PPaDS MMXX

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konzultacie dohodou

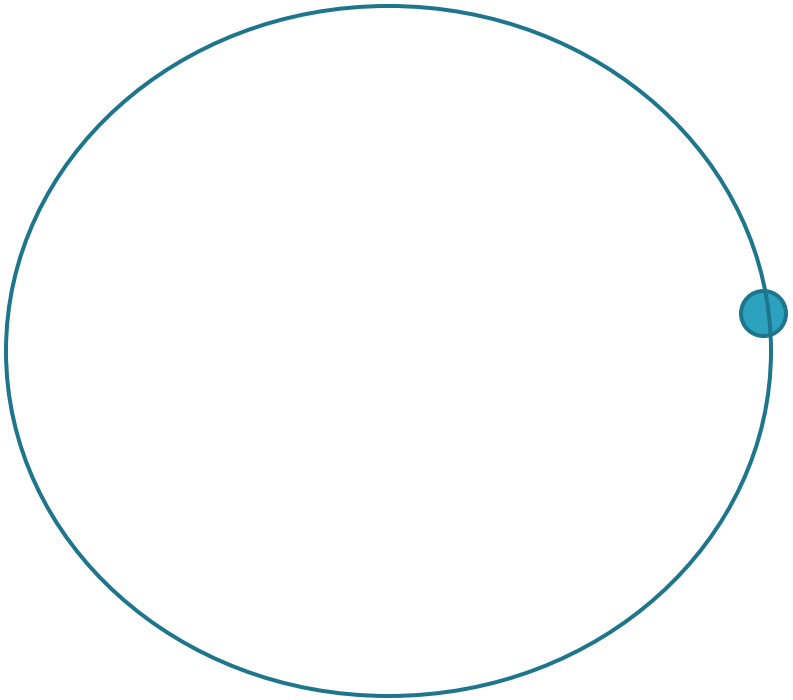
Opakovanie…

- Bariera
- Este raz bariera
- SimpleBarrier cez Event
- Fibonacci

Bariera…

Bariera…

Bariera…



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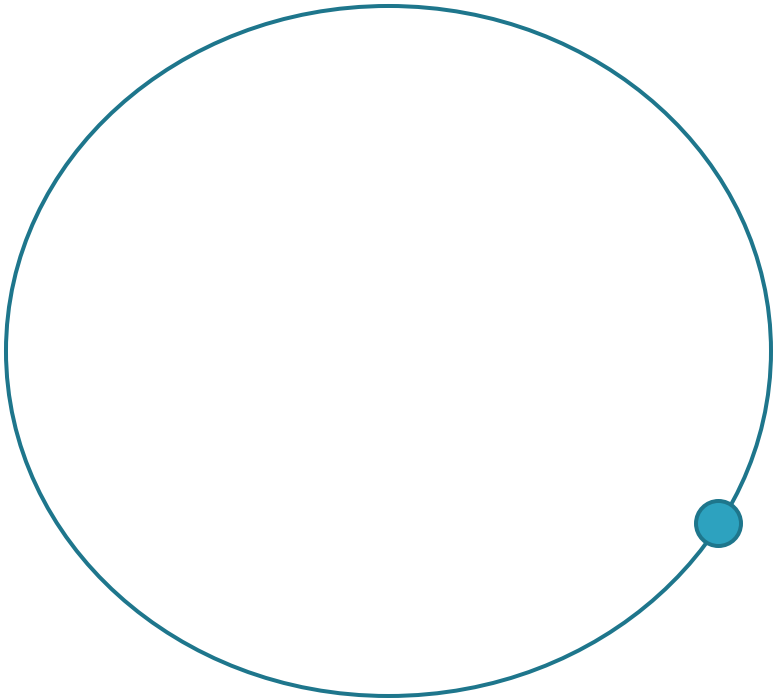

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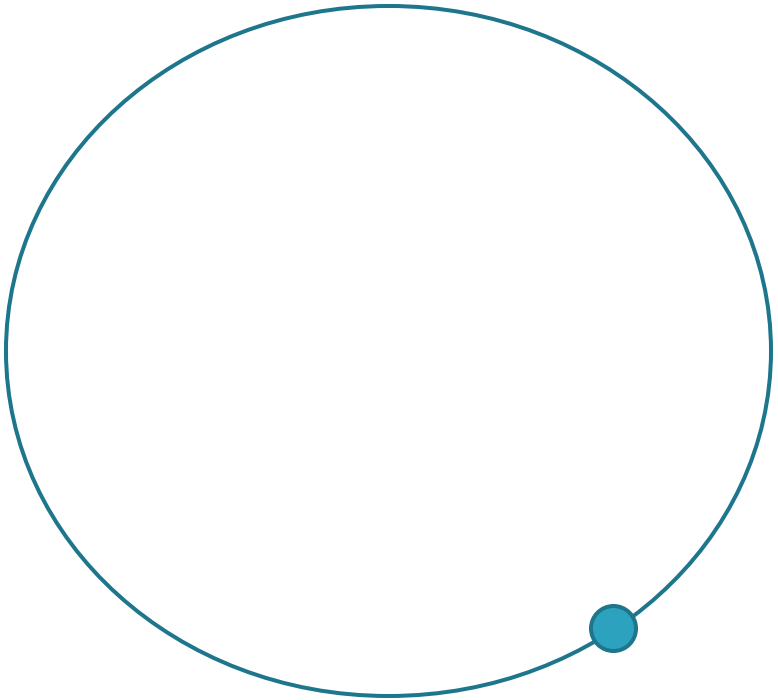

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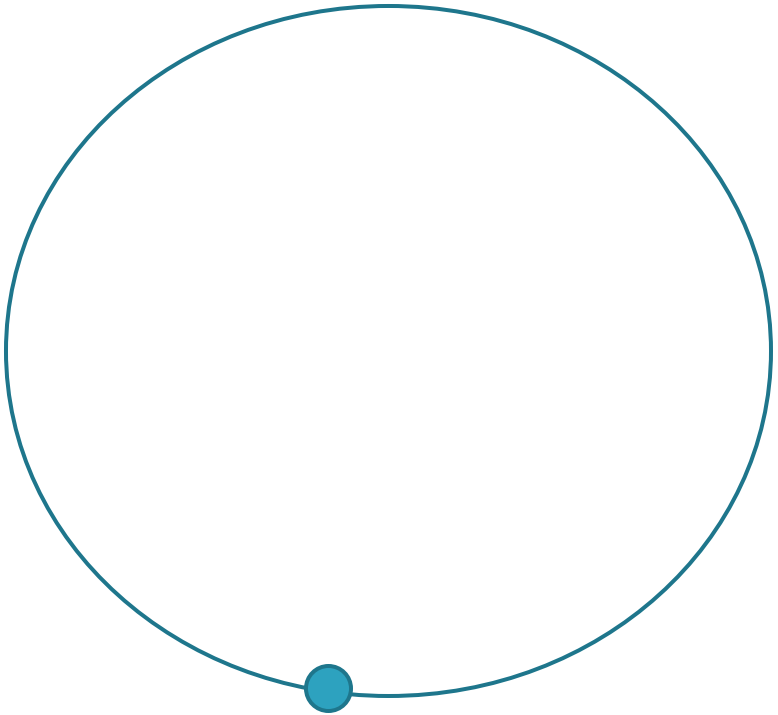

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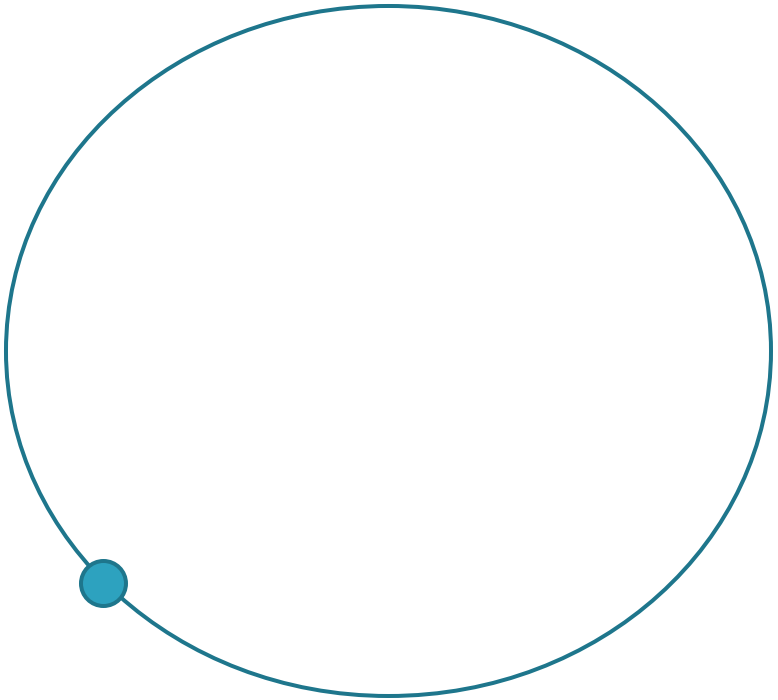

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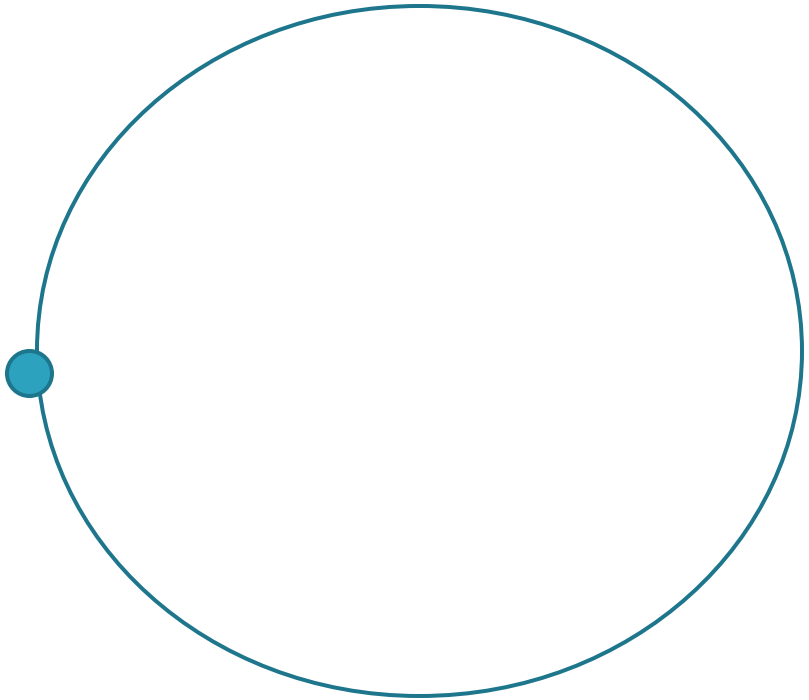

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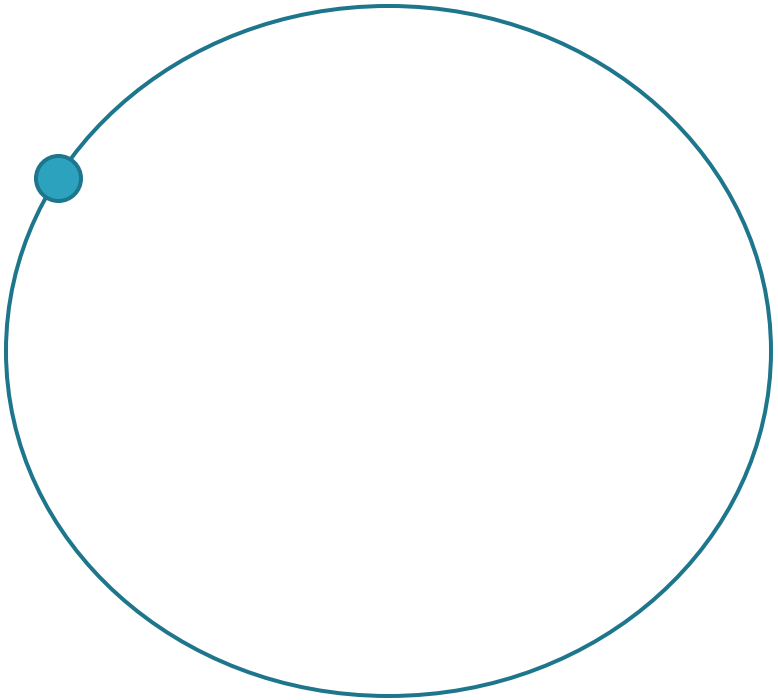

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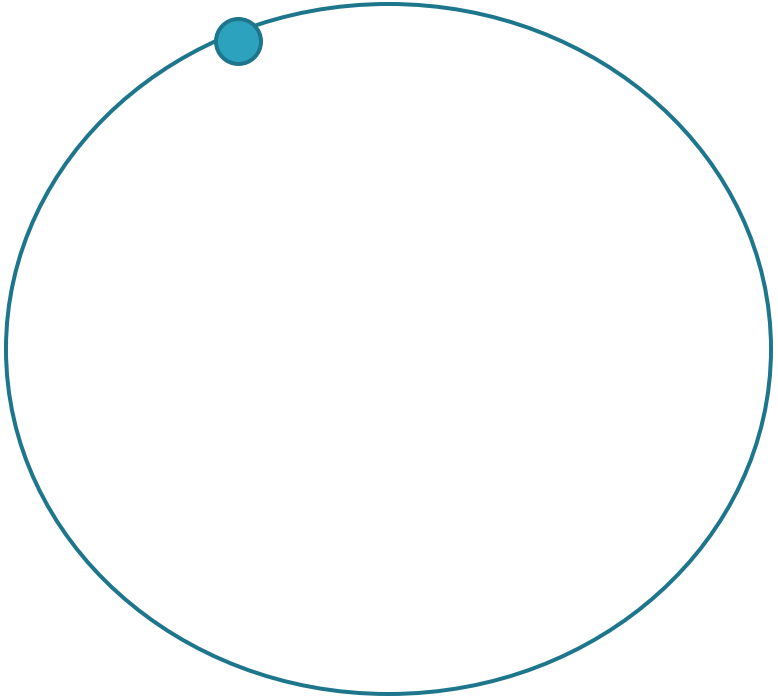

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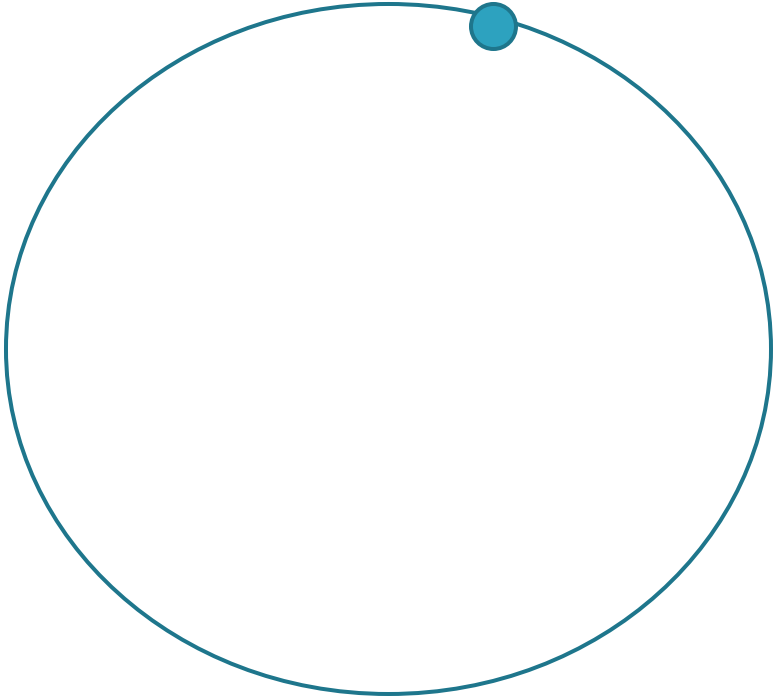

