```cpp
/*

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*/

#include <string>

#include <iostream>

using namespace std;

namespace ScoutDb {

        class Team {

        public:

                unsigned short int teamIndex,
                        matchesPer,
                        matchesPlayed;

                unsigned short int* allies;
                unsigned short int* opponents;

                unsigned char record[3];

                unsigned char ap,
                        wp;
```

```cpp
        int sp;

        int allyScoreSum,
                oppScoreSum;

        double avgScored,
                avgScoredOn,
                scoreRatio,
                opr,
                dpr,
                ccwm;

        void init(unsigned short index, unsigned short matchesPerTeam) { //Constructor
                matchesPer = matchesPerTeam;
                allies = (unsigned short int*)(malloc(matchesPerTeam * sizeof(unsigned
short int)));
                opponents = (unsigned short int*)(malloc(2 * matchesPerTeam *
sizeof(unsigned short int)));
                teamIndex = index;
                matchesPlayed = 0;
                sp = 0;
                ap = 0;
                allyScoreSum = 0;
                oppScoreSum = 0;
                avgScored = 0;
                avgScoredOn = 0;
                scoreRatio = 0;
                for(int i = 0; i < sizeof(record); i++)
                        record[i] = 0;

                for(int i = 0; i < matchesPerTeam; i++) {
                        allies[i] = 0;
                        opponents[2 * i] = 0;
                        opponents[2 * i + 1] = 0;
                }
        }

        void upStats(unsigned short int ally, unsigned short *opps, short score, short
oppScore) {
                if (matchesPlayed < matchesPer) { //For the cases where a team has an
extra match that doesn't count
                        allies[matchesPlayed] = ally;
                        opponents[2 * matchesPlayed] = opps[0];
```
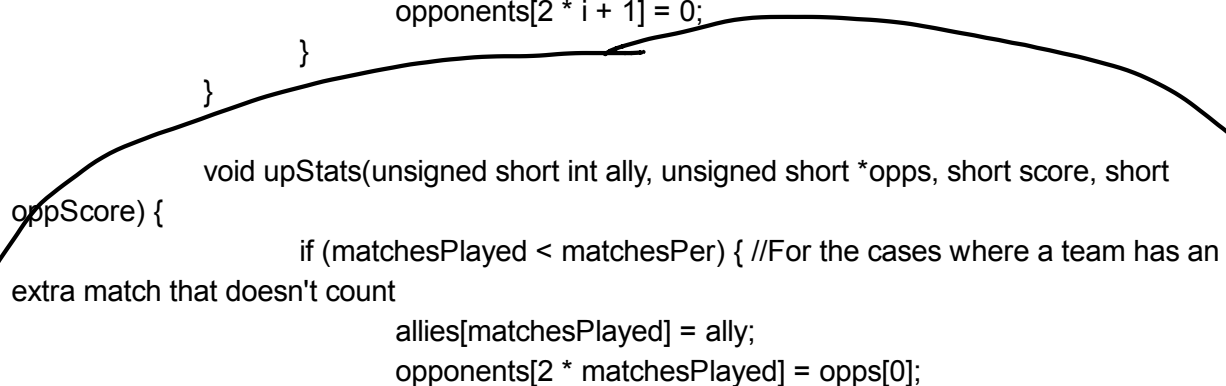
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                                            opponents[2 * matchesPlayed + 1] = opps[1];
                                            if (score > oppScore) { //If a win
                                                    record[0]++;
                                                    sp += oppScore;
                                            }
                                            else if (score < oppScore) { //If a loss
                                                    record[1]++;
                                                    sp += score;
                                            }
                                            else { //If a tie
                                                    record[2]++;
                                                    sp += score;
                                            }
                                            allyScoreSum += score;
                                            oppScoreSum += oppScore;
                                            avgScored = allyScoreSum / (matchesPlayed + 1);
                                            avgScoredOn = oppScoreSum / (matchesPlayed + 1);
                                            if (avgScoredOn != 0)
                                                    scoreRatio = avgScored / avgScoredOn;
                                            else
                                                    scoreRatio = DBL_MAX;
                                            wp = (2 * record[0]) + record[2]; // 2 WP for win, 1 WP for tie

