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Parallelism and Locality

1. How do parallelism and locality get used in modern microprocessor designs?

Assumptions

- 20 issue OOO processor, unlimited window size
- Perfect branch prediction
- 4 MB F.A. 1-word line cache, single cycle access
- 100 cycle main memory access
- Nonblocking cache
- No structural hazards

1. Program mallocs and initializes a 1 MB linked list data structure
2. Program runs a C loop:

```
for (p=head; p!=NIL; p = p->link)
    ++(p->value);
```

```
        J       test
loop:   LW      R5, 0(R4)
        ADDI    R5, R5, #1
        SW      R5, 0(R4)
        LW      R4, 4(R4)
test:   BNEZ    R4, loop
```

Assume 100,000 iterations with this data set

1. X and Y are in main memory
2. C loop:

```
for (i=0; i < 100,000; i++)
    Y(i) = a*X(i) + Y(i);
```

```
foo:  LD     F2, 0 (R1)       ; load X(i)
      MULTD  F4, F2, F0       ; multiply a*X(i)
      LD     F6, 0 (R2)       ; load Y(i)
      ADDD   F6, F4, F6       ; add a*X(i) + Y(i)
      SD     0 (R2), F6       ; store Y(i)
      ADDI   R1, R1, #8       ; increment X index
      ADDI   R2, R2, #8       ; increment Y index
      SGTI   R3, R1, #100000; test if done
      BEQZ   R3, foo          ; loop if not done
```

2. Which loop is faster? Why? How much faster?