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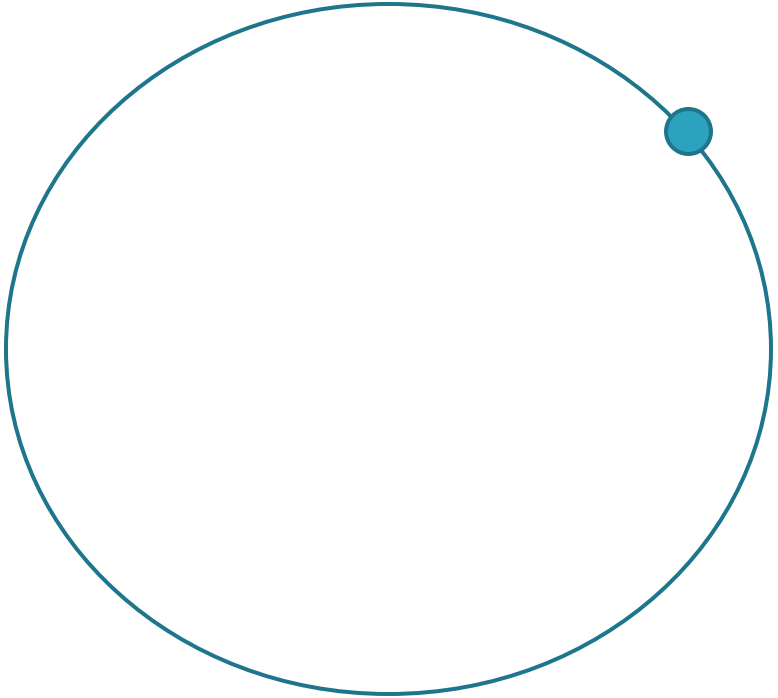

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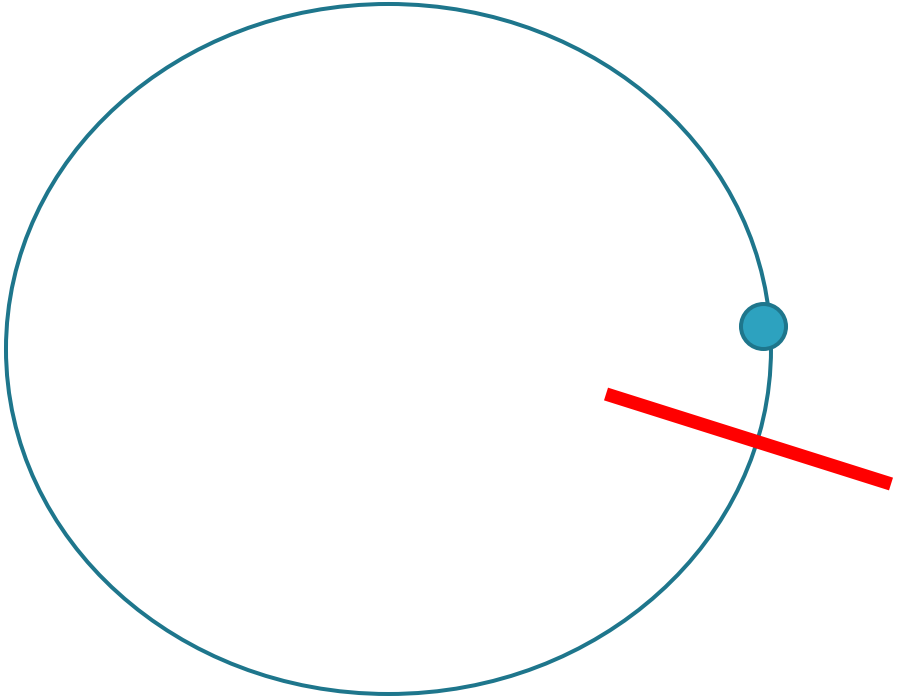

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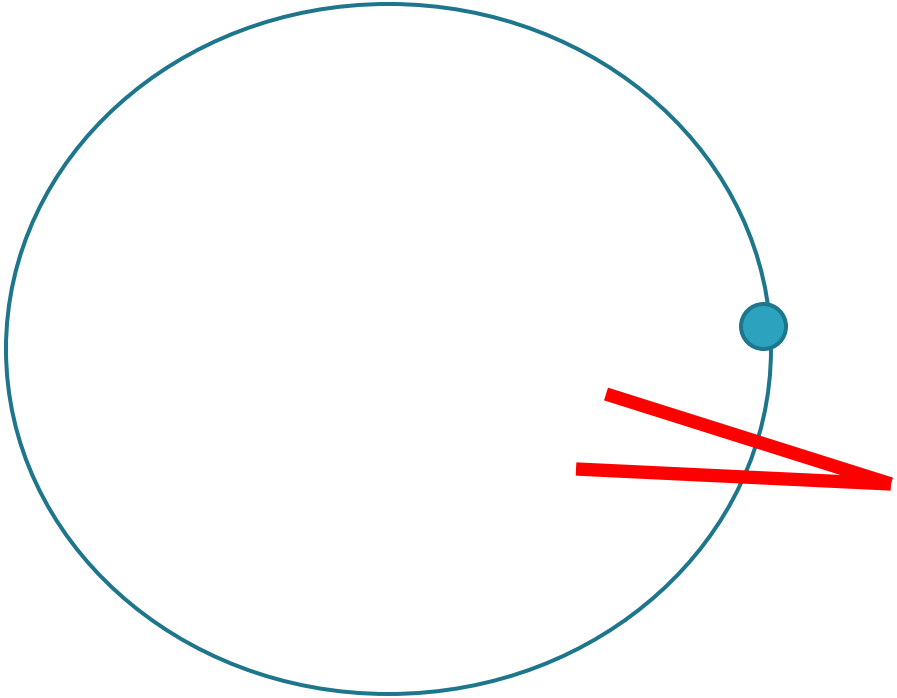

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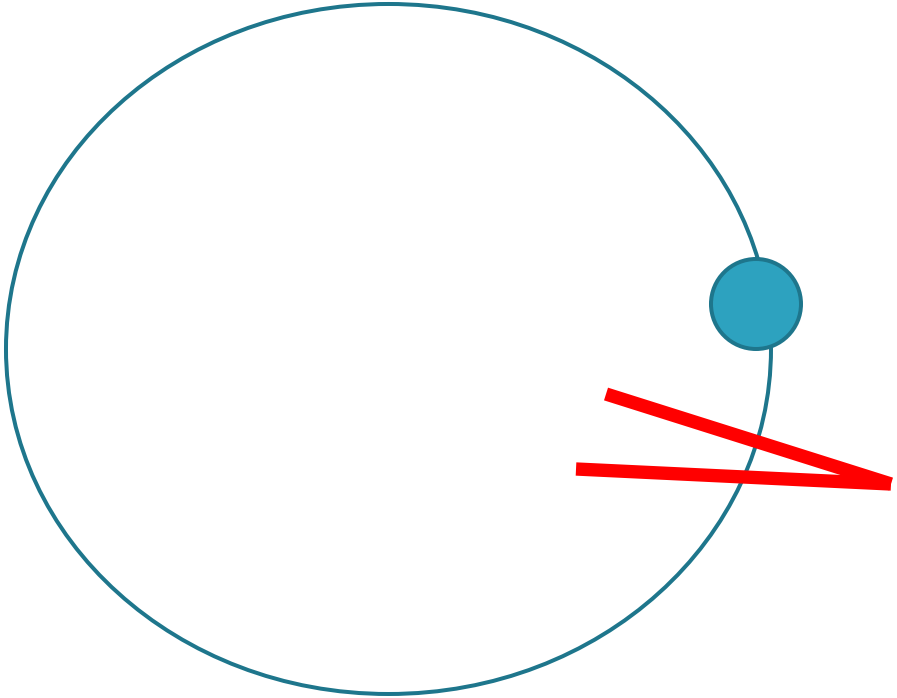

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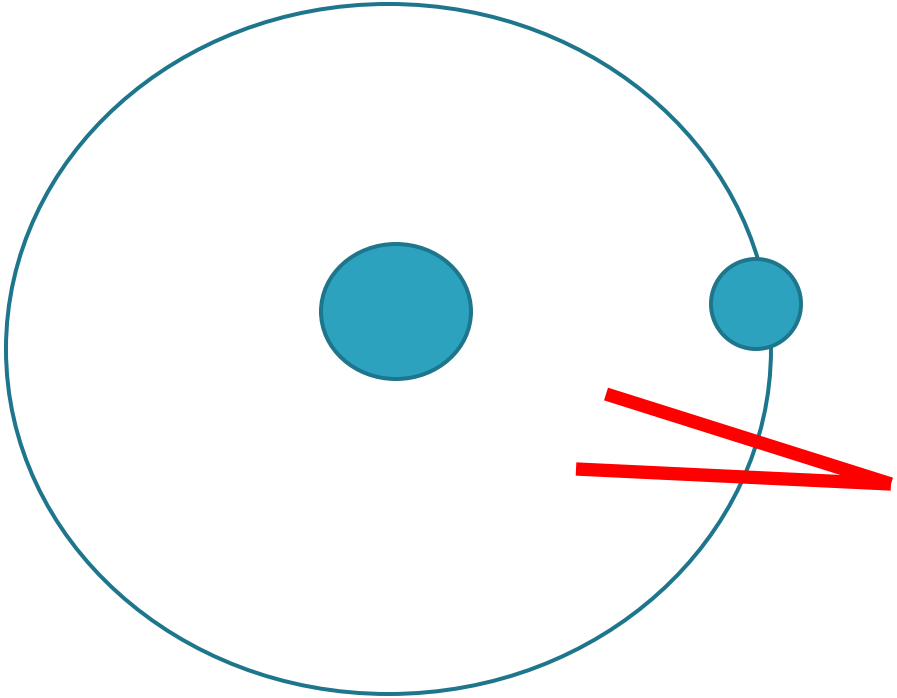

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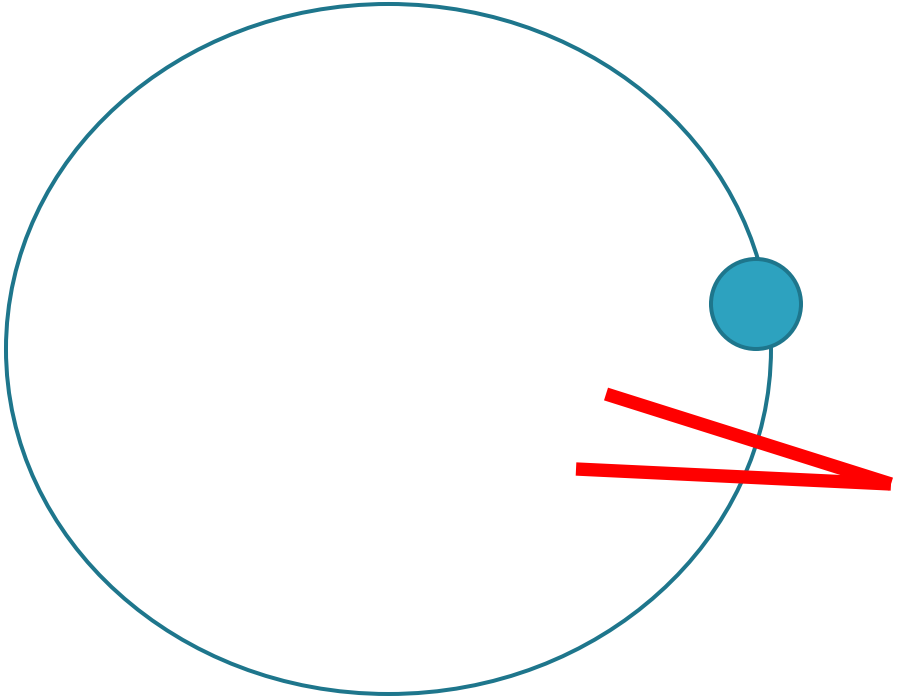

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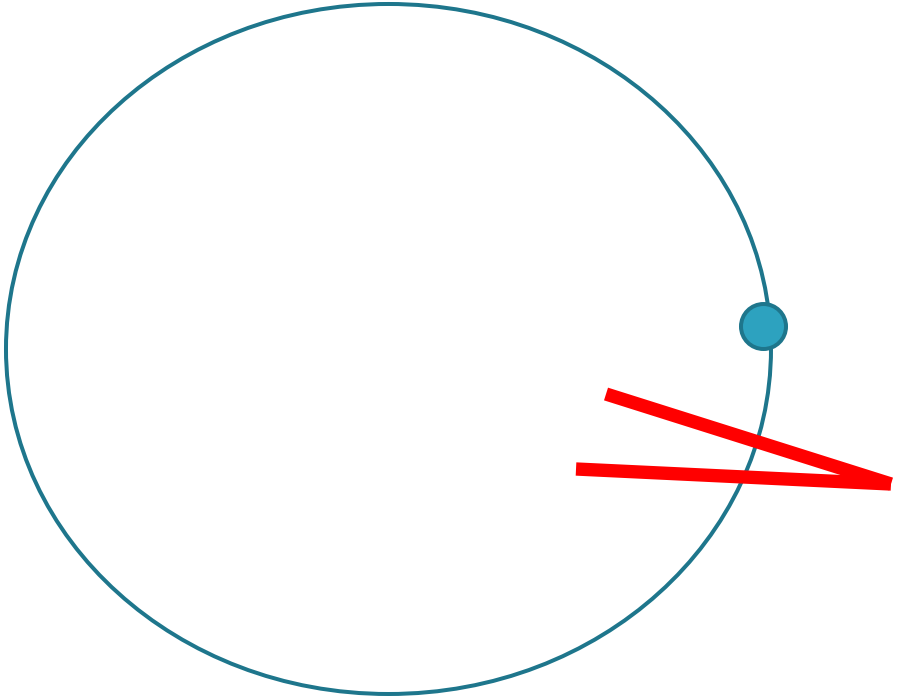