                                            matchesPlayed++;

                                    }

                            return;
                    }

            };

    }

    /*
     * tourneyStats.hpp
     *
     *  Created on: Apr 5, 2017
     *      Author: Lentil
     */

    using namespace std;
```

```cpp
#ifndef TOURNEYSTATS_HPP_
#define TOURNEYSTATS_HPP_

#include <string>
#include <iostream>
#include "teamStatTracker.hpp"

namespace ScoutDb {

        class Tournament {
        public: Team *Teams,
                **pTeams;
                unsigned char matchesPerTeam;
                unsigned short int matchCt,
                        teamCt;

                string input;


                Tournament(unsigned int matchCount, unsigned char teamCount) {
                        matchCt = matchCount;
                        teamCt = teamCount;
                        matchesPerTeam = floor(4 * matchCt / teamCt);
                        Teams = (Team*)(calloc(teamCt, sizeof(Team*)));
                        pTeams = (Team**)(calloc(teamCt, sizeof(Team**)));
                        for (int i = 0; i < teamCt; i++) {
                                Teams[i].init(i, matchesPerTeam);
                                cout << "Team Index (Save for referencing team later): " << i <<
endl;
                        }
                        for (int i = 0; i < teamCt; i++) {
                                pTeams[i] = &Teams[i];
                        }
                }
        };
}




#endif /* TOURNEYSTATS_HPP_ */
```

```cpp
#include <cassert>
#include <cmath>
#include <cstring>

#include <algorithm>
#include <iomanip>
#include <iostream>

#define MM_EPSILON 1e-10

#define MM_FZERO(f) (fabs((f)) < MM_EPSILON)
#define MM_FEQUAL(f, g) MM_FZERO(f - g)
#define MM_FIXZERO(e, f)                                \
  {                                                     \
    if (MM_FZERO(e)) f = 0.;                            \
  }

#ifdef MM_DEBUG
#define MM_TRACEMTX printMtx(arr, rows, cols)
#define MM_TRACE
#else
#define MM_TRACEMTX
#endif

namespace MatrixMath {
        inline void printMtx(double *arr, size_t rows, size_t cols) {
                std::ios fmt(nullptr);
                fmt.copyfmt(std::cout);

                for (size_t r = 0; r < rows; ++r) {
                        for (size_t c = 0; c < cols; ++c) {
                                if (c) std::cout << (c == rows ? " | " : " ");

                                double val = arr[r * cols + c], aval = fabs(val);

                                std::cout << std::setw(10) << std::setfill(' ')
                                        << (aval >= 1e3 || aval <= 1e-2 && aval != 0. ?
                                                std::scientific :
                                                std::fixed)
                                        << std::setprecision(3) << arr[r * cols + c];
                        }

