Parallel Performance

Mohamed Iskandarani

December 2, 2008
Outline

Amdahl
Amdahl’s law

- **Definitions:**
  - $t_s(P)$ execution time of serial portion on $P$ processors
  - $t_p(P)$ execution time of parallel portion on $P$ processors
  - Speedup = \( \frac{\text{time on 1 processors}}{\text{time on P processors}} = \frac{t_s(1) + t_p(1)}{t_s(P) + t_p(P)} \)

- **Assumptions**
  1. uniform serial time: $t_s(1) = t_s(P) = t_s$.
  2. parallel overhead is negligible: $t_1(P) = Pt_p(P)$
Amdahl’s law

\[
S = \frac{t_s + t_p(1)}{t_s + \frac{t_p(1)}{P}} = \frac{1}{\frac{t_s}{t_s + t_1(P)} + \frac{t_p(1)}{P[t_s + t_p(1)]}}
\]

\[
= \frac{\beta_A + \frac{1-\beta_A}{P}}{1}
\]

\[
\beta_A = \frac{t_s}{t_s + t_1(P)} = \text{serial fraction}
\]
Amdahl’s law for fixed $\beta_A$
Amdahl’s law for fixed $P$
Gustafson’s law

\[ S = \frac{t_s + Pt_p(P)}{t_s + t_p(P)} = \frac{t_s}{t_s + t_p(P)} + P \frac{t_p(P)}{t_s + t_p(P)} \]

\[ \beta_G = \frac{t_s}{t_s + t_p(P)} = \text{scaled serial fraction} \]
Amdahl-Gustafson’s equivalence

\[(1 - \beta_A)t_s = \beta_A t_p(1)\]

\[(1 - \beta_G)t_s = \beta_G t_p(P)\]

\[\frac{(1 - \beta_A)}{(1 - \beta_G)} = P \frac{\beta_A}{\beta_G}\]
π Timings for various $N$
$\pi$ Scalability for various $N$
Scalability for various $N$

- Thick black line is ideal speed-up
- low $N$ does not scale
- $S$ deteriorates as $P$ increases
- $S$ measures efficiency
MPI derived data type

- Specify **non-contiguous** areas in memory
- Column of a table stored row-wise
- `MPI_Type_Vector(count, blocklength, stride, &oldtype, newtype, info)`
- `MPI_Type_Commit(newtype, info)`
- `MPI_Type_free(newtype, info)`
MPI derived data type

- MPI_Type_Vector(count, blocklength, stride, & oldtype, newtype, info)

- integer :: count
  number of copies

- integer :: blocklength
  the number of elements of the old data type

- integer :: stride
  stride in memory of old data type

- integer :: oldtype
  old data type

- integer :: newtype
  new data type created
**MPI derived data type**

```
MPI_Vector_Type(5,1,7,MPI_INTEGER,newt,info)
```