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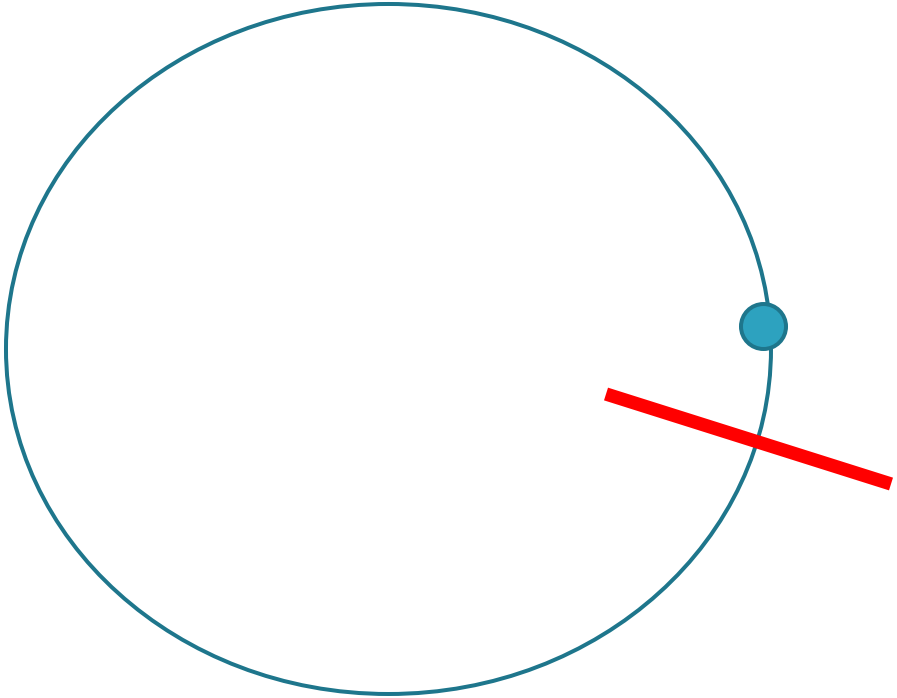

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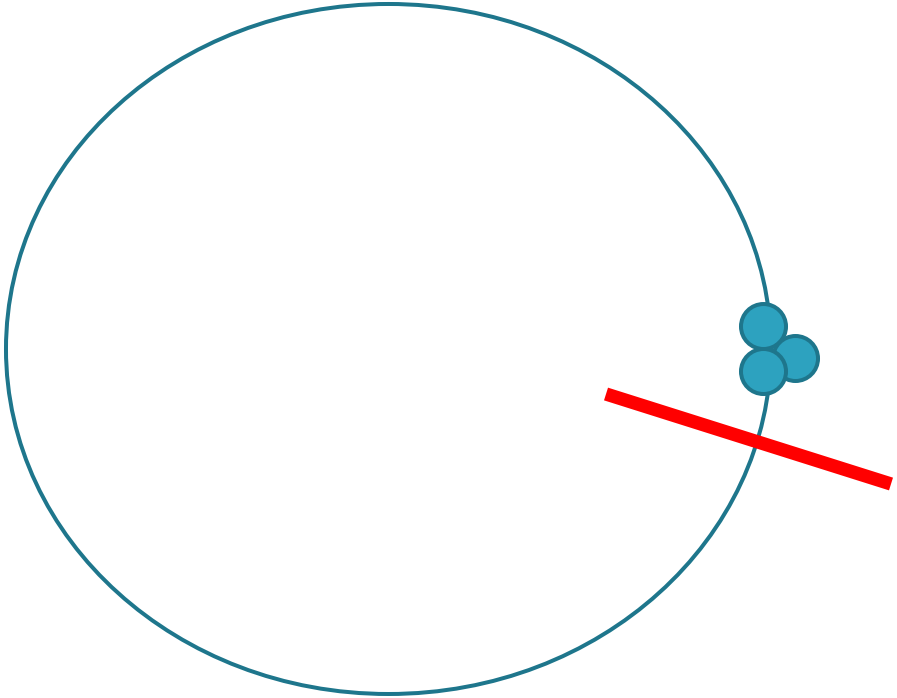

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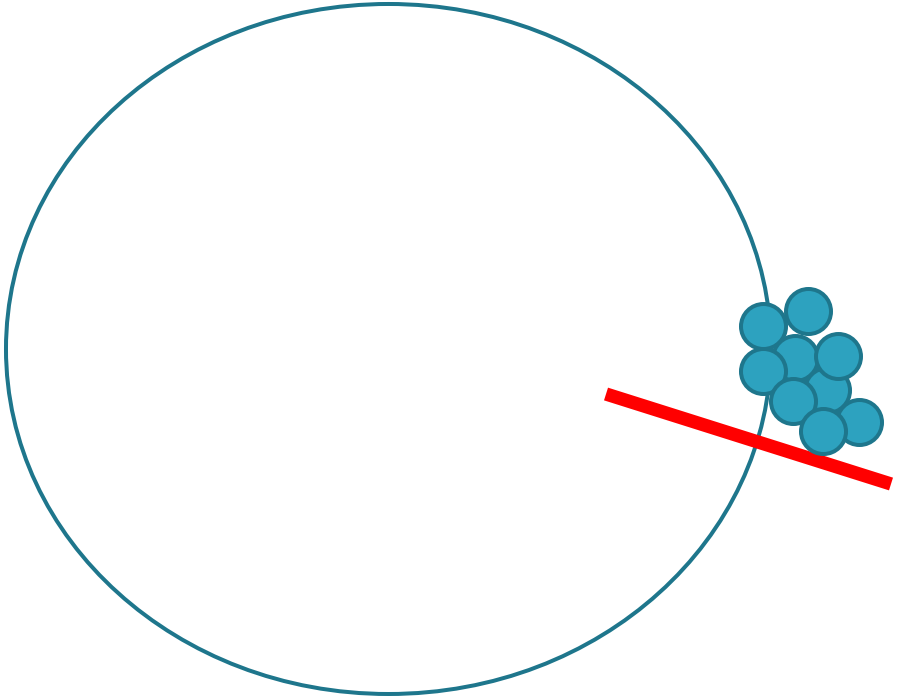

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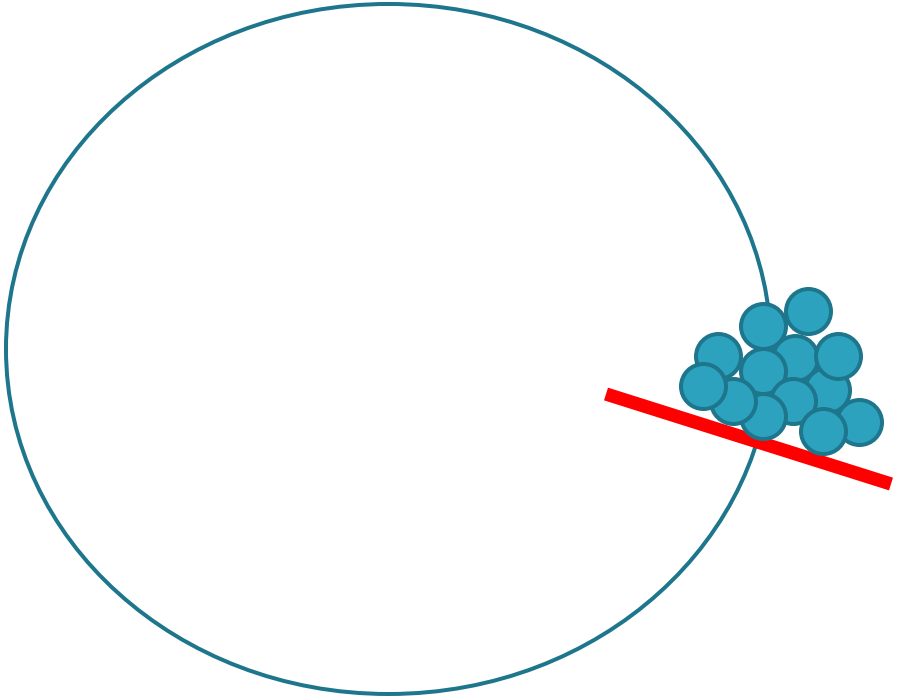

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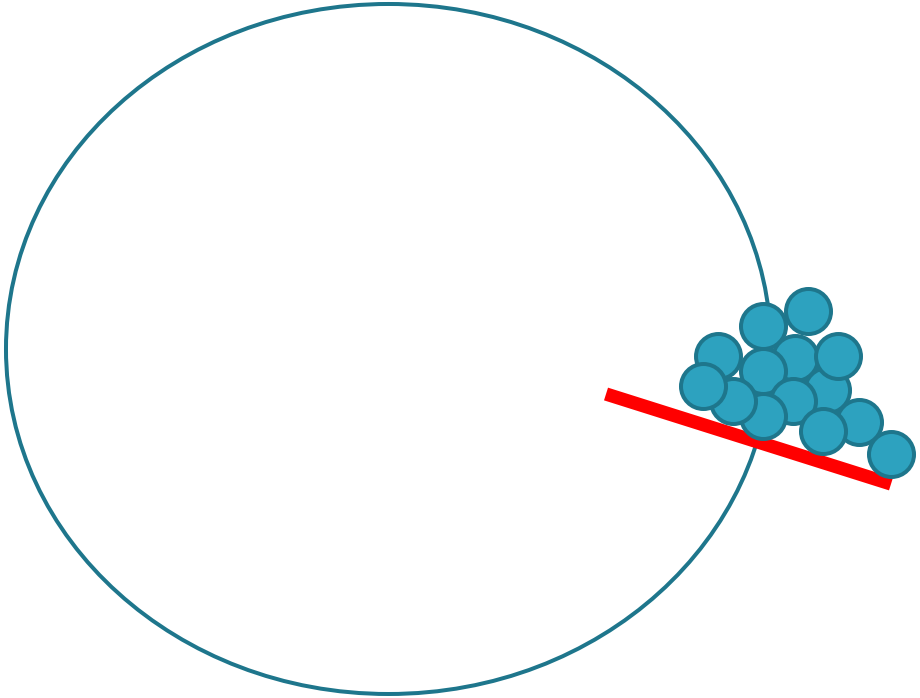

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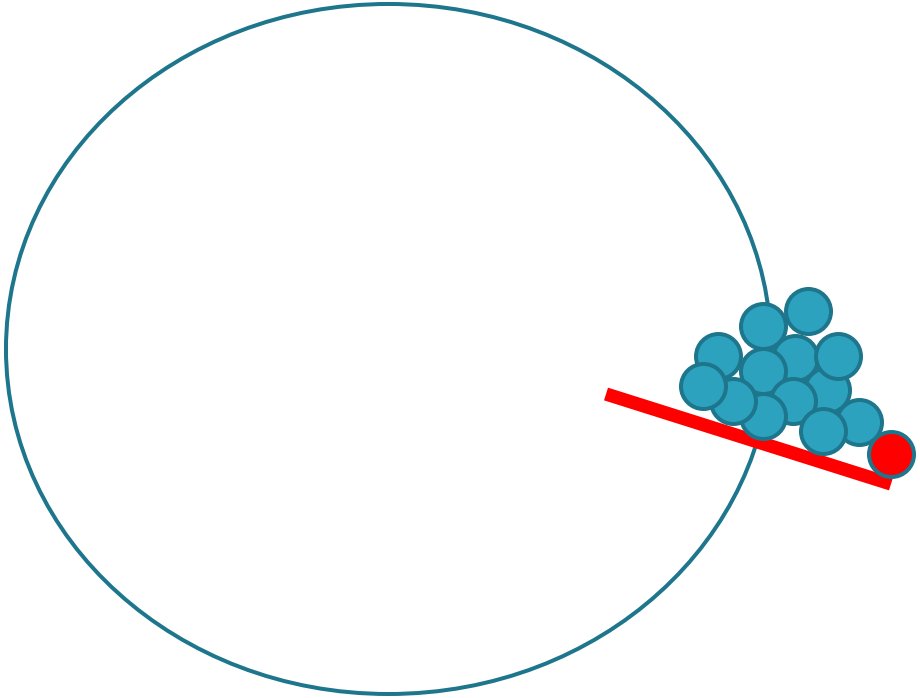

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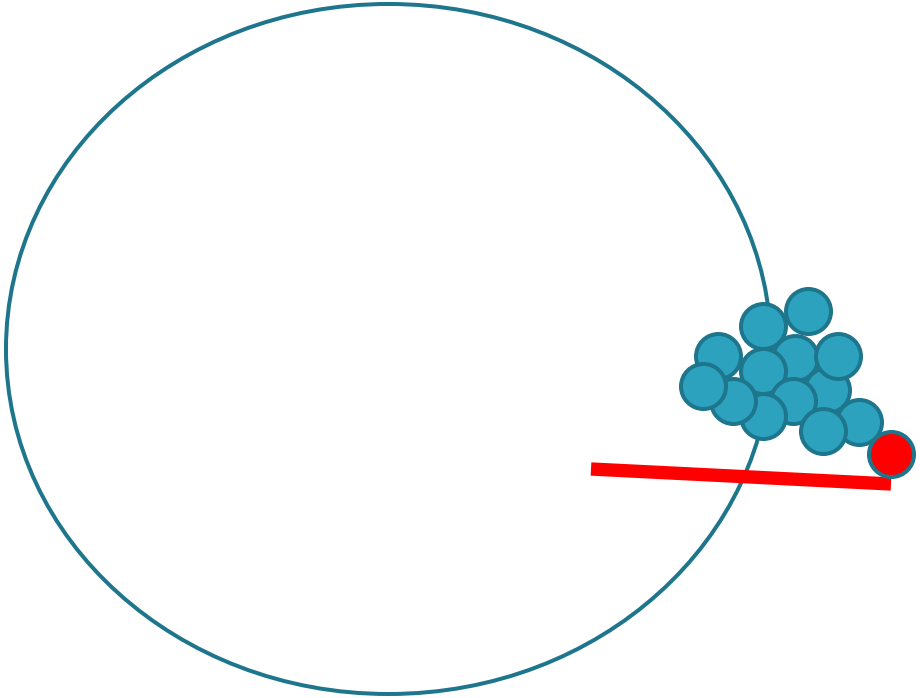

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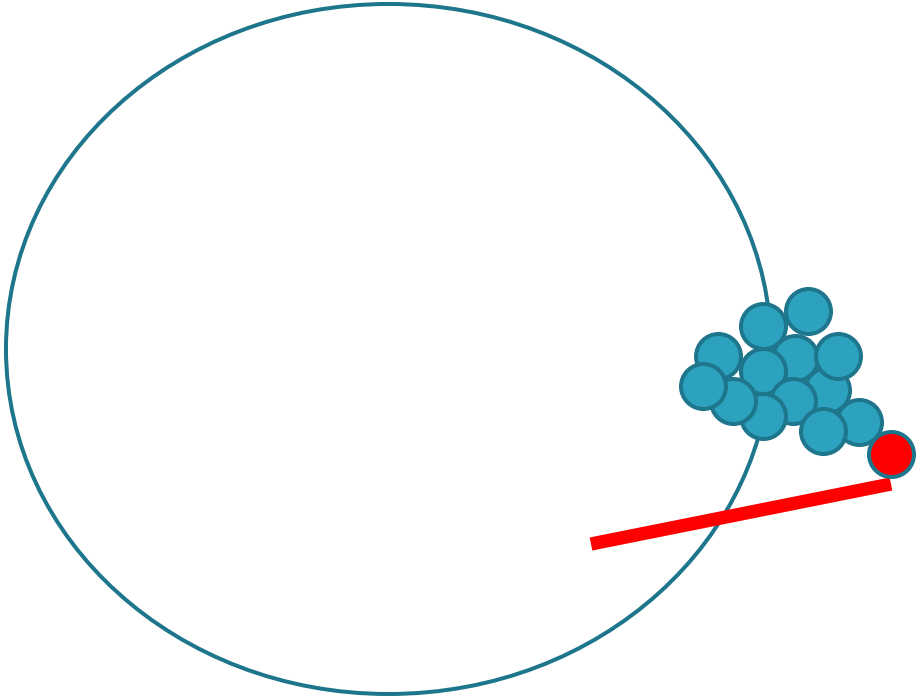