                        std::cout << std::endl;
```

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                }

                std::cout.copyfmt(fmt);
        }

        inline void printMtx(double *arr, size_t dim) { printMtx(arr, dim, dim); }

        class MatrixInverter {
                size_t  rows, cols;
                double *arr;

        public:
                MatrixInverter(double *mat, size_t matSize)
                        : rows(matSize), cols(matSize * 2) {
                        arr = new double[rows * cols];

                        for (size_t row = 0; row < matSize; ++row) {
                                memcpy(arr + row * cols, mat + row * matSize, matSize *
sizeof(double));

                                for (size_t col = 0; col < matSize; ++col) {
                                        cell(row, rows + col) = col == row ? 1. : 0.;
                                }
                        }
                }

                ~MatrixInverter() { delete[] arr; }

        private:
                inline double &cell(size_t row, size_t col) {
                        assert(row < rows);
                        assert(col < cols);
                        return arr[row * cols + col];
                }

                void rowMult(size_t row, double fac) {
#ifdef MM_TRACE
                        std::cout << "[Inverter] Multiplying row " << row << " by " << fac
                                << std::endl;
#endif

#ifdef MM_DEBUG
                        if (!MM_FEQUAL(fac, 1.)) {
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#else
                if (MM_FEQUAL(fac, 1.)) return;
#endif

                for (size_t i = 0; i < cols; ++i)
                        MM_FIXZERO(cell(row, i) *= fac, cell(row, i))

#ifdef MM_DEBUG
                }
#endif

        MM_TRACEMTX;
        }

    void rowAdd(size_t from, size_t to, double fac) {
#ifdef MM_TRACE
        std::cout << "[Inverter] Adding " << fac << " times row " << from
                << " to row " << to << std::endl;
#endif

#ifdef MM_DEBUG
        if (!MM_FZERO(fac)) {
#else
        if (MM_FZERO(fac)) return;
#endif

        for (size_t i = 0; i < cols; ++i)
                MM_FIXZERO(cell(to, i) += cell(from, i) * fac, cell(to, i))

#ifdef MM_DEBUG
        }
#endif

    MM_TRACEMTX;
    }

void rowSwap(size_t a, size_t b) {
#ifdef MM_TRACE
    std::cout << "[Inverter] Swapping rows " << a << " and " << b << std::endl;
#endif

    for (size_t i = 0; i < cols; ++i) std::swap(cell(a, i), cell(b, i));
```

```cpp
		MM_TRACEMTX;
	}

public:
	// Returns the determinant of the input matrix.  You're welcome.
	double gaussElim() {
		double det = 1;

		MM_TRACEMTX;

		for (size_t i = 0; i < rows; ++i) {
			if (MM_FZERO(cell(i, i))) { // To avoid a divide-by-zero
				size_t j = i + 1;

				while (j < rows && MM_FZERO(cell(j, i))) ++j;

				// Everything below us is zero.  Our work here is done.
				if (j == rows) {
#ifdef MM_DEBUG
					std::cout << "[Inverter] Skipping row/column " << i
						<< " due to zeroes." << std::endl;

					det = 0.;
					continue; // You could technically return here, since we know
the
						// matrix isn't invertible now, but we don't to
get the full
						// debug output.
#else
#ifdef MM_TRACE
					std::cout << "[Inverter] No pivot found in row/column " << i
						<< "; stopping" << std::endl;
#endif

					return 0.;    // The matrix isn't invertible.
#endif
				}

				det = -det;
				rowSwap(i, j);
			}

			det *= cell(i, i);
```

```cpp
                        rowMult(i, 1. / cell(i, i));

                        for (size_t j = i + 1; j < rows; ++j) rowAdd(i, j, -cell(j, i));
                }

                for (size_t i = 0; i < rows; ++i) {
                        size_t j = 0;

                        while (j < rows && MM_FZERO(cell(i, j))) ++j;

#ifdef MM_DEBUG
                        if (j == rows) {
                                std::cout << "[Inverter] No pivot in row " << i << std::endl;

                                continue;
                        }
#else
                        assert(j < rows); // We should've already stopped if a pivot is missing.
#endif

                        assert(j >= i);
                        assert(MM_FEQUAL(cell(i, j), 1.));

                        if (j == rows) continue;

                        for (size_t k = 0; k < i; ++k) { rowAdd(i, k, -cell(k, j)); }
