(ip));  
readMemory(&d[ip], sizeof(d[ip]));  
readMemory(&h, sizeof(h));  
readMemory(&ip, sizeof(ip));  
writeMemory(&d[ip], sizeof(d[ip]));  
d[ip] -= h;  
readMemory(&iq, sizeof(iq));  
readMemory(&d[iq], sizeof(d[iq]));  
readMemory(&h, sizeof(h));  
readMemory(&iq, sizeof(iq));  
writeMemory(&d[iq], sizeof(d[iq]));  
d[iq] += h;  
readMemory(&ip, sizeof(ip));  
readMemory(&iq, sizeof(iq));  
writeMemory(&a[ip][iq], sizeof(a[ip][iq]));  
a[ip][iq] = 0.0;  
writeMemory(&j, sizeof(j));
```



```

readMemory(&ip, sizeof(ip));
readMemory(&j, sizeof(j));
for (j = 1; j <= ip - 1; j++) {
    readMemory(&a, sizeof(a));
    readMemory(&j, sizeof(j));
    readMemory(&ip, sizeof(ip));
    readMemory(&j, sizeof(j));
    readMemory(&iq, sizeof(iq));
    ROTATE(a, j, ip, j, iq)
    readMemory(&j, sizeof(j));
    writeMemory(&j, sizeof(j));
    readMemory(&j, sizeof(j));
    readMemory(&ip, sizeof(ip));
}
readMemory(&ip, sizeof(ip));
readMemory(&iq, sizeof(iq));
writeMemory(&j, sizeof(j));
readMemory(&j, sizeof(j));
for (j = ip + 1; j <= iq - 1; j++) {
    readMemory(&a, sizeof(a));
    readMemory(&ip, sizeof(ip));
    readMemory(&j, sizeof(j));
    readMemory(&j, sizeof(j));
    readMemory(&iq, sizeof(iq));
    ROTATE(a, ip, j, j, iq)
    readMemory(&j, sizeof(j));
    writeMemory(&j, sizeof(j));
    readMemory(&j, sizeof(j));
    readMemory(&iq, sizeof(iq));
}
readMemory(&iq, sizeof(iq));

```

```

writeMemory(&j, sizeof(j));
readMemory(&j, sizeof(j));
readMemory(&n, sizeof(n));
for (j = iq + 1; j <= n; j++) {
    readMemory(&a, sizeof(a));
    readMemory(&iq, sizeof(iq));
    readMemory(&j, sizeof(j));
    readMemory(&ip, sizeof(ip));
    readMemory(&j, sizeof(j));
    ROTATE(a, ip, j, iq, j)
    readMemory(&j, sizeof(j));
    writeMemory(&j, sizeof(j));
    readMemory(&j, sizeof(j));
    readMemory(&n, sizeof(n));
}
writeMemory(&j, sizeof(j));
readMemory(&j, sizeof(j));
readMemory(&n, sizeof(n));
for (j = 1; j <= n; j++) {
    readMemory(&v, sizeof(v));
    readMemory(&j, sizeof(j));
    readMemory(&ip, sizeof(ip));
    readMemory(&j, sizeof(j));
    readMemory(&iq, sizeof(iq));
    ROTATE(v, j, ip, j, iq);
    readMemory(&j, sizeof(j));
    writeMemory(&j, sizeof(j));
    readMemory(&j, sizeof(j));
    readMemory(&n, sizeof(n));
}
readMemory(nrot, sizeof(nrot));

```