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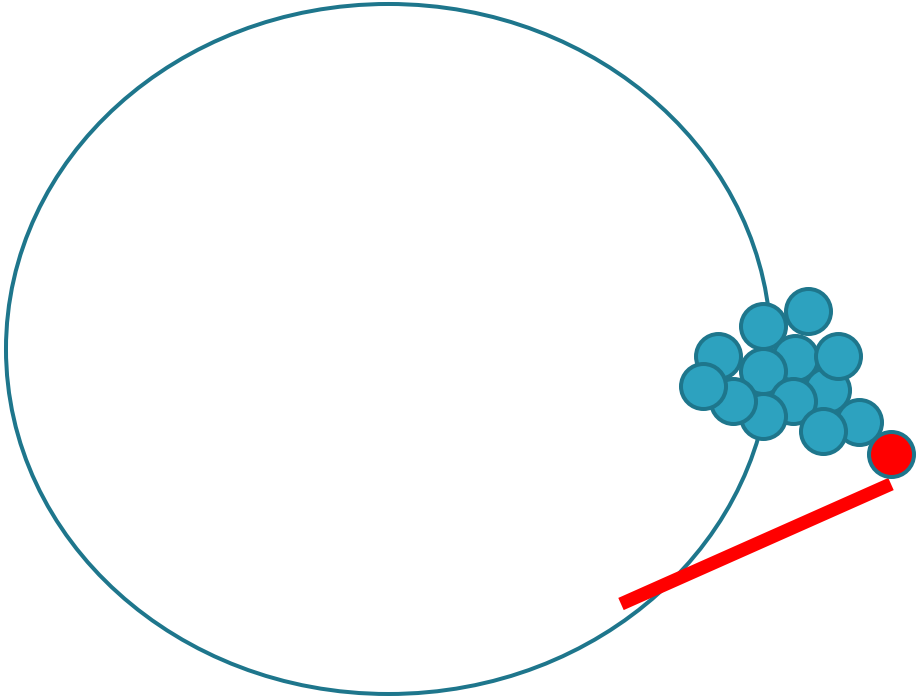

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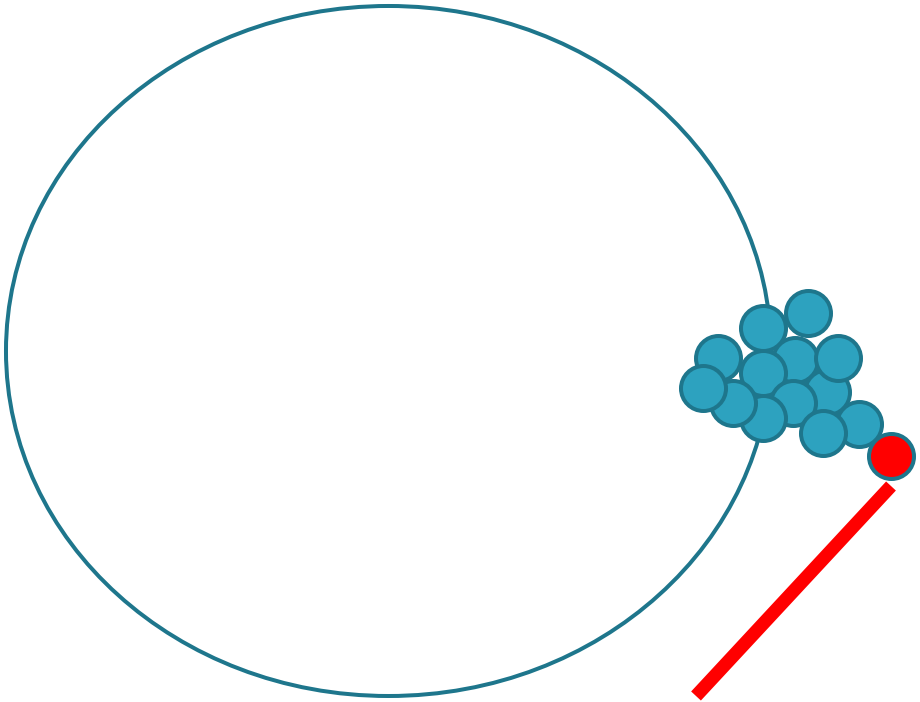

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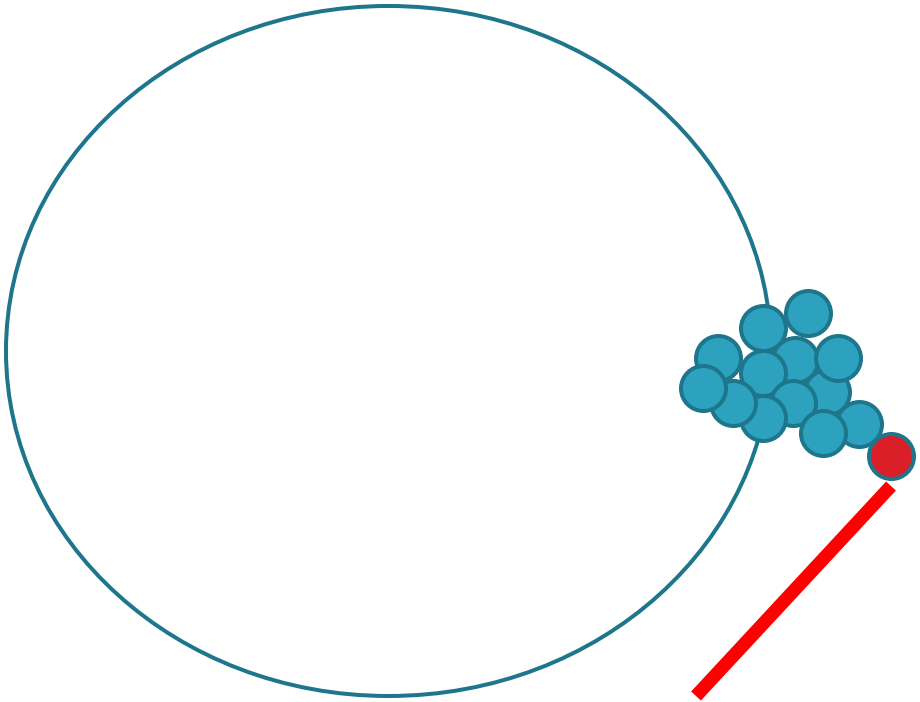

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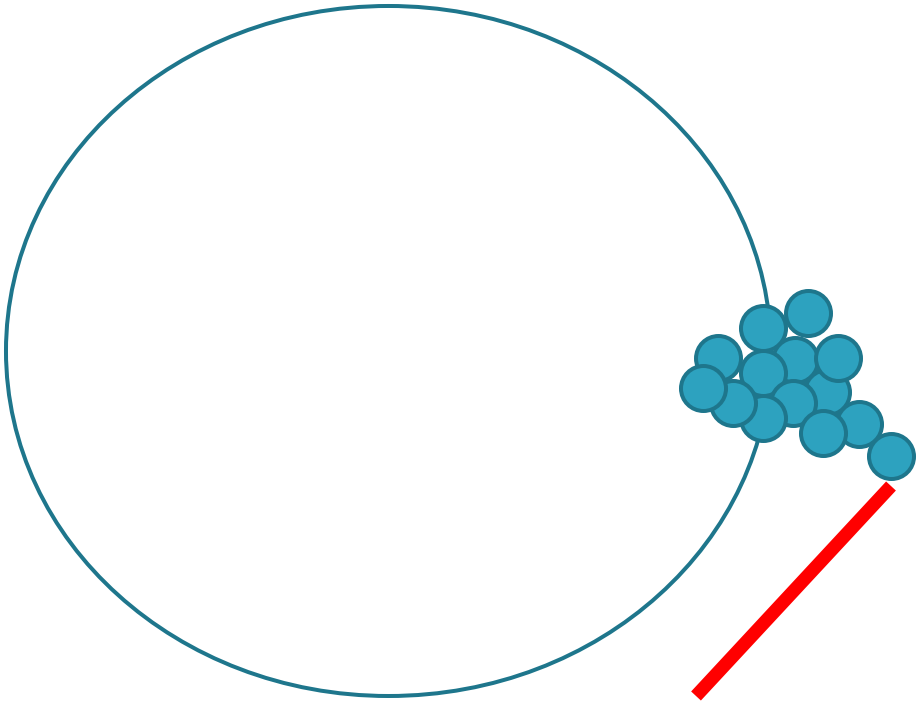

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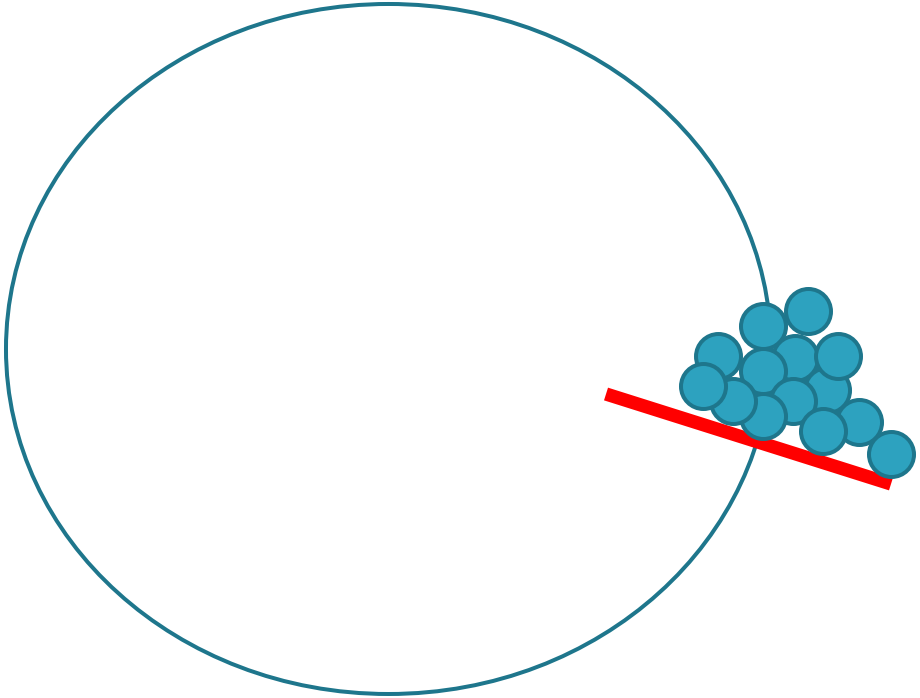

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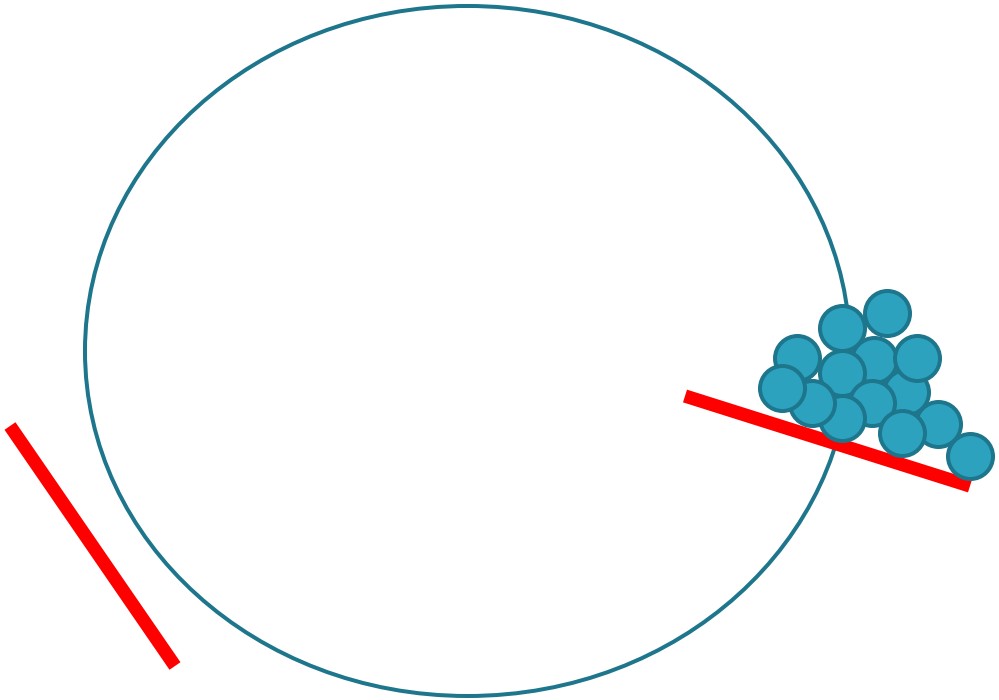

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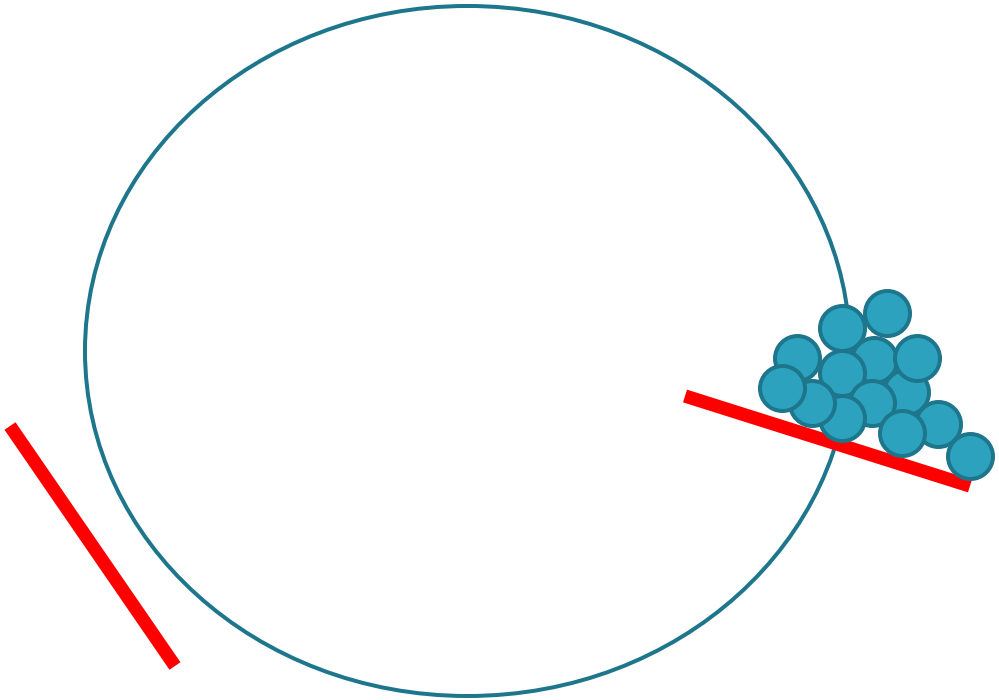

