Branch prediction

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Assignment problem:

Implement Pentium M dynamic branch predictor

Environment:

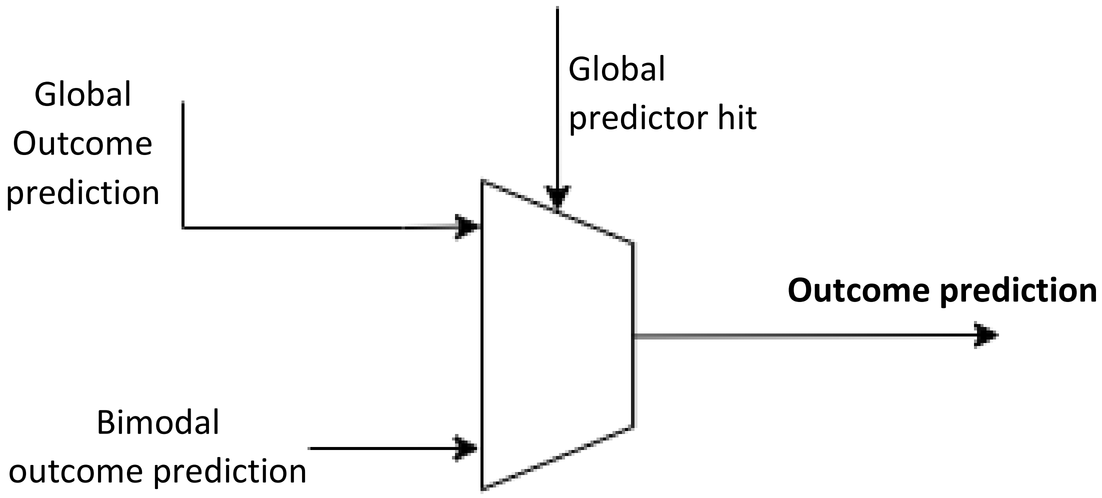
OS: Ubuntu

Compile:

1. cd src folder
2. *make*
3. back to branch-prediction folder
4. *run traces* or *csh run traces* (might have to install csh and bc)

Code modification:

1. **Using G-share as global predictor**
2. **Using bimodal as local predictor**
3. **Architecture:**



Code:

```
class pm_update : public branch_update {
public:
        unsigned int index;
        unsigned int g_index;
};

class pm_predictor : public branch_predictor {
public:
#define TABLE_BITS      15
#define HISTORY_LENGTH  15

        pm_update u;
        branch_info bi;
        unsigned int history;
        unsigned char g_tab[1<<TABLE_BITS];
        unsigned char b_tab[1<<TABLE_BITS];
        pm_predictor (void) : history(0) {
        memset (g_tab, 0, sizeof (g_tab));
        memset (b_tab, 0, sizeof (b_tab));
        }
        branch_update *predict (branch_info & b) {
        bi=b;

                if (b.br_flags & BR_CONDITIONAL) {
                        u.index = b.address & ((1<<TABLE_BITS)-1); // address & all 1 bits
                        u.g_index= (history << (TABLE_BITS - HISTORY_LENGTH)) ^ u.index;

                        if(history>>1<<1) //show right most bit
                                u.direction_prediction(g_tab[u.g_index]>>1);     //use global
                        else
                                u.direction_prediction(b_tab[u.index]>>1);       //use bimodal

                } else {
                        u.direction_prediction (true);
                }
                u.target_prediction (0);
                return &u;
        }

        void update (branch_update *u, bool taken, unsigned int target) {

        if (bi.br_flags & BR_CONDITIONAL) {
                unsigned char *b = &b_tab[((pm_update*)u)->index];
                unsigned char *g = &g_tab[((pm_update*)u)->g_index];

                if (taken) {            //2-bit counter
                                if (*g < 3) (*g)++; if (*b < 3) (*b)++;

                        } else {
                                if (*g > 0) (*g)--; if (*b > 0) (*b)--;
                        }
                history <<= 1;
                        history |= taken;
                        history &= (1<<HISTORY_LENGTH)-1;
                }
        }
};
```

Result:

