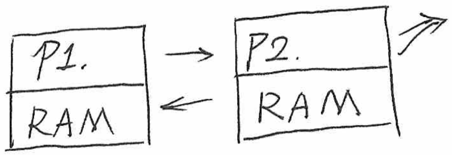
Sep.

multiprocessing
↳ parallel programming.

{shared / distributed} > memory. → threads / → processes.



communication.
message-passing.

duals of each other.
(Laver & Needham, 1979)

Threads   Processes.

new Thread( )

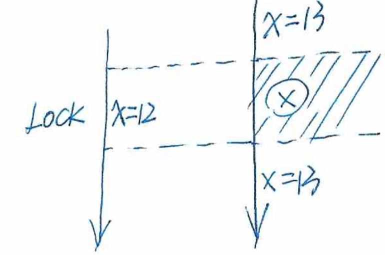
Order of the executions of threads matters.
⇓
RACE. condition
↳ nondeterminism

determinism function: f(x)=f(x)
non function: f(x) ⇒ {12, 13}

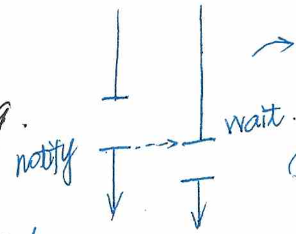
- local variables (stack) unshared.
- thread local value.

Control Ordering < wait for threads / synchronization op.
↳ {prevent concurrency / orders events

Lock mutual execusion.



condition variables.
In C++. this->lock( ) could cause dead lock
In Java. wait( ) and notify( )

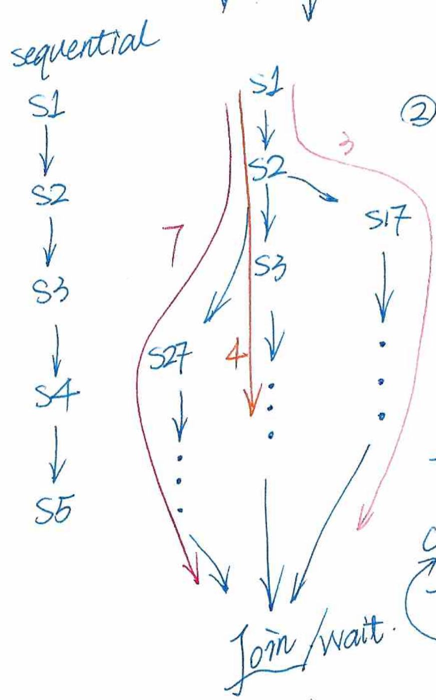


→ "happens-before".

Multithreaded Challengs:
①. Correctness.   Heisenbug.
↳ because of < nondeter / # potential interleavings.

②. (Speed) Performance.

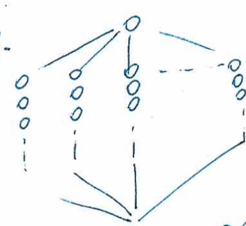
serialization is the enemy.



T_1 : 9 units.
Critical Path: longest sequence
$T_\infty = 7$ "span"

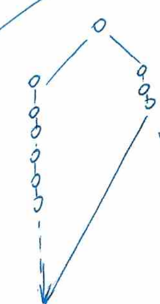
$T_P \le \frac{T_1}{P} + T_\infty$

embarrassingly.



→ $T_1 = 4000,000$, $T_P = 1,000,000$ ⇒ $\frac{4,000,000}{1,000,000} = 4$

Let $T_\infty = 4$.
↓
4+4 = 8



→ load imbalance.