\[\chi\]

- Pipeline setup time and memory latency can be added to
- \( T = \) clock cycle in seconds,
- \( \chi = \) stages in pipe (one clock cycle per stage),

A simple model can be derived using 2 basic architectural

Simple Vector Timing Model
execution rate.

\[
\lim_{n \to \infty} \frac{\alpha t}{u} = \lim_{n \to \infty} \frac{\alpha t}{u} = \frac{\alpha t}{u} \cdot 
\]

operations per second:

\[
\lim_{n \to \infty} \frac{1}{\alpha t} = \lim_{n \to \infty} \frac{1}{\alpha t} = \frac{1}{\alpha t} \cdot 
\]

where time \( t_0 \) is called the startup time;

where \( t_0 \) is the rate of sequential execution in

\[
\alpha t \cdot u + 0 t = (1 - u) \cdot t + 0 = \alpha t \cdot 
\]

less than that due to latches in pipe;

less than that due to latches in pipe;

\[
\alpha t \cdot u + t \cdot u = \alpha t \cdot 
\]

It follows that for a vector of length \( n \):
(Hockey) that has practical advantages.

Time can be rewritten as the linear function of $u$.

at the asymptotic vector rate during the startup time.

is the number of elements that could be processed.

Define $u \equiv \frac{\tau}{0} (I - I)$.
You do not have to have α or other low level parameters.

∞ \frac{n_t}{\tau / \tau u + u} = α_t

(\tau + \tau / \tau u) \tau =

τ + \tau / \tau u =

τ + 0 = α_t
\[
\frac{d + 1}{\infty_{\frac{u}{u} \mid u}} = \frac{\infty_{\frac{u}{u} \mid u} + u}{\infty_{\frac{u}{u} \mid u}} = \frac{u}{u} = \frac{u}{u} \\
\text{Performance (operations per second) for vector length n.}
\]
\[ q_f(n - 1) + \alpha_f n = t \]

In vector mode, time can be written if some fraction of the computations are performed.

\[ \text{scalar mode.} \]

Let \( t^v \) be the amount of time it takes to perform all in vector mode at the asymptotic performance rate \( n \to \infty \), i.e.,

\[ \text{ignore the effects of startup costs.} \]

Let \( t^s \) be the amount of time it takes to perform all in scalar mode at the asymptotic performance rate \( n \to \infty \), i.e.,

\[ \text{mix of scalar and vector processing.} \]

Suppose there are \( n \) computations to be performed using a

**Amdahl's Law**
\[
g^* = t_s = \frac{\hat{t}_v}{t} = \frac{t_v}{t} = \frac{1}{1 - \frac{v}{n \tau}} = g \lambda = g R_\infty
\]

The speedup over sequential processing is given by

\[
g = \frac{t_v}{t} = \frac{\hat{t}_v}{t} = \frac{n \tau}{n \tau + (1 - v) n \tau \lambda} = \frac{n \tau}{n \tau + (1 - v) n \tau \lambda}
\]

The time relative to perfect vector performance is

\[
\hat{t}_v \leq t \leq t_s \quad \text{and} \quad R_\infty = \frac{r_v}{r_s}
\]
Given efficiency, the larger must be to achieve a gain via vectorization. The returns effect. The more benefit there is to be diminishing returns. Unfortunately, the function 9 for various H shows a clear can be vectorized. speedup possible using vectorization given that unoperations follows that 9 can be viewed as the fraction of the best
\[ n(\infty R - 1) + \infty R = \infty R (n - 1) + n = b \] 
and 
\[ I \geq b > \infty R / I \] 
\[ R < \infty \] 
\[ I \geq n > 0 \]

as a function of \( b \) and \( R \). We have To see how quickly this degradation occurs consider with \( n \)}


<table>
<thead>
<tr>
<th>$r_1^2$</th>
<th>0.50</th>
<th>0.75</th>
<th>0.95</th>
<th>$R$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3</td>
<td>5</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

So consider the fraction, $\frac{r_1^2}{R}$ needed so that $g = 1/2$. It becomes close to 1 very quickly.

Let $\kappa = \frac{\infty R}{a - \infty R} = (a, \infty R)^a$

I.e., the mixed-mode computations run a factor

of a slower than the asymptotic vector rate.
related rates model. You will see many times since it is the simplest possible.

It is the first example of convex combination of which.

Wrong.

It is simply a convex combination so it cannot be.

Responses were of the form "Amadahl's Law is wrong!"

Processors.

It has been used as an argument against vector published.

Amadahl's Law caused great pessimism when it was
The question is not whether it is right or wrong. The questions are "Is it applicable?" and "When it is applicable and optimistic is the computation useful?"