```

        writeMemory(nrot, sizeof(nrot));
        ++(*nrot);
    }
}

writeMemory(&ip, sizeof(ip));
readMemory(&ip, sizeof(ip));
readMemory(&n, sizeof(n));
for (ip = 1; ip <= n; ip++) {
    readMemory(&ip, sizeof(ip));
    readMemory(&b[ip], sizeof(b[ip]));
    readMemory(&ip, sizeof(ip));
    readMemory(&z[ip], sizeof(z[ip]));
    readMemory(&ip, sizeof(ip));
    writeMemory(&b[ip], sizeof(b[ip]));
    b[ip] += z[ip];
    readMemory(&ip, sizeof(ip));
    readMemory(&ip, sizeof(ip));
    readMemory(&b[ip], sizeof(b[ip]));
    writeMemory(&d[ip], sizeof(d[ip]));
    d[ip] = b[ip];
    readMemory(&ip, sizeof(ip));
    writeMemory(&z[ip], sizeof(z[ip]));
    z[ip] = 0.0;
}
}

nrerror("Too many iterations in routine jacobi");
}

#undef ROTATE
#undef NRANSI
//CACHESIM.C

```

```

#include <stdio.h>
#include <stdint.h>
#include <stdbool.h>
#include <math.h>
#include <string.h>

//Maximum number of lines and ways.
#define MAX_LINES 16384
#define MAX_WAYS 16 //confirm
#define WRITEBACK 1
#define WRITETHRU 2
#define WRITETHRUNA 3
FILE *report;
//cache structure
struct cache {
    uint32_t cacheSize;
    uint16_t line;
    uint8_t way;
    uint8_t BL;
    uint8_t B; //BL*W
    uint16_t L;
    //arrays
    uint8_t lru[MAX_LINES][MAX_WAYS];
    uint32_t tag[MAX_LINES][MAX_WAYS];
    bool d[MAX_LINES][MAX_WAYS];
    bool v[MAX_LINES][MAX_WAYS];
};

//read Counters
struct readCounter {
    uint32_t rMem;
    uint32_t rLine;
    uint32_t rMiss;
    uint32_t rCache;
    uint32_t rDirtyReplace;
};

//write Counters
struct writeCounter {
    uint32_t wMem;
    uint32_t wLine;
    uint32_t wMiss;
    uint32_t wCache;
    uint32_t wThruMem;
    uint32_t wDirtyReplace;
};

struct cache cache;
struct readCounter rc;
struct writeCounter wc;
uint32_t flushCount = 0;

uint32_t writeMem = 0, readMem = 0;
uint8_t writeStrategy = 0;

void clearCounters(void) {
    rc.rMem = 0;
    rc.rLine = 0;
    rc.rMiss = 0;
    rc.rDirtyReplace = 0;
    rc.rCache = 0;
    readMem = 0;

```

```

        wc.wMem = 0;
        wc.wLine = 0;
        wc.wMiss = 0;
        wc.wDirtyReplace = 0;
        wc.wCache = 0;
        writeMem = 0;
        flushCount = 0;
    }

    void init(uint8_t iwriteStrategy, uint8_t inWay, uint8_t ibl) {

        uint16_t iline = 0;
        uint8_t iway = 0;
        uint8_t w = 4;
        cache.BL = ibl;
        cache.B = ibl*w;
        cache.way = inWay;
        cache.cacheSize = 65536;
        cache.L = cache.cacheSize / (cache.B*cache.way);
        writeStrategy = iwriteStrategy;
        //clear v and d bits
        memset(cache.d, 0, sizeof(cache.d));
        memset(cache.v, 0, sizeof(cache.v));

        //Assigning LRU to good values
        for (iline = 0; iline < cache.L; iline++) {
            for (iway = 0; iway < cache.way; iway++) {
                cache.lru[iline][iway] = iway;
            }
        }
    }

    uint32_t getLine(uint32_t add) {
        uint32_t currLine;
        uint8_t l, b;
        l = log(cache.L) / log(2);
        b = log(cache.B) / log(2);
        currLine = ((add >> b) & (uint32_t)(pow(2, l) - 1));
        return currLine;
    }

    uint32_t getTag(uint32_t add) {
        uint32_t ctag = 0;
        uint8_t l, b, t;
        l = log(cache.L) / log(2);
        b = log(cache.B) / log(2);
        t = 32 - l - b;
        ctag = (add >> (b + 1));
        return ctag;
    }

    bool isMiss(uint32_t add) {
        uint32_t tag;
        cache.line = getLine(add);
        tag = getTag(add);
        uint8_t i = 0;
        for (i = 0; i < cache.way; i++) {
            if (cache.v[cache.line][i] == 1) {
                if (cache.tag[cache.line][i] == tag) {
                    return false;
                }
            }
        }
    }

```