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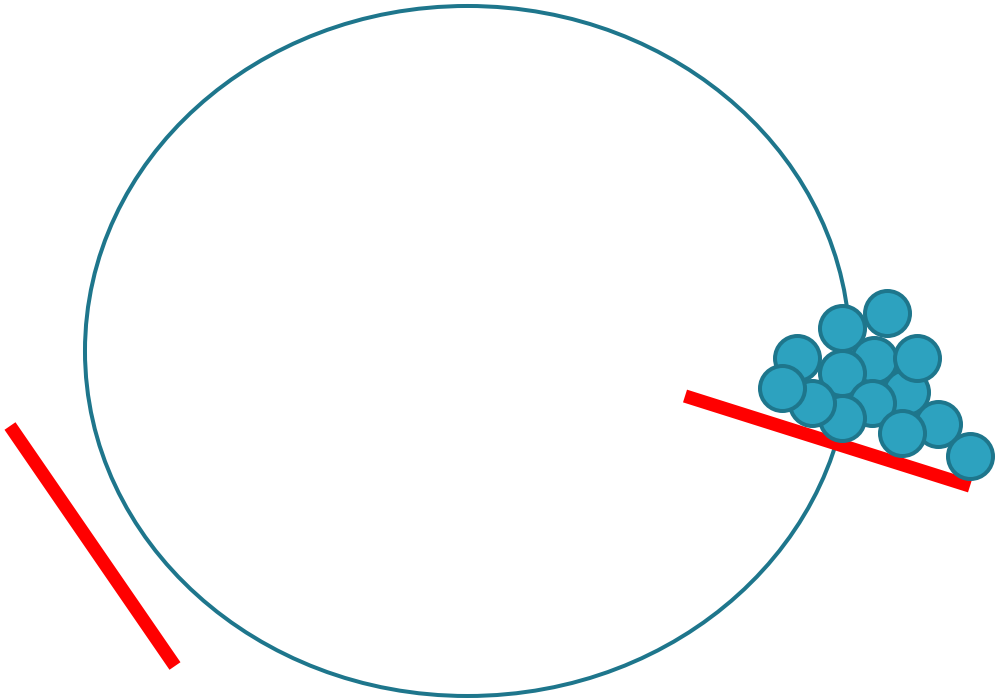

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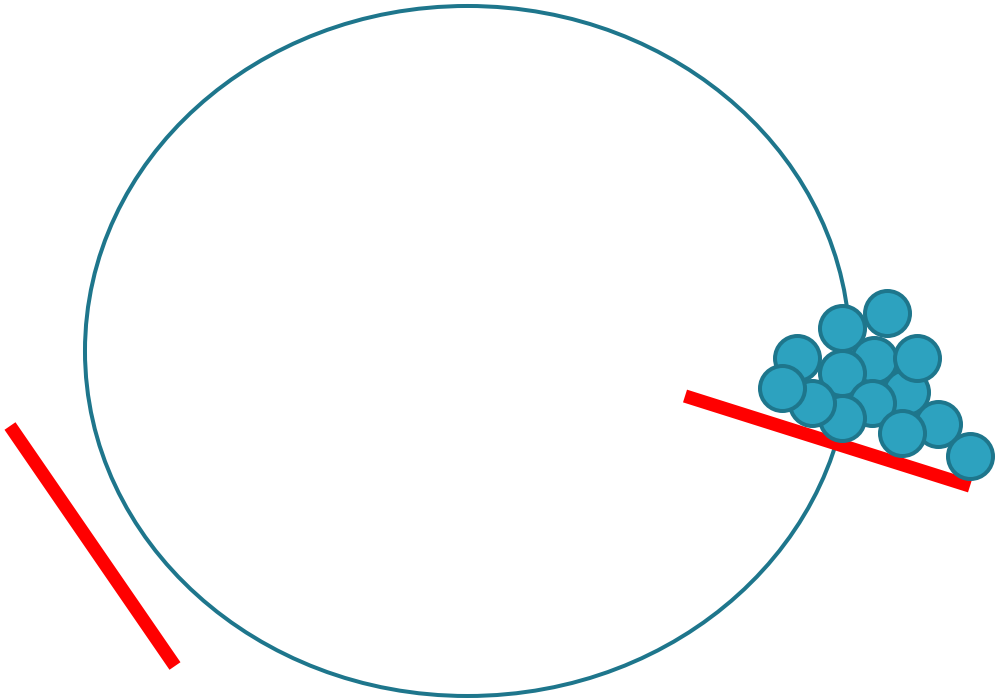


Este raz bariera

1) while True:
2) rendezvous
3) s_barr1()
4) nejaky kod
5) s_barr2()

Init(N):

s_barr1 ← SimpleBarrier(N)

s_barr2 ← SimpleBarrier(N)

Este raz bariera

```
1) while True:
2)     rendezvous
3)     s_barr1()
4)     nejaky kod
5)     s_barr2()
```

```
1) while True:
2)     s_barr2()
3)     rendezvous
4)     s_barr1()
5)     nejaky kod
```

Este raz bariera

1) while True:
2) s_barr2()
3) miesto stretnutia
4) s_barr1()
5) kod vykonavany po stretnuti sa

Este raz bariera

1) while True:
2) kod vykonavany pred stretnutim sa
3) s_barr2()
4) miesto stretnutia
5) s_barr1()
6) kod vykonavany po stretnuti sa

Este raz bariera

1) while True:
2) kod vykonavany pred stretnutim sa
3) s_barr2()
4) miesto stretnutia
5) s_barr1()
6) kod vykonavany po stretnuti sa

SimpleBarrier cez Semafor

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          T.signal(N)
6)  M.unlock()
7)  T.wait()
```

Init(N):

C ← 0

M ← Mutex()

T ← Semaphore(0)

SimpleBarrier cez Event

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
```

Init(N):

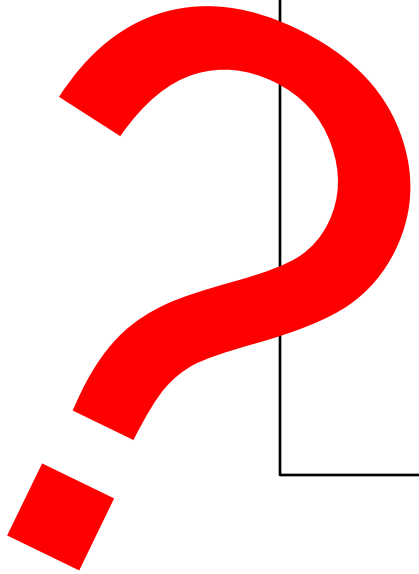
C ← 0

M ← Mutex()

E ← Event()

SimpleBarrier cez Event

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
```



Init(N):

C ← 0

M ← Mutex()

E ← Event()

SimpleBarrier cez Event

```
1) M.lock()
2)     C += 1
3)     if C == N:
4)         C = 0
5)         E.set()
6) M.unlock()
7) E.wait()
```

SimpleBarrier cez Event

```
1) M.lock()
2)       C += 1
3)       if C == N:
4)             C = 0
5)             E.set()
6) M.unlock()
7) E.wait()
```

```
1) while True:
2)       s_barrier1()
3)       s_barrier2()
```

SimpleBarrier cez Event

```
1) M.lock()
2)       C += 1
3)       if C == N:
4)             C = 0
5)             E.set()
6) M.unlock()
7) E.wait()
```

```
1) while True:
2)       s_barrier1()
3)       s_barrier2()
```

- Udalost ostava stale nastavena!

SimpleBarrier cez Event

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
8)
```

```
1)  while True:
2)      s_barrier1()
3)      s_barrier2()
```

- Opravime

SimpleBarrier cez Event

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
8)  E.clear()
```

```
1)  while True:
2)      s_barrier1()
3)      s_barrier2()
```

- Opravime

SimpleBarrier cez Event

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
8)  E.clear()
```

```
1)  while True:
2)      s_barrier1()
3)      s_barrier2()
```

- Samozrejme zle

SimpleBarrier cez Event

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
8)  E.clear()
```

```
1)  while True:
2)      s_barrier1()
3)      s_barrier2()
```

- Samozrejme zle
  - Vid ukazka…

SimpleBarrier cez Event

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
8)  E.clear()
```

```
1)  while True:
2)      s_barrier1()
3)      s_barrier2()
```

- Posledne vlakno, ktore **prejde cez** wait(), musi spustat clear()!

SimpleBarrier cez Event

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
```

```
8)
9)      C += 1
10)     if C == N:
11)         ....
12)
13)
```

SimpleBarrier cez Event

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
```

```
8)  M.lock()
9)      C += 1
10)     if C == N:
11)         …
12)
13) M.unlock()
```

SimpleBarrier cez Event

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
```

```
8)  M.lock()
9)      C += 1
10)     if C == N:
11)
12)         E.clear()
13) M.unlock()
```

SimpleBarrier cez Event

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
```

```
8)  M.lock()
9)      C += 1
10)     if C == N:
11)         C = 0
12)         E.clear()
13) M.unlock()
```

SimpleBarrier cez Event

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
```

```
8)  M.lock()
9)      C += 1
10)     if C == N:
11)         C = 0
12)         E.clear()
13) M.unlock()
```

SimpleBarrier cez Event OPTIM1

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          C = 0
5)          E.set()
6)  M.unlock()
7)  E.wait()
```

```
8)  M.lock()
9)      C -= 1
10)     if C == 0:
11)         C = 0
12)         E.clear()
13) M.unlock()
```

SimpleBarrier cez Event OPTIM1

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          E.set()
5)  M.unlock()
6)  E.wait()
```

```
7)  M.lock()
8)      C -= 1
9)      if C == 0:
10)         E.clear()
11) M.unlock()
```

SimpleBarrier cez Event OPTIM1

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          E.set()
5)  M.unlock()
6)  E.wait()
```

```
7)  M.lock()
8)      C -= 1
9)      if C == 0:
10)         E.clear()
11) M.unlock()
```

Nie optimalne… 2x serializacia

SimpleBarrier cez Event OPTIM2

```
1)  M.lock()
2)      C += 1
3)      if C == N:
4)          E.set()
5)  M.unlock()
6)  E.wait()
```

Mozeme dat E.clear()

do prvej serializacie?

SimpleBarrier cez Event OPTIM2

```
1)  M.lock()
2)
3)
4)      C += 1
5)      if C == N:
6)          E.set()
7)  M.unlock()
```

```
7)  E.wait()
```

SimpleBarrier cez Event OPTIM2

```
1)  M.lock()
2)      if C == 0:
3)          E.clear()
4)      C += 1
5)      if C == N:
6)          E.set()
7)  M.unlock()
```

```
7)  E.wait()
```

SimpleBarrier cez Event OPTIM2

```
1)  M.lock()
2)      if C == 0:
3)          E.clear()
4)      C += 1
5)      if C == N:
6)          E.set()
7)  M.unlock()
```

```
7)  E.wait()
```

Musi iba jedno vlakno vykonavat E.clear()?

SimpleBarrier cez Event OPTIM3

```
1) M.lock()
2)     E.clear()
3)     C += 1
4)     if C == N:
5)         E.set()
6) M.unlock()
7) E.wait()
```

SimpleBarrier cez Event OPTIM3

```
1) M.lock()
2)       E.clear()
3)       C += 1
4)       if C == N:
5)             E.set()
6) M.unlock()
7) E.wait()
```

Pozor!

Zavisi od implementacie metody E.clear()!

V akom vztahu je ku metode E.wait()?

ReusableBarrier

1) b1()
2) b2()

Init(N):

b1 ← SimpleBarrier(N)

b2 ← SimpleBarrier(N)

Fibonacci

- N prvkov postupnosti (mimo! prvych 2)
  - fib_seq := {0, 1, 0, 0, …, 0}
  - len(fib_seq) is N+2
- Prvok postupnosti i:
  - fib_seq[i] = fib_seq[i-1] + fib_seq[i-2]

Fibonacci naïve

0, 1, x1, x2, x3, x4, …, x_n

x1 – vlakno necaka

x2 – vlakno caka na thr(x1)

x3 – caka sa na thr(x1) a thr(x2)

x4 – caka sa na thr(x2) a thr(x3)

…

x_n – caka na thr(x_n-1) a thr(x_n-2)

Fibonacci naïve

```
0, 1, x1, x2, x3, x4, …, x_n
T1:    --
T2:        T1
T3:        T1   T2
T4:             T2   T3
T5:                  T3   T4
T6:                       T4   T5
```

Fibonacci naïve

- Vidime, ze kazde vlakno, okrem prvych 2, caka vzdy na 2 predosle vlakna
- Vytvorme teda pre kazde vlakno (okrem prvych 2) synchronizacne objekty, napr. Semafory
- Kazde vlakno musi spravit (okrem prvych 2) 2x wait nad svojim semaforom, aby mohlo ist

Fibonacci naïve

Init(N):

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sem ← Sem(0) * N

Thread_i(id):

1) sem[id].wait()
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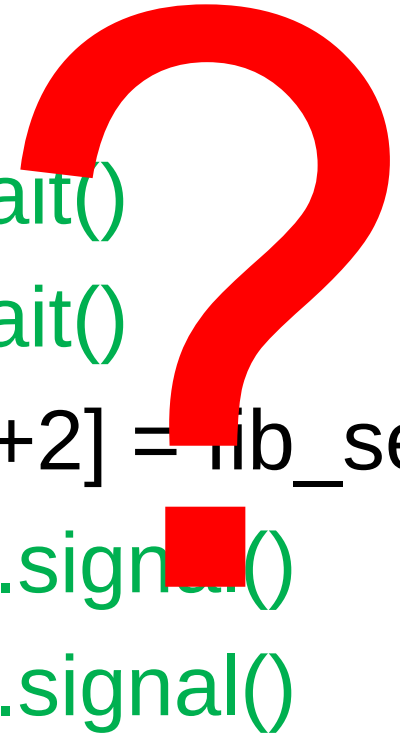

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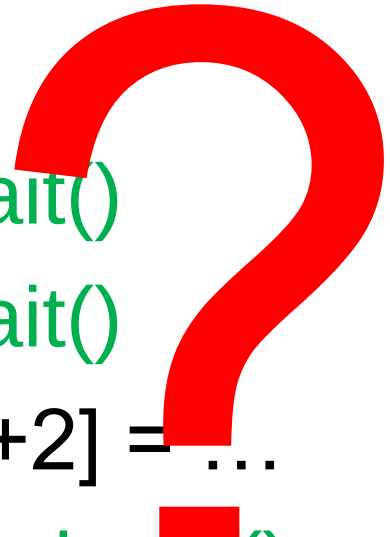

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Fibonacci naïve v2

```
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T1:    --
T2:         T1
T3:         T1   T2
T4:              T2   T3
T5:                   T3   T4
T6:                        T4   T5
```

