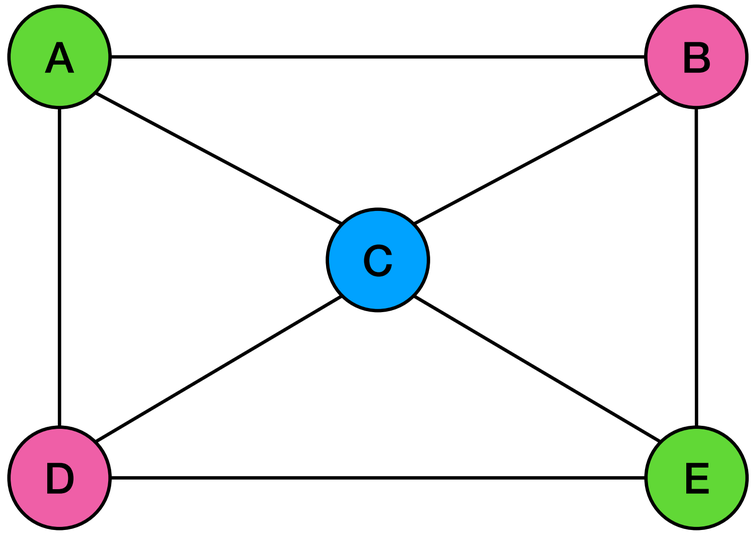
Dealing with Spills

does this always work?

- Modified algorithm:
  - If no node can be safely removed, pick one anyway, mark it as a **potential spill**
  - Keep going

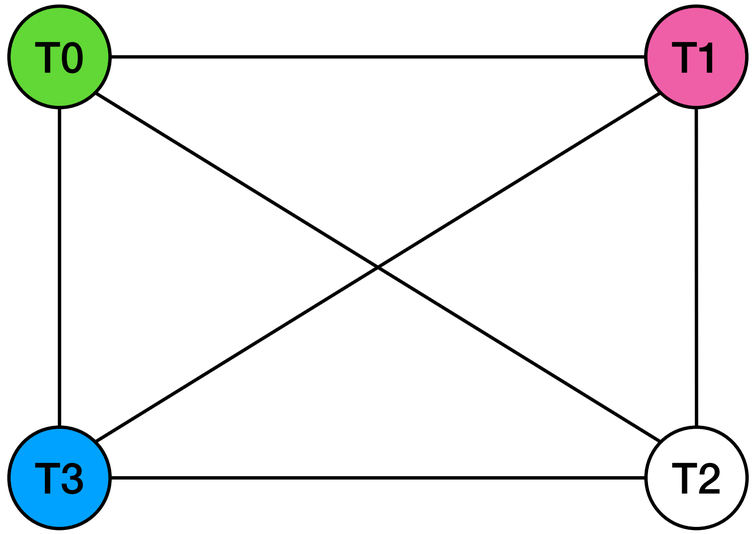
- If graph *still* can't be colored, need to deal with spill



does this always work?

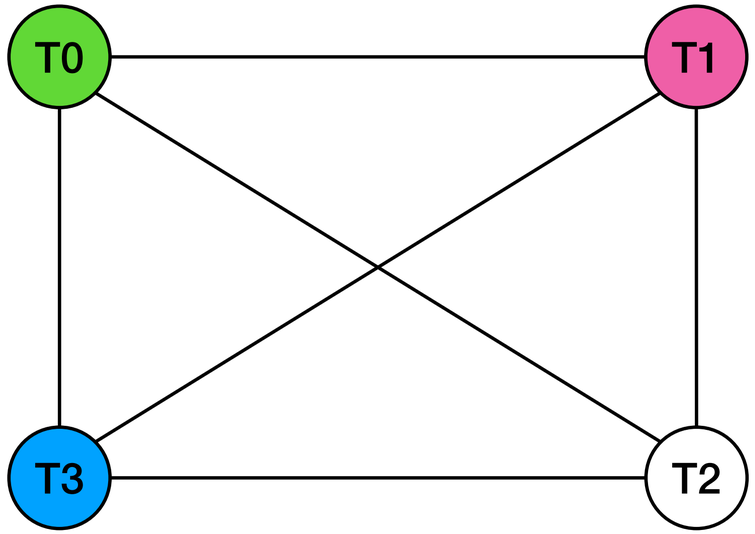
- Modified algorithm:
  - If no node can be safely removed, pick one anyway, mark it as a **potential spill**
  - Keep going