```

        }
    }
    return true;
}

bool isDirty(uint16_t line, uint8_t way) {
    if (cache.d[line][way] == true)
        return true;
    else
        return false;
}

void clearDirty(uint16_t line, uint8_t way) {
    cache.d[line][way] = false;
}

void invalidate(uint16_t line, uint8_t way) {
    cache.v[line][way] = false;
}

void validate(uint16_t line, uint8_t way) {
    cache.v[line][way] = true;
}

void updateLru(uint16_t line, uint8_t way) {
    uint8_t n = 0;
    cache.lru[line][way] = 0;
    for (n = 0; n < cache.way; n++) {
        if (n != way) {
            cache.lru[line][n]++;
        }
    }
}

void readCache(uint32_t add) {
    //increment cache counter
    rc.rLine++;
    rc.rCache++;
}

void writeCache(uint32_t add) {
    //increment cache counter
    wc.wLine++;
    wc.wCache++;
}

void writeBack(uint32_t line, uint32_t way) {
    //we write back to memory whatever was in cache
    if (cache.v[line][way] == 1) {
        writeMem++;
    }
}

void readBlock(uint16_t line, uint8_t way) {
    readMem++;
}

uint8_t getLruWay(uint16_t line) {
    uint8_t ilru = 0;
    uint8_t currentilru = 0;
    for (ilru = 0; ilru < (cache.way - 1); ilru++) {
        if (cache.lru[line][ilru] > cache.lru[line][ilru + 1]) {

```

```

        currentILru = ilru;
    }
}
return currentILru;
}

void readLine(uint32_t add) {
    uint8_t oldestWay = 0;

    if (isMiss(add)) {
        rc.rMiss++; //increment counter
        cache.line = getLine(add);
        oldestWay = getLruWay(cache.line); //oldest way
        if (isDirty(cache.line, oldestWay)) {
            rc.rDirtyReplace++; //counter
            writeBack(cache.line, oldestWay);
            clearDirty(cache.line, oldestWay);
        }
        invalidate(cache.line, oldestWay);
        readBlock(cache.line, oldestWay);
        cache.tag[cache.line][oldestWay] = getTag(add);
        validate(cache.line, oldestWay);
    }
    updateLru(cache.line, oldestWay);
    readCache(add);
}

void readMemory(void *p, uint32_t size) {
    uint32_t oldLine;
    oldLine = -1;
    uint32_t i = 0;
    uint32_t add;
    rc.rMem++; //counter
    for (i = 0; i < size; i++) {
        add = (uint32_t)p + i;
        cache.line = getLine(add);
        if (cache.line != oldLine) {
            readLine(add);
        }
        oldLine = cache.line;
    }
}

void writeline(uint32_t add) {
    uint8_t oldestWay;
    cache.line = getLine(add);
    oldestWay = getLruWay(cache.line); //oldest way

    if (isMiss(add) && ((writeStrategy == WRITEBACK) || (writeStrategy ==
WRITETHRU))) {
        wc.wMiss++;
        if (isDirty(cache.line, oldestWay)) {
            wc.wDirtyReplace++;
            writeBack(cache.line, oldestWay);
            clearDirty(cache.line, oldestWay);
        }
        invalidate(cache.line, oldestWay);
        cache.tag[cache.line][oldestWay] = getTag(add);
        readBlock(cache.line, oldestWay);
        validate(cache.line, oldestWay);
    }
}

```

