A little bit of physics

1 year = 365 days = 3×10^7 seconds/year

$T \approx 20$ billion years
$\approx 2 \cdot 10^{10}$ years
$= 6 \times 10^{17}$ seconds

$\Delta t = \frac{\text{dist}}{\text{velo.}}$

$\frac{T}{\Delta t} \leftarrow$ smallest possible time interval

t = time during which the light goes through the smallest elementary particle.

Heisenberg's uncertainty principle.
$\Delta x \, \Delta p \geq \hbar$ — planck's constant

Q Next Thursday : Quiz / Test.

$a+b$ add(a, b)

$$\begin{cases} \text{add}(m, 0) = m \\ \text{add}(m, n+1) = \text{add}(m, n) + 1 \end{cases}$$

PR $$\begin{cases} f(\bar{m}, 0) = g(\bar{m}) \\ f(\bar{m}, n+1) = h(\bar{m}, n, f(\bar{m}, n)) \end{cases}$$

General case $k = 1$

$$\begin{cases} f(m_1, 0) = g(m_1) \\ f(m_1, n+1) = h(m_1, n, f(m_1, n)) \end{cases}$$

$$\begin{cases} f(m_1, 0) = g(m_1) = \pi_1^1 \\ f(m_1, n+1) = f(m_1, n) + 1 \end{cases}$$

$\Rightarrow h = \sigma \circ \pi^3_3 \Rightarrow a+b$ is $PR(\pi^3_1, \sigma \circ \pi^3_3)$

Describe in Java code:

$prev(0) = 0$
$prev(n+1) = n$ $\Rightarrow$

```
prev = 0
for (i=0; i<n; i++) {
    prev = i;
}
```

$sub(m, 0) = m$
$sub(m, n+1) = sub(m,n) - 1.$

```
int sub = m;

for (i=0; i<n; i++) {
    prev = 0;
    for (j=0; j<sub; j++)
    {   prev = j; }
    sub = prev;
}
```

+ Big motivation:

1) what is computable?

To prove that something is NOT computable we need to have a formal def. of computable function.

Church's Thesis: ~~Any computable~~
Anything that ~~has~~ can be computed by any computational device can be ~~compiled~~ computed by a Java program.

So to prove that set is not computable we can prove that this Smth can NOT be computed by Java program.

Problem : Java is huge, difficult to describe $\Rightarrow$ it is impossible to prove anything.

We need a simplified definition that will still cover all Java-computable f-s but that will be easier to describe and thus, easier to prove.

1st attempt : Natural #s, σ / for-loops, ++ $\Rightarrow$ p.r fn.

Are we covering all computable f-ns?
Almost all, but not all.

2nd attempt : μ-recursive f.n.

2c) $\mu m\,(b + m == a) \Rightarrow$ This is $a \dot{-} b$

smallest m s.that $b + m == a$

$$\text{if} \begin{cases} a > b \to a - b \\ a \leq b \to 0 \end{cases}$$

+ Prove $a > b$ is μ.rec.

$a > b \Leftrightarrow a - b > 0$

$(a \dot{-} b) > 0$

positive (0) = 0
positive (n+1) = 1

$$\text{positive}(k) = \begin{cases} 1 & \text{if } k > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$\text{positive}(k) = \begin{cases} 1 & \text{if } k > 0 \\ 0 & \text{otherwise} \end{cases} \Rightarrow$$

```
// Java el code :

int positive = 0

for( i=0; i<n; i++ )
{
    positive = 1;
}
```