                }

                return det;
        }

        void outputIdent(double *output) {
                for (size_t i = 0; i < rows; ++i) {
                        for (size_t j = 0; j < rows; ++j) {
                                output[i * rows + j] = arr[i * cols + j];
                        }
                }
        }

        void outputInverse(double *output) {
                for (size_t i = 0; i < rows; ++i) {
                        for (size_t j = 0; j < rows; ++j) {
                                output[i * rows + j] = arr[i * cols + rows + j];
```

```
                }
            }
        }

        void printAll(double *output) {
            memcpy(output, arr, rows * cols * sizeof(double));
        }
    };
}

#include <cstdio>
#include <cstring>

#include "tourneyStats.hpp"

#include "matMath.hpp"

using namespace std;

using namespace ScoutDb;

using namespace MatrixMath;

void bubbleSort(Tournament* tournament, int* outArr) {
        int swapBuf;
        bool bIsOrdered;

        for (int i = 0; i < tournament->teamCt; i++) {
                outArr[i] = i;
        }

        do {
                bIsOrdered = true;
                for (int i = 1; i < tournament->teamCt; i++) {
                        if (tournament->Teams[outArr[i]].opr < tournament->Teams[outArr[i -
    1]].opr) {

                                bIsOrdered = false;
                                swapBuf = outArr[i];
                                outArr[i] = outArr[i - 1];
                                outArr[i - 1] = swapBuf;

                        }
                }
                for (int i = 0; i < tournament->teamCt; i++) {
```
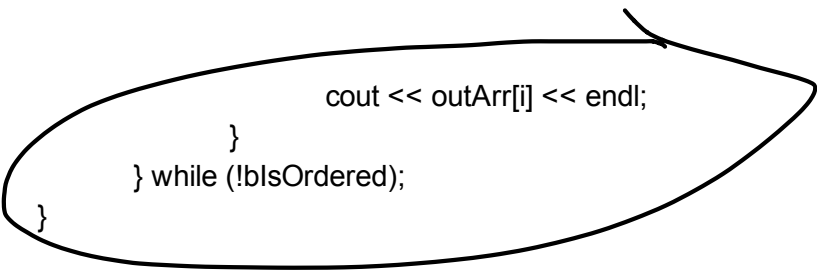
```
                        cout << outArr[i] << endl;
                }
        } while (!bIsOrdered);
}

void updateTeams(Tournament *tourney, unsigned short teamCt, unsigned short *teamInds, short
*scores) {
        for (int i = 0; i < teamCt; i++) {
                if(tourney->Teams[i].teamIndex == teamInds[0]) {
                        tourney->Teams[i].upStats(teamInds[1], &teamInds[2], scores[0],
scores[1]);
                }
                else if (tourney->Teams[i].teamIndex == teamInds[1]) {
                        tourney->Teams[i].upStats(teamInds[0], &teamInds[2], scores[0],
scores[1]);
                }
                else if (tourney->Teams[i].teamIndex == teamInds[2]) {
                        tourney->Teams[i].upStats(teamInds[3], &teamInds[0], scores[1],
scores[0]);
                }
                else if (tourney->Teams[i].teamIndex == teamInds[3]) {
                        tourney->Teams[i].upStats(teamInds[2], &teamInds[0], scores[1],
scores[0]);
                }
        }
}

int main(){
        string input;
        unsigned short matchCt,
                teamCt,
                teamIndices[4];
        short scores[2];

        cout << "How many matches are there?" << endl;
        cin >> input;
        matchCt = stoi(input, NULL, 10);
        cout << "How many teams are there?" << endl;
        cin >> input;
        teamCt = stoi(input, NULL, 10);
        Tournament* Tourney = new Tournament(matchCt, teamCt);
        int *sortedTeamList = (int*)(calloc(teamCt, sizeof(int)));
        for (int i = 0; i < matchCt; i++) {
```

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        cout << "What is the index of the first red team?" << endl;
        cin >> input;
        teamIndices[0] = stoi(input, NULL, 10);
        cout << "What is the index of the second red team?" << endl;
        cin >> input;
        teamIndices[1] = stoi(input, NULL, 10);
        cout << "What is the index of the first blue team?" << endl;
        cin >> input;
        teamIndices[2] = stoi(input, NULL, 10);
        cout << "What is the index of the second blue team?" << endl;
        cin >> input;
        teamIndices[3] = stoi(input, NULL, 10);
        cout << "What is the red score for the match?" << endl;
        cin >> input;
        scores[0] = stoi(input, NULL, 10);
        cout << "What is the blue score for the match?" << endl;
        cin >> input;
        scores[1] = stoi(input, NULL, 10);
        updateTeams(Tourney, teamCt, teamIndices, scores);
    }
    bubbleSort(Tourney, sortedTeamList);
    cout << "Rankings by OPR" << endl;
    for (int i = 0; i < teamCt; i++) {
        cout << i + 1 << ": " << sortedTeamList[i] << endl;
    }
}
```