```

        if (!(isMiss(add)) || (writeStrategy == WRITEBACK) || (writeStrategy ==
WRITETHRU)) {
            writeCache(add);
            if (writeStrategy == WRITEBACK) {
                cache.d[cache.line][oldestWay] = true;
            }

            updateLru(cache.line, cache.way);
        }
    }

void writeThruMem(uint32_t add) {
    wc.wThruMem++;
}

void writeMemory(void* p, uint32_t size) {
    uint32_t oldLine = -1;
    uint32_t i = 0, j = 0, k = 0, size32 = 0;
    uint32_t add;
    wc.wMem++; //counter
    for (i = 0; i < size; i++) {
        add = ((uint32_t)p) + i;
        cache.line = getLine(add);
        if (cache.line != oldLine) { //on B byte boundary
            writeline(add);
        }
        oldLine = cache.line;
    }
    if ((writeStrategy == WRITETHRUNA) || (writeStrategy == WRITETHRU)) {
        size32 = size / 4;
        for (j = 0; j < size32; j++) {
            writeThruMem(add); //on 32 bit boundary important to calculate
the boundary differently
        }
    }
}

void cFlush(void) {
    uint32_t i;
    uint8_t j;
    for (i = 0; i < cache.L; i++)
    {
        for (j = 0; j < cache.way; j++)
        {
            if (cache.d[i][j] == 1)
            {
                flushCount++;
                cache.d[i][j] = 0;
            }
        }
    }
}

void printReport(void) {
    printf("counter write strategy %d\n", writeStrategy);
    printf("counter associativity %d\n", cache.way);
    printf("counter burst lenfth %d\n", cache.BL);

    printf("counter read memory %d\n", rc.rMem);
    printf("counter read line %d\n", rc.rLine);
    printf("counter read miss %d\n", rc.rMiss);
}

```



```

printf("counter read dirty %d\n", rc.rDirtyReplace);
printf("counter read cache %d\n", rc.rCache);
printf("counter read %d\n", readMem);

printf("counter write memory %d\n", wc.wMem);
printf("counter write line %d\n", wc.wLine);
printf("counter write miss %d\n", wc.wMiss);
printf("counter read dirty %d\n", wc.wDirtyReplace);
printf("counter write cache %d\n", wc.wCache);
printf("counter write thru %d\n", wc.wThruMem);
printf("counter read %d\n", writeMem);
}

extern sendReport(void) {
    report = fopen("report.csv", "a");
    if (report == NULL)
    {
        fprintf(stderr, "can't open file!\n");
        exit(1);
    }
    fprintf(report, " %d\t", writeStrategy);
    fprintf(report, " %d\t", cache.way);
    fprintf(report, " %d\t", cache.BL);
    fprintf(report, " %d\t", rc.rMem);
    fprintf(report, " %d\t", rc.rLine);
    fprintf(report, " %d\t", rc.rMiss);
    fprintf(report, " %d\t", rc.rDirtyReplace);
    fprintf(report, " %d\t", rc.rCache);
    fprintf(report, " %d\t", readMem);
    fprintf(report, " %d\t", wc.wMem);
    fprintf(report, " %d\t", wc.wLine);
    fprintf(report, " %d\t", wc.wMiss);
    fprintf(report, " %d\t", wc.wDirtyReplace);
    fprintf(report, " %d\t", wc.wCache);
    fprintf(report, " %d\t", wc.wThruMem);
    fprintf(report, " %d\t", writeMem);
    fprintf(report, " \n");
    fclose(report);
}

```

## CONCLUSION:

We were unable to run the case for  $N = 16$  for some unknown reason. Calculated the best using number of misses.

The best case in decreasing order is

Write Strategy is Write through Allocate, Number of ways is 1 and Burst length 8,

Write Strategy is Writeback, Number of ways is 1 and Burst length 8,

Write Strategy is Write through Non allocate, Number of ways is 1 and Burst length 8,

The worst cases are

Write Strategy is Write through Allocate, Number of ways is 4 and Burst length 1,

Write Strategy is Writeback, Number of ways is 4 and Burst length 1,

Write Strategy is Write through Non allocate, Number of ways is 4 and Burst length 1,