TABLE_BITS, HISTORY_LENGTH =5

```
traces/164.gzip/gzip.trace.bz2              25.240
traces/175.vpr/vpr.trace.bz2               39.215
traces/176.gcc/gcc.trace.bz2               59.213
traces/181.mcf/mcf.trace.bz2                 39.018
traces/186.crafty/crafty.trace.bz2            36.577
traces/197.parser/parser.trace.bz2            29.878
traces/201.compress/compress.trace.bz2          25.502
traces/202.jess/jess.trace.bz2              35.491
traces/205.raytrace/raytrace.trace.bz2          11.629
traces/209.db/db.trace.bz2                 25.225
traces/213.javac/javac.trace.bz2             9.318
traces/222.mpegaudio/mpegaudio.trace.bz2        8.972
traces/227.mtrt/mtrt.trace.bz2              11.814
traces/228.jack/jack.trace.bz2             33.109
traces/252.eon/eon.trace.bz2                22.314
traces/253.perlbmk/perlbmk.trace.bz2           50.969
traces/254.gap/gap.trace.bz2               36.111
traces/255.vortex/vortex.trace.bz2            34.773
traces/256.bzip2/bzip2.trace.bz2            1.220
traces/300.twolf/twolf.trace.bz2            43.748
average MPKI: 28.966
```

TABLE_BITS, HISTORY_LENGTH =10

```
traces/164.gzip/gzip.trace.bz2              13.032
traces/175.vpr/vpr.trace.bz2               22.798
traces/176.gcc/gcc.trace.bz2               33.340
traces/181.mcf/mcf.trace.bz2                 22.720
traces/186.crafty/crafty.trace.bz2            17.199
traces/197.parser/parser.trace.bz2            14.296
traces/201.compress/compress.trace.bz2          9.866
traces/202.jess/jess.trace.bz2              9.260
traces/205.raytrace/raytrace.trace.bz2          6.175
traces/209.db/db.trace.bz2                 7.979
traces/213.javac/javac.trace.bz2             5.036
traces/222.mpegaudio/mpegaudio.trace.bz2        4.809
traces/227.mtrt/mtrt.trace.bz2              5.948
traces/228.jack/jack.trace.bz2             11.717
traces/252.eon/eon.trace.bz2                6.614
traces/253.perlbmk/perlbmk.trace.bz2           15.936
traces/254.gap/gap.trace.bz2               9.459
traces/255.vortex/vortex.trace.bz2            7.140
traces/256.bzip2/bzip2.trace.bz2            0.215
traces/300.twolf/twolf.trace.bz2            33.716
average MPKI: 12.862
```

TABLE_BITS, HISTORY_LENGTH =15

```
traces/164.gzip/gzip.trace.bz2              12.472
traces/175.vpr/vpr.trace.bz2               13.550
traces/176.gcc/gcc.trace.bz2               11.250
traces/181.mcf/mcf.trace.bz2                 15.832
traces/186.crafty/crafty.trace.bz2            5.837
traces/197.parser/parser.trace.bz2            10.013
traces/201.compress/compress.trace.bz2          7.830
traces/202.jess/jess.trace.bz2              1.561
traces/205.raytrace/raytrace.trace.bz2          2.782
traces/209.db/db.trace.bz2                 3.910
traces/213.javac/javac.trace.bz2             2.250
traces/222.mpegaudio/mpegaudio.trace.bz2        2.172
traces/227.mtrt/mtrt.trace.bz2              2.699
traces/228.jack/jack.trace.bz2             3.045
traces/252.eon/eon.trace.bz2                1.808
traces/253.perlbmk/perlbmk.trace.bz2           2.554
traces/254.gap/gap.trace.bz2               3.926
traces/255.vortex/vortex.trace.bz2            1.222
traces/256.bzip2/bzip2.trace.bz2            0.094
traces/300.twolf/twolf.trace.bz2            21.489
average MPKI: 6.314
```

TABLE_BITS=, HISTORY_LENGTH =20

```
traces/164.gzip/gzip.trace.bz2              12.647
traces/175.vpr/vpr.trace.bz2               12.183
traces/176.gcc/gcc.trace.bz2               8.839
traces/181.mcf/mcf.trace.bz2                 14.881
traces/186.crafty/crafty.trace.bz2            4.323
traces/197.parser/parser.trace.bz2            9.374
traces/201.compress/compress.trace.bz2          7.228
traces/202.jess/jess.trace.bz2              1.395
traces/205.raytrace/raytrace.trace.bz2          2.372
traces/209.db/db.trace.bz2                 3.689
traces/213.javac/javac.trace.bz2             2.018
traces/222.mpegaudio/mpegaudio.trace.bz2        1.944
traces/227.mtrt/mtrt.trace.bz2              2.274
traces/228.jack/jack.trace.bz2             2.416
traces/252.eon/eon.trace.bz2                1.454
traces/253.perlbmk/perlbmk.trace.bz2           1.740
traces/254.gap/gap.trace.bz2               3.528
traces/255.vortex/vortex.trace.bz2            0.960
traces/256.bzip2/bzip2.trace.bz2            0.095
traces/300.twolf/twolf.trace.bz2            16.709
average MPKI: 5.503
```