- If graph *still* can't be colored, need to deal with spill



what do we do?

- If a variable cannot be assigned to a register, it needs to be placed on the stack
- Need to generate extra instructions to load/store from stack --- those instructions need registers too!
- Naïve approach: reserve registers for managing spills
- Better approach: **rewrite code**



code rewriting

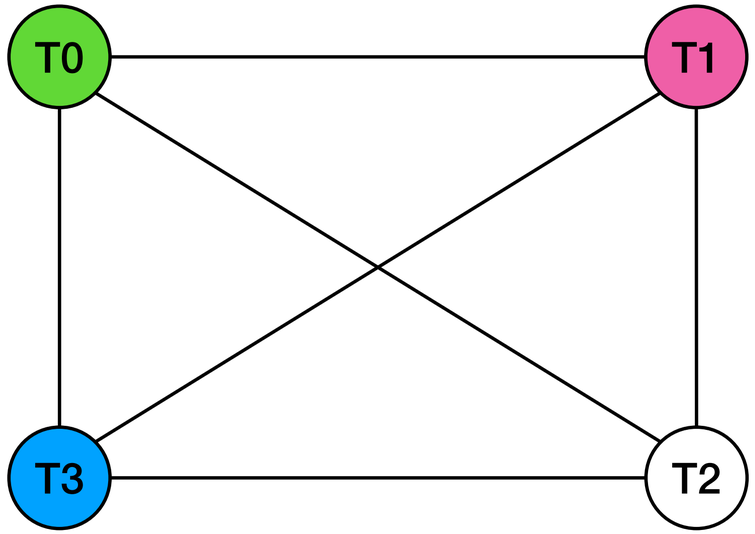
- Assign spilled temporary to memory location (e.g., T2)
- Introduce a new temporary for each instruction that uses T2

T2 = T0 + T1

becomes

T19 = T0 + T1

SW T19, [stack location of T2]



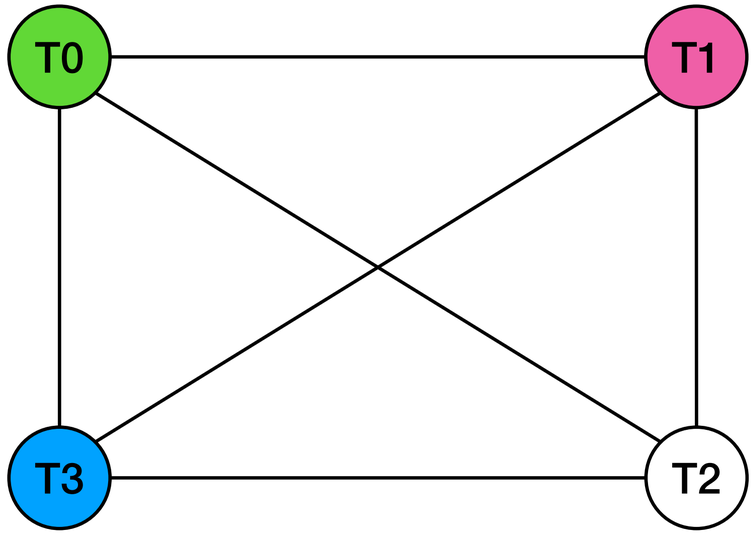
code rewriting

- Assign spilled temporary to memory location (e.g., T2)
- Introduce a new temporary for each instruction that uses T2

