Swap

Problem

Swap two integers x and y.

```
t = x;
x = y;
y = t;
```

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No-Temp Swap

Problem

Swap two integers x and y without using a temporary.

```
x = x ^ y;
y = x ^ y;
x = x ^ y;
```

Example

x	10111101	10010011	10010011	00101110
y	00101110	00101110	10111101	10111101

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y = x ^ y;
x = x ^ y;
```

Example

x	10111101	10010011	10010011	00101110
y	00101110	00101110	10111101	10111101

Why it works

XOR is its own inverse: $(x \wedge y) \wedge y = x$.

Performance

Poor at exploiting instruction-level parallelism (ILP).

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Minimum of Two Integers

Problem

Find the minimum r of two integers x and y.

```
if (x < y)
  r = x;
else
  r = y;
```

or

```
r = (x < y) ? x : y;
```

Performance

A mispredicted branch empties the processor pipeline

- ~16 cycles on the cloud facility's Intel Core i7's.

The compiler might be smart enough to avoid the unpredictable branch, but maybe not.

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No-Branch Minimum

Problem

Find the minimum z of two integers x and y without a branch.

```
r = y ^ ((x ^ y) & -(x < y));
```

Why it works:

- C represents the Booleans TRUE and FALSE with the integers 1 and 0, respectively.
- If $x < y$, then $-(x < y) = -1$, which is all 1's in two's complement representation. Therefore, we have $y \wedge (x \wedge y) = x$.
- If $x \geq y$, then $-(x < y) = 0$. Therefore, we have $y \wedge 0 = y$.

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