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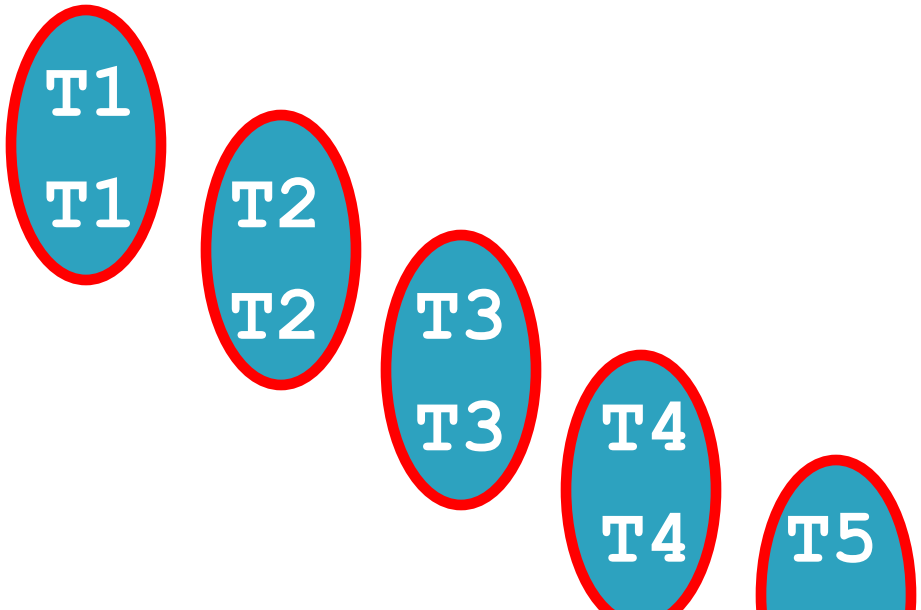
T4:
T5:
T6:
```



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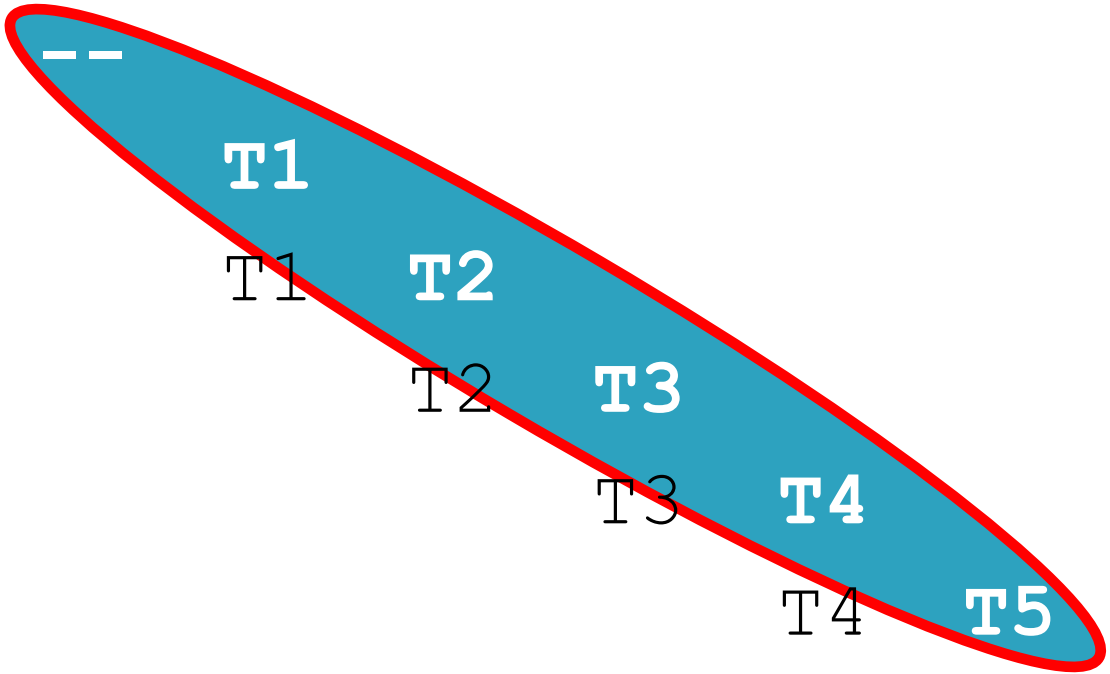
T5:                     T3   T4
T6:                          T4   T5
```



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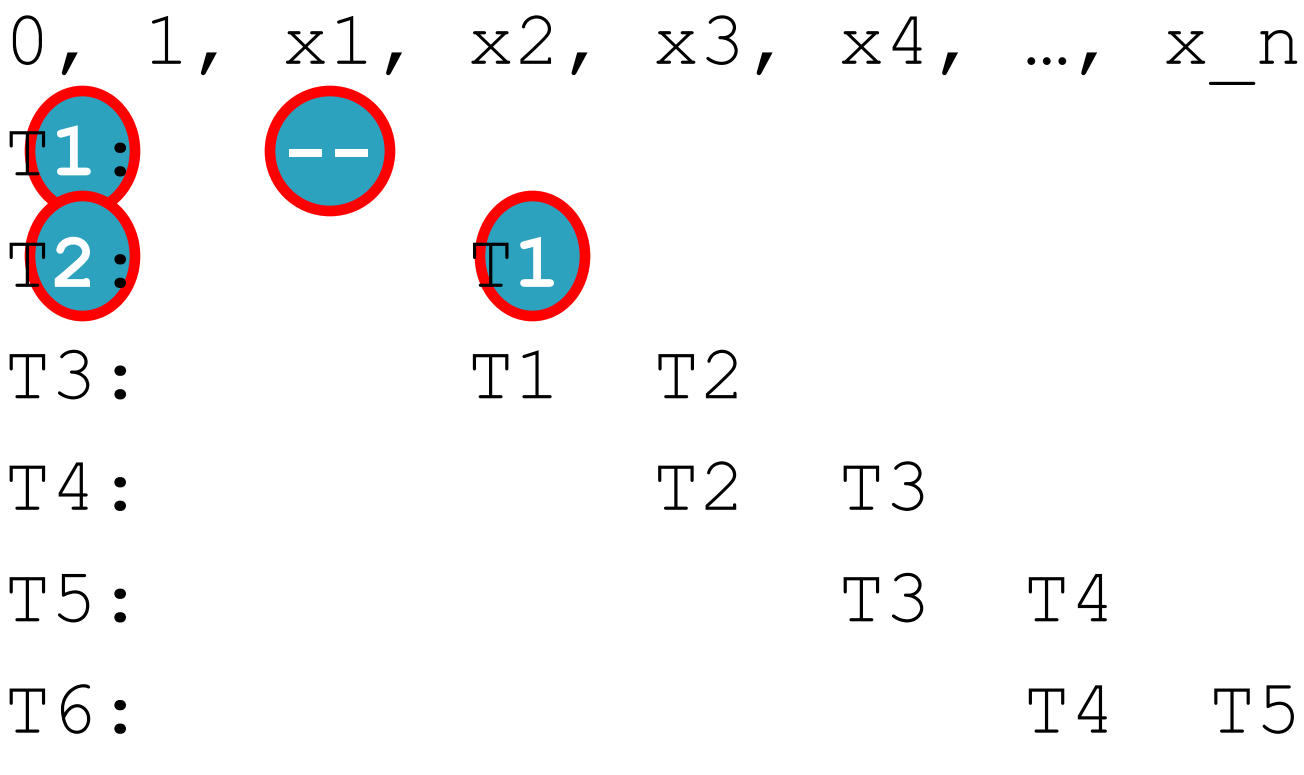
Fibonacci naïve v2



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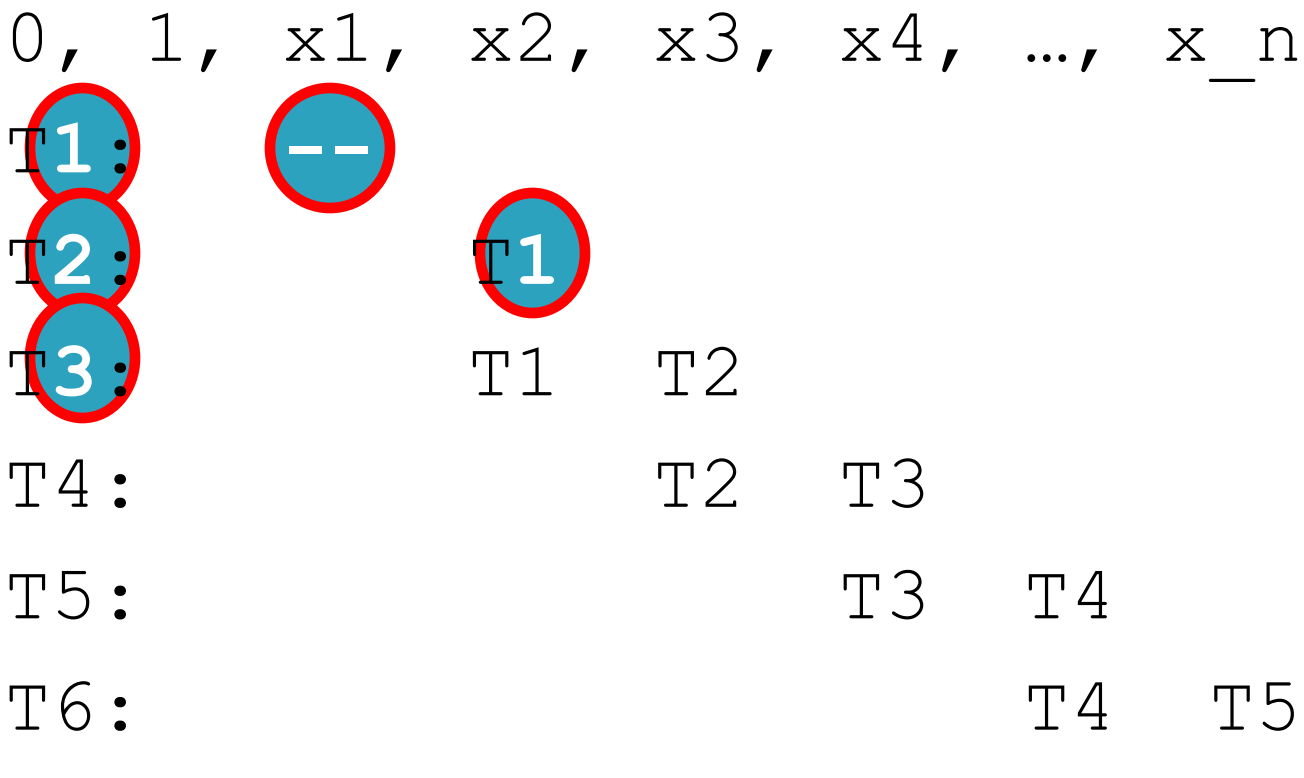
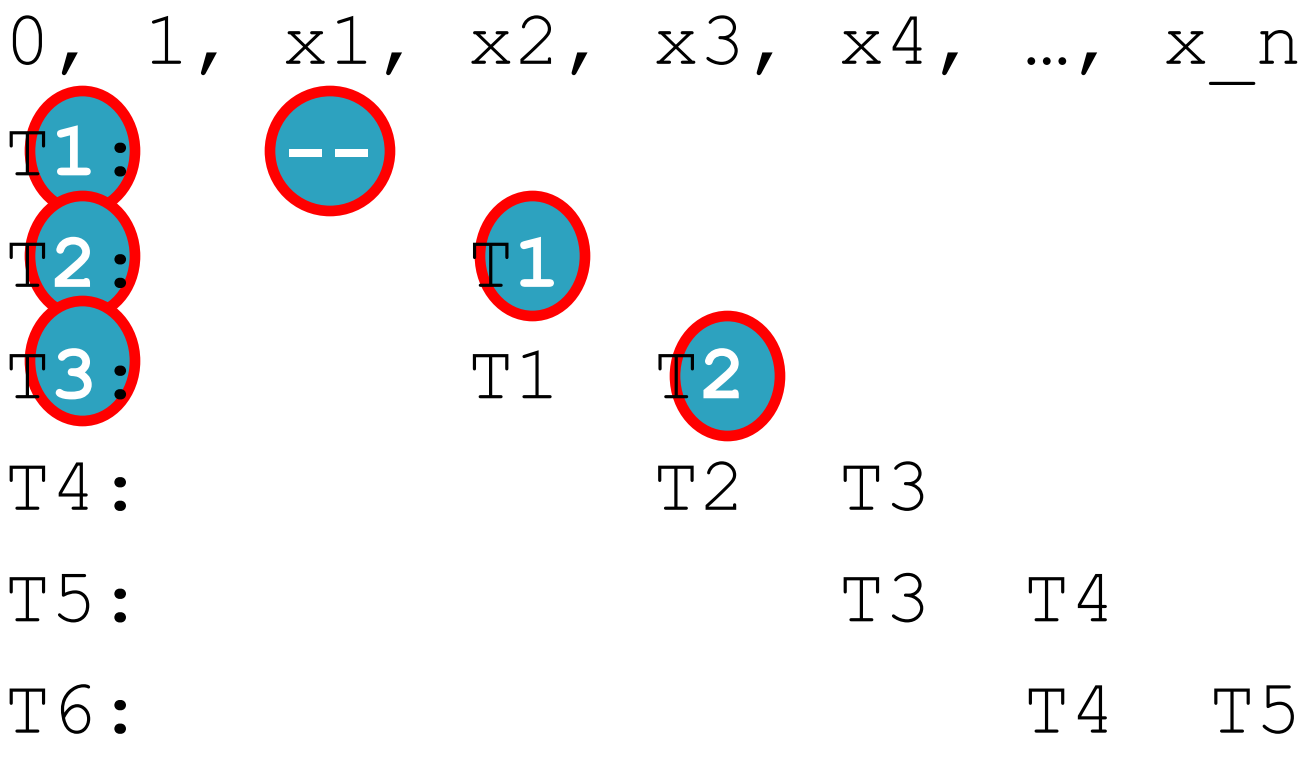
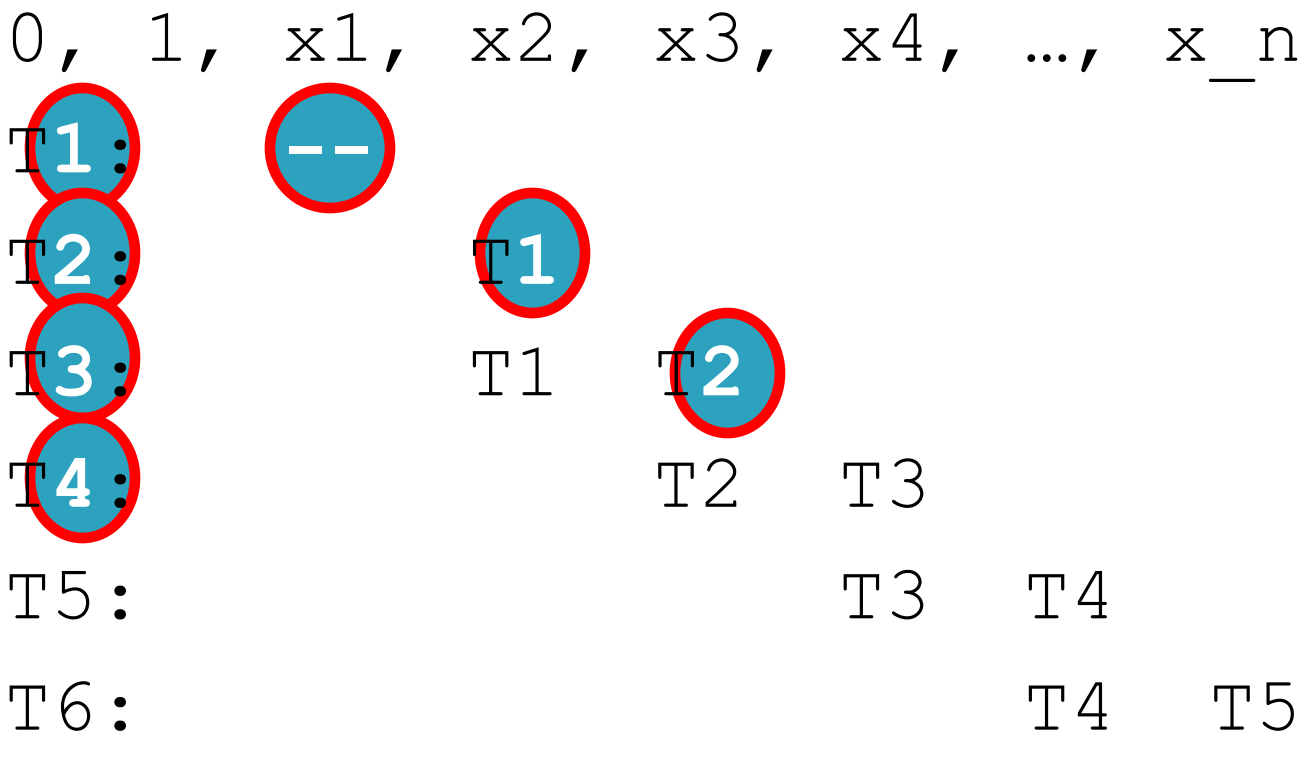