T1 = T2 + T3

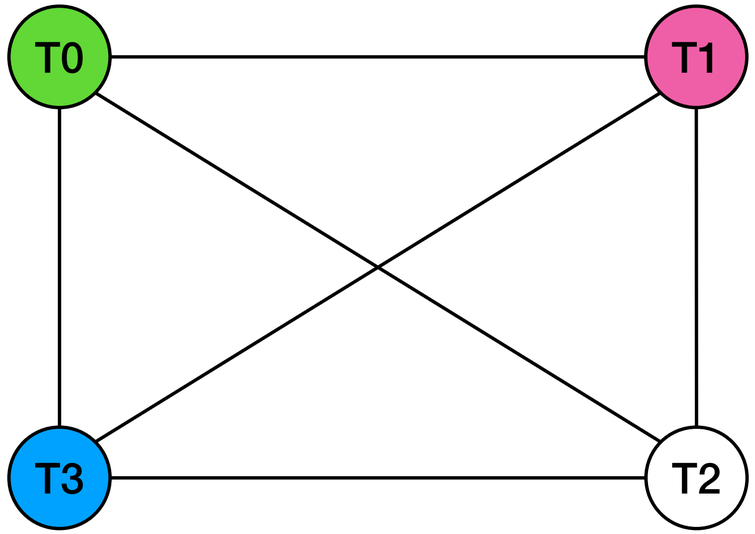
becomes

LW T37, [stack location of T2]
T1 = T37 + T3



code rewriting

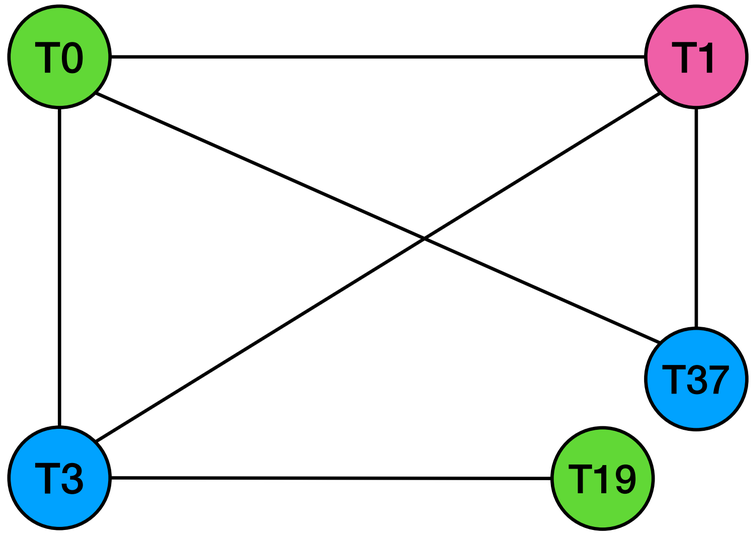
- Assign spilled temporary to memory location (e.g., T2)
- Introduce a new temporary for each instruction that uses T2
- Rerun liveness analysis, register allocation algorithm



code rewriting

- Why does this help?
- T2 is eliminated from the graph entirely
- Newly introduced temporaries have very short live range, so not too many edges!
- Less likely to have spills

- This is an example of **live range splitting**
  - Lots of refinement to reduce loads/stores



upshot

- Global register allocation allows for variables to be mapped to the same register across basic blocks
- Live range splitting allows for efficient generation of spill code
- Graph coloring-based allocation is *effective* but potentially *slow*
  - Iteration algorithm that keeps rewriting code, recomputing liveness, redoing allocation
- Many modern compilers, especially JITs, use simpler, but potentially less-efficient register allocators (e.g., linear-scan register allocation)

what do we have?

- We now have a full-featured language:
  - Arithmetic operations
  - Control flow
  - Functions

- And compiler:
  - Code generation
  - Register allocation

- Good base to keep adding features!

next: module 3!