

Institut für Informatik/UIBK Final Exam Parallel Systems 25. Juni 2008	first name, last name	Student id (Matr.Nr) and study id (Studienkennzahl)
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Insert your name and student id in the grey area above. Only pen and blank paper is allowed for this exam. No extra material such as books, course material, any electronic device, etc. is allowed. The exam is closed book. Indicate a detailed solution description for each question in this exam.

1. Performance Prediction (1.5)

Given the following C program, determine the loop cost in terms of cache lines for the entire loop nest. Assume a cache line size of 4 words and the cache fills up when executing the innermost loop. Show the cache costs for each reference group in addition to the costs for the entire loop.

```
float A[N][N], B[N], C[N];

for (i=0; i< N; ++i)
  for (k=0; k< N; ++k)
    A[i] = A[i]+C[k]*B[i];
```

2. Dependence Analysis (1.5)

Show the dependence and direction vectors for the accesses to X in the following loop nest. State if the dependencies are true or anti dependencies. Finally, indicate whether any loop nest can be safely executed in parallel.

```
for (i=2; i< 10; ++i)
  for (j=2; j< 10; ++j) {
    X(I,J) = A(I)+B(J)
    Y(I,J)=Y(I,J)+X(I,J-1)
    Z(I,J)=X(I+1,J-1)+X(I,J+1)
  }
```

3. Code Optimization (1.0)

Using techniques discussed in the class, modify the following code section to possibly improve its memory behaviour. Also recall that in C programs, the rightmost dimension is contiguous in memory. Name all transformations that you apply and state why you have applied them and why it improves performance.

```
float A[1024][1024], B[1024][1024], C[1024][1024];

for (i=0; i< 1024; ++i)
  for (j=0; j< 1024; ++j)
    A[i][j] = B[j][i]+C[j+1][i];
```

4. Computer Evaluation (1.0)

- Explain the isospeed scalability
- Explain Sun and Ni's law