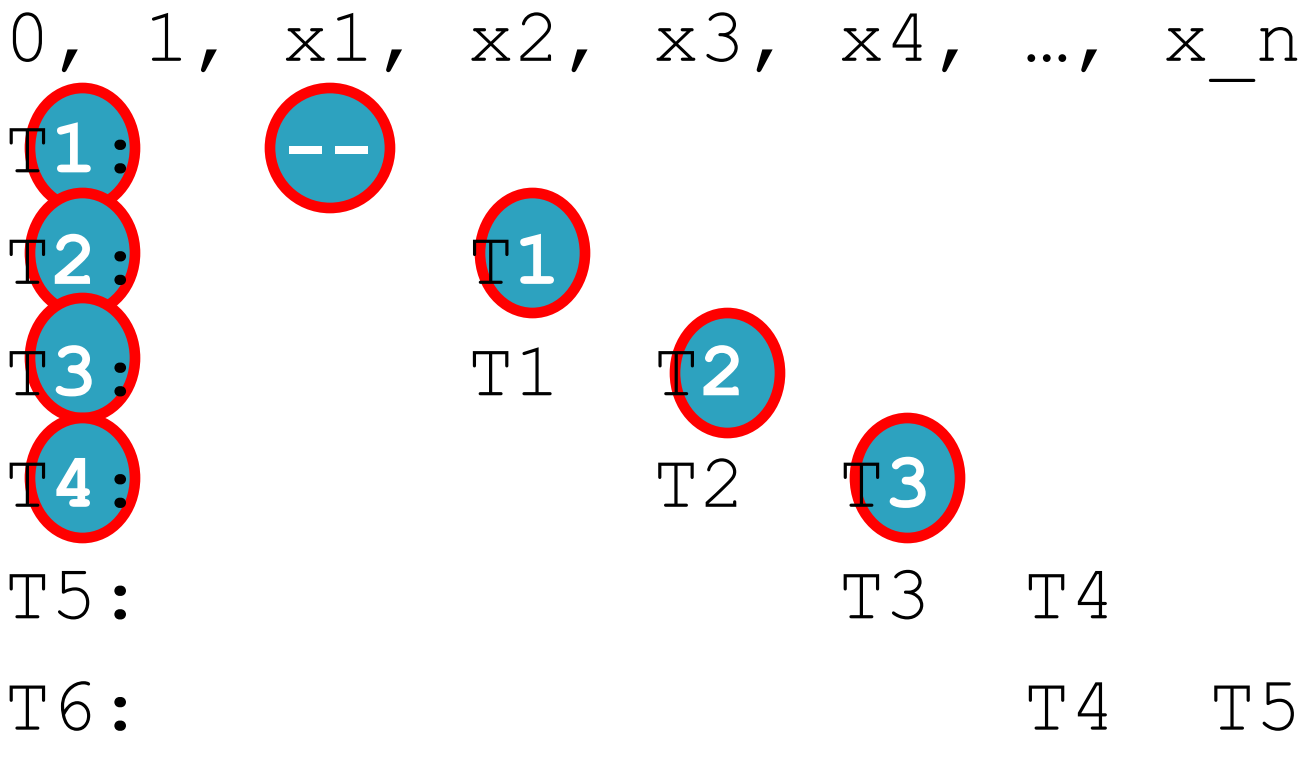
Fibonacci naïve v2



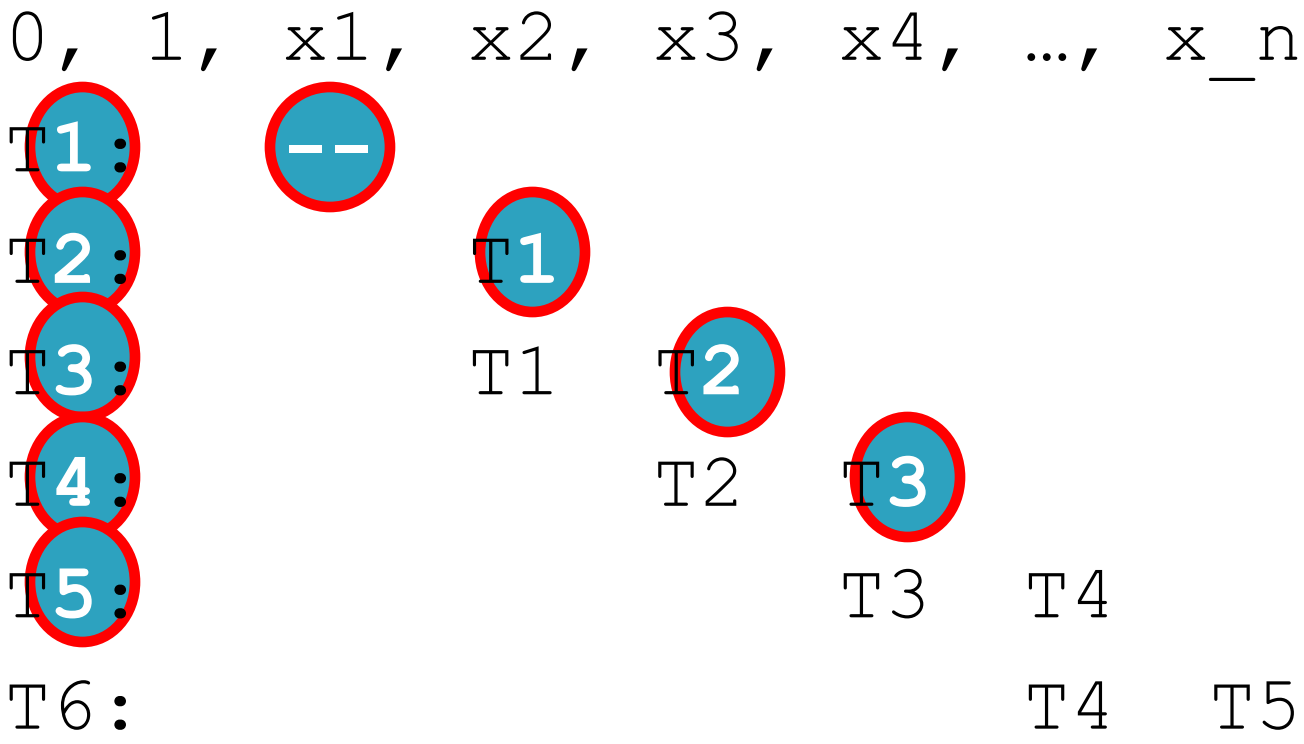
Fibonacci naïve v2



Fibonacci naïve v2



Fibonacci naïve v2



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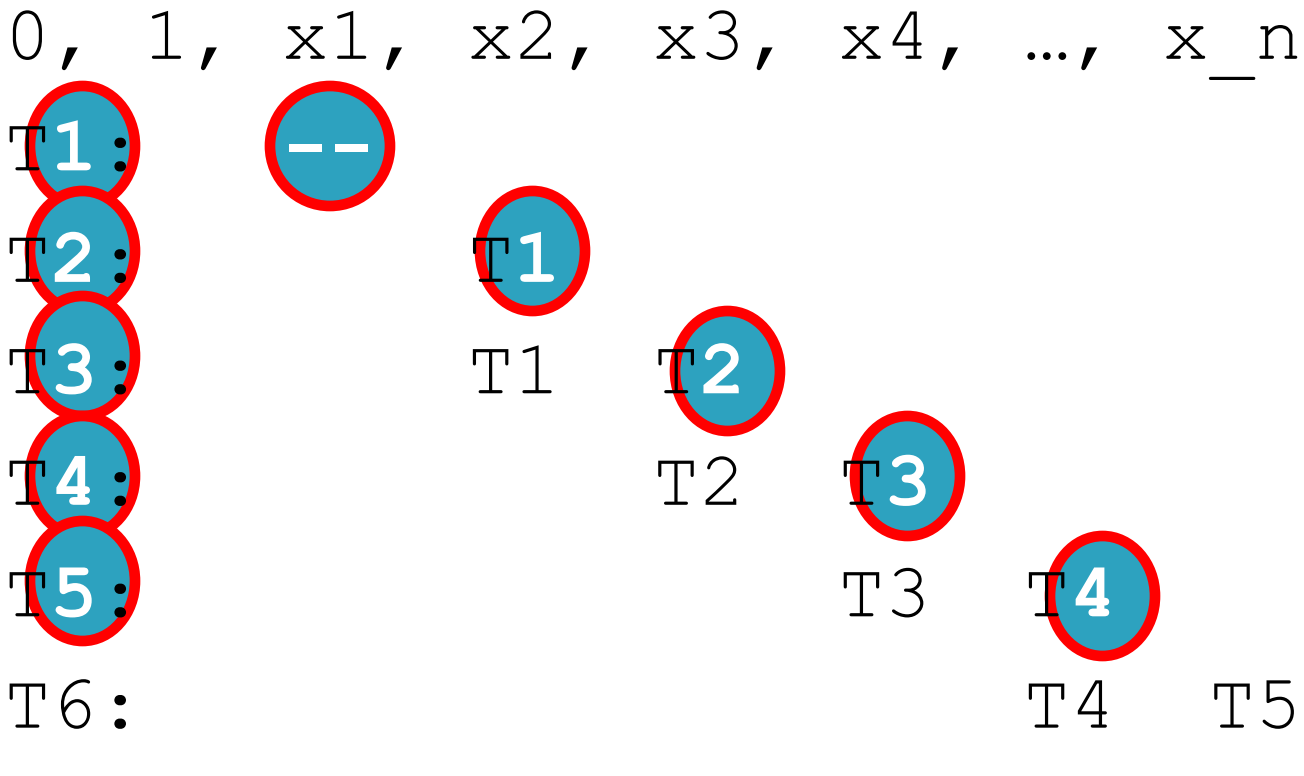

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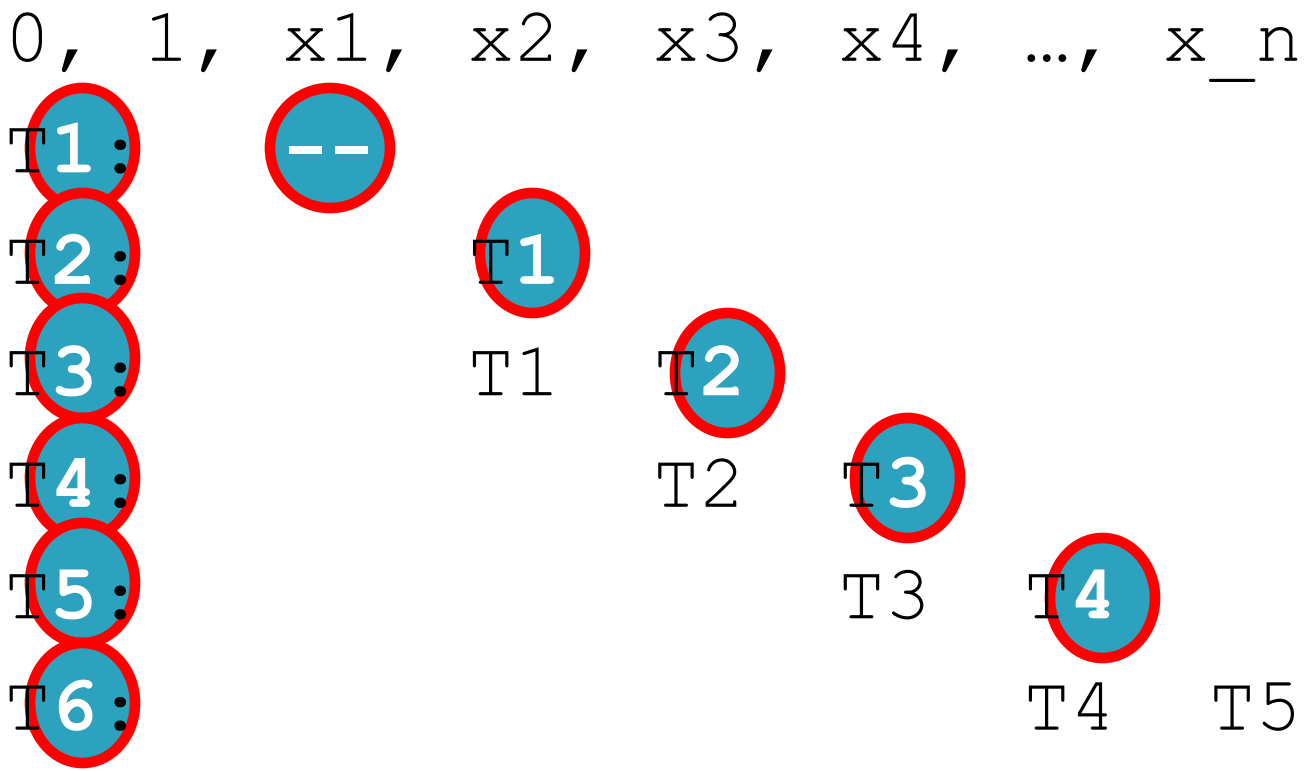

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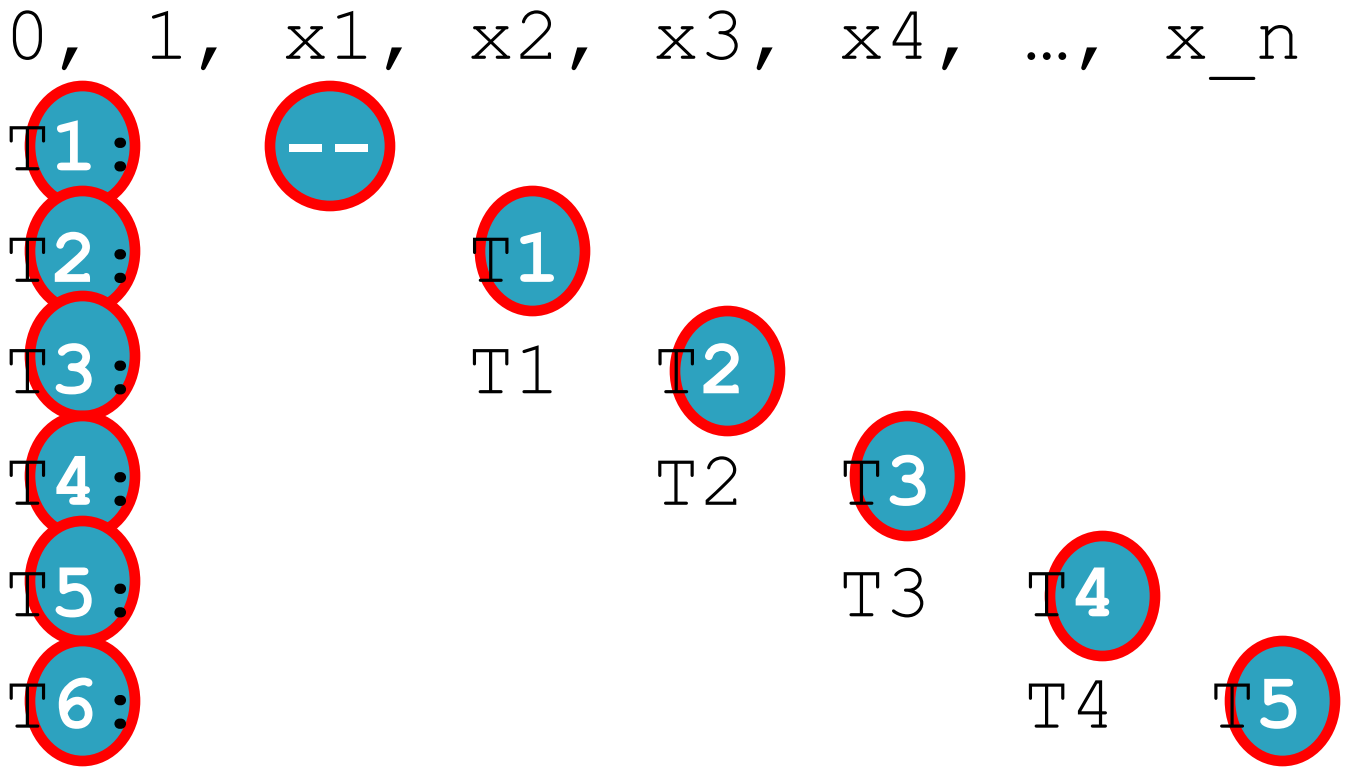

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Fibonacci alla S. Podhorec

- Hm… kolko mame synchronizacnych objektov?
- Da sa to na menej nez cca N?

Fibonacci alla S. Podhorec

```
0, 1, x1, x2, x3, x4, …, x_n
T1:    --
T2:        T1
T3:        T1   T2
T4:             T2   T3
T5:                  T3   T4
T6:                       T4   T5
```

Fibonacci alla S. Podhorec

```
   0, 1, x1, x2, x3, x4, x5, x6, …, xn
E1 s1 s2 s3
E2:          s1  s2  s3
E3:                  s1  s2 …
…
```

Fibonacci alla S. Podhorec

```
E1: s1 s2 s3
E2: s1 s2 s3
E3: s1 s2 s3
…
```

Fibonacci alla S. Podhorec

- Kolko synchronizacnych objektov potrebujeme?
- P semaforov, Q udalosti (napriklad)
- Ako urcime ich pocty?

Fibonacci alla S. Podhorec

- Potrebujeme, aby P*Q = N
- Takze si urcime cisla nasledovne:
  - If N%P == 0: Q = N / P
  - Else: Q = N / P + 1
- Vieme optimalizovat P, Q tak, aby sme pouzili co najmenej synchronizacnych objektov?

Fibonacci alla S. Podhorec

- Snad ano, ked sme zvladli Matematiku 1 ;)

Fibonacci alla S. Podhorec

- Snad ano, ked sme zvladli Matematiku 1 ;)
- Urobme si parcialnu derivaciu…

Fibonacci alla S. Podhorec

- Potrebujeme rozlozit N na sucin cisiel P a Q tak, aby P+Q bolo co najmensie
- Algoritmus:
  - for P in range(1, round(N**0.5)+1):
  - Q := N // P
  - if P*Q != N:
  - Q += 1
  - print(“%d + %d = %d”, P, Q, P+Q)

Fibonacci

- Hm… kolko mame teraz synchronizacnych objektov?
- Aka je zlozitost tohto riesenia vzhladom na pocet synchronizacnych objektov voci poctu vlakien, ktore sa maju synchronizovat?
- Da sa to na menej nez 2*N^(1/2)?

Fibonacci

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T2:         T1
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Fibonacci

- Co potrebujeme dosiahnut?

- Synchronizacny vzor **SERIALIZACIA**
- T1 < T2 < T3 < T4 < … < T_n

Fibonacci

- Co potrebujeme dosiahnut?

- Synchronizacny vzor **SERIALIZACIA**
- T1 < T2 < T3 < T4 < … < T_n
  - Ak sa vykonava T4, T1 aj T2 aj T3 su uz vykonane!
  - Vseobecne plati, ze T_i < T_j, j>i

Fibonacci

```
0, 1, x1, x2, x3, x4, …, x_n
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T6:                        T4   T5
```

Fibonacci s udalostou

- Problem serializacie znamena, ze:
  - T1 < T2, T2 < T3, T3 < T4, …
  - T1 < T2 < T3 < T4 < …
  - V 1 case iba 1 vlakno je aktivne!!!

Fibonacci s udalostou

1) fib_seq[id+2] = …

Init(N):

fib_seq ← [0,1]+[0]*N

Fibonacci s udalostou

1) e.wait()

2) fib_seq[id+2] = …

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e ← Event()

Fibonacci s udalostou

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3) e.signal()

Init(N):

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Fibonacci s udalostou

```
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Fibonacci s udalostou

```
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Init(N):

fib_seq ← [0,1]+[0]*N

e ← Event()

cnt ← 0

Fibonacci s udalostou

```
1)      while True:
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3)          if cnt == thr_id: break

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Init(N):

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e ← Event()

cnt ← 0

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()
3)          m.lock()
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5)          m.unlock()



6)       fib_seq[id+2] = …



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Init(N):

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cnt ← 0

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```
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Init(N):

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m ← Mutex()

cnt ← 0

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9)      cnt += 1
10)     m.unlock()
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cnt ← 0

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```

Init(N):

fib_seq ← [0,1]+[0]*N

e ← Event()

m ← Mutex()

cnt ← 0

- wait() – clear() – signal()

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # nech vsetky vlakna pokracuju z tejto fnc dalej
3)          m.lock()
4)          if cnt == thr_id: break
5)          m.unlock()
6)      m.unlock()

7)      e.clear()
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                # nech vsetky vlakna pokracuju z tejto fnc dalej
3)          m.lock()                # vsetky su medzi R2-R3, iba jedno ide na R3 (vlakno Ti)
4)          if cnt == thr_id: break
5)          m.unlock()
6)      m.unlock()

7)      e.clear()
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # nech vsetky vlakna pokracuju z tejto fnc dalej
3)          m.lock()                    # vsetky okrem Ti su medzi R2-R3
4)          if cnt == thr_id: break     # nech pre vlakno Ti plati podmienka, takze ide na R6
5)          m.unlock()
6)      m.unlock()

7)      e.clear()
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # nech vsetky vlakna pokracuju z tejto fnc dalej
3)          m.lock()                    # vsetky okrem Ti su medzi R2-R3
4)          if cnt == thr_id: break     # nech pre vlakno Ti plati podmienka
5)          m.unlock()
6)      m.unlock()

7)      e.clear()               # Ti spravi clear(), stale mame ostatne vlakna medzi R2-R3
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # nech vsetky vlakna pokracuju z tejto fnc dalej
3)          m.lock()                    # postupne vsetky okrem Ti a Ti+1 idu dalej
4)          if cnt == thr_id: break     # nech pre vlakno Ti plati podmienka
5)          m.unlock()
6)      m.unlock()

7)      e.clear()               # Ti spravilo clear()!
8)      fib_seq[id+2] = …       # medzicasom nech vsetky vlakna okrem Ti+1 pokracuju zo stavu medzi
                                # R2-R3 dalej, takze sa znovu v cykle dostanu na e.wait()
9)      m.lock()
10)     cnt += 1
11)     m.unlock()
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # vsetky okrem Ti a Ti+1 cakaju vo funkcii wait()
3)          m.lock()                    # vlakno Ti+1 je stale medzi R2-R3
4)          if cnt == thr_id: break
5)          m.unlock()
6)      m.unlock()

7)      e.clear()
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1                # Ti spravi zvysenie pocitadla, vsetky okrem Ti+1 su na wait()
11)     m.unlock()
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # vsetky okrem Ti a Ti+1 cakaju vo funkcii wait()
3)          m.lock()                    # vlakno Ti+1 je stale medzi R2-R3
4)          if cnt == thr_id: break     # podmienka uz neplati pre Ti, ale pre Ti+1!
5)          m.unlock()
6)      m.unlock()

7)      e.clear()
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1                # Ti urobilo aktualizaciu podmienky
11)     m.unlock()
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # vsetky okrem Ti a Ti+1 cakaju vo funkcii wait()
3)          m.lock()                    # vlakno Ti+1 je stale medzi R2-R3
4)          if cnt == thr_id: break     # podmienka uz neplati pre Ti, ale pre Ti+1!
5)          m.unlock()
6)      m.unlock()

7)      e.clear()
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1                # Ti urobilo aktualizaciu podmienky
11)     m.unlock()              # Ti urobi unlock(), ale na R12 zatial nepokracuje!
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # vsetky okrem Ti a Ti+1 cakaju vo funkcii wait()
3)          m.lock()                    # vlakno Ti+1 je stale medzi R2-R3
4)          if cnt == thr_id: break     # podmienka uz neplati pre Ti, ale pre Ti+1!
5)          m.unlock()
6)      m.unlock()

7)      e.clear()
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()              # Ti urobilo unlock(), ale na R12 zatial nepokracuje
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # vsetky okrem Ti a Ti+1 cakaju vo funkcii wait()
3)          m.lock()                    # vlakno Ti+1 pokracuje dalej
4)          if cnt == thr_id: break     #
5)          m.unlock()
6)      m.unlock()

7)      e.clear()
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1
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```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # vsetky okrem Ti a Ti+1 cakaju vo funkcii wait()
3)          m.lock()                    #
4)          if cnt == thr_id: break     # podmienka pre Ti+1 je splnena, ide na R6
5)          m.unlock()
6)      m.unlock()

7)      e.clear()
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()              # Ti urobilo unlock(), ale na R12 zatial nepokracuje
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```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # vsetky okrem Ti a Ti+1 cakaju vo funkcii wait()
3)          m.lock()                    #
4)          if cnt == thr_id: break     #
5)          m.unlock()
6)      m.unlock()

7)      e.clear()               # po R6 moze vykonat R7
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()              # Ti urobilo unlock(), ale na R12 zatial nepokracuje
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # vsetky okrem Ti a Ti+1 cakaju vo funkcii wait()
3)          m.lock()                    #
4)          if cnt == thr_id: break     #
5)          m.unlock()
6)      m.unlock()

7)      e.clear()               # po vykonani R7 mame problem!
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()              # Ti urobilo unlock(), ale na R12 zatial nepokracuje
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # vsetky okrem Ti a Ti+1 cakaju vo funkcii wait()
3)          m.lock()                    #
4)          if cnt == thr_id: break     #
5)          m.unlock()
6)      m.unlock()

7)      e.clear()               # vlakno Ti+1 urobilo clear(), ale vlakno Ti nestihlo urobit signal()!
8)      fib_seq[id+2] = …  #

9)      m.lock()
10)     cnt += 1
11)     m.unlock()              # Ti urobilo unlock(), ale na R12 zatial nepokracuje
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # vsetky okrem Ti a Ti+1 cakaju vo funkcii wait()
3)          m.lock()                    #
4)          if cnt == thr_id: break     #
5)          m.unlock()
6)      m.unlock()

7)      e.clear()               # chceli sme zachovat v kazdom cykle postupnost
8)      fib_seq[id+2] = …  # pred kazdym signal() urobit clear()!!!

9)      m.lock()
10)     cnt += 1
11)     m.unlock()              # Ti urobilo unlock(), ale na R12 zatial nepokracuje
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```

Fibonacci s udalostou

```
1)      while True:
2)          e.wait()                    # vsetky okrem Ti a Ti+1 cakaju vo funkcii wait()
3)          m.lock()                    #
4)          if cnt == thr_id: break     #
5)          m.unlock()
6)      m.unlock()

7)      e.clear()               # wait() – clear() – signal() --- [wait()] – clear() – signal() …
8)      fib_seq[id+2] = …  # … [wait()] – clear() – signal() --- [wait()] – clear() – signal() …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()              # Ti urobilo unlock(), ale na R12 zatial nepokracuje
12)     e.signal()
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Fibonacci s udalostou

```
1)      while True:
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3)          m.lock()                    #
4)          if cnt == thr_id: break     #
5)          m.unlock()
6)      m.unlock()

7)      e.clear()               # namiesto toho mame pokazenu postupnost
8)      fib_seq[id+2] = …  # wait() – clear() – [wait()] – clear() – signal() – signal() …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()              # Ti urobilo unlock(), ale na R12 zatial nepokracuje
12)     e.signal()
```

Fibonacci s udalostou

```
1)      while True:
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3)          m.lock()
4)          if cnt == thr_id: bre
5)          m.unlock()
6)      m.unlock()

7)      e.clear()               # namiesto  mame pokaz  postupnost
8)      fib_seq[id+2] = …  # wait() –  r() – [wait()] – c  r() – signal() – signal() …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()              # Ti urobilo unlock(), ale na R12 zatial nepokracuje
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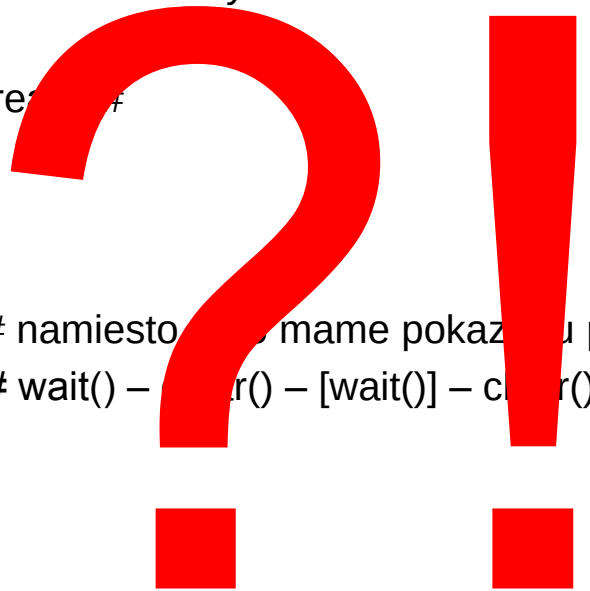
```



Fibonacci s udalostou hardened

```
1)      while True:
2)          e.wait()
3)          m.lock()
4)          if cnt == thr_id: break
5)          m.unlock()
6)      m.unlock()

7)      e.clear()
8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()
12)     e.signal()
```

Init(N):

fib_seq ← [0,1]+[0]*N

e ← Event()

m ← Mutex()

cnt ← 0

Fibonacci s udalostou hardened

```
1)      while True:
2)          e.wait()
3)          m.lock()
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```

Init(N):

fib_seq ← [0,1]+[0]*N

e ← Event()

m ← Mutex()

cnt ← 0

b← R_barrier_ex(N, e.clear())

Fibonacci s udalostou hardened

```
1)      while True:
2)          e.wait()
3)          b.wait(N-cnt)
4)          m.lock()
5)          if cnt == thr_id: break
6)          m.unlock()
7)      m.unlock()

8)      fib_seq[id+2] = …

9)      m.lock()
10)     cnt += 1
11)     m.unlock()
12)     e.signal()
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4)          m.lock()
5)          if cnt == thr_id: break
6)          m.unlock()
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8)      fib_seq[id+2] = …

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1)      while True:
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5)          if cnt == thr_id: break
6)          m.unlock()
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8)      fib_seq[id+2] = …

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10)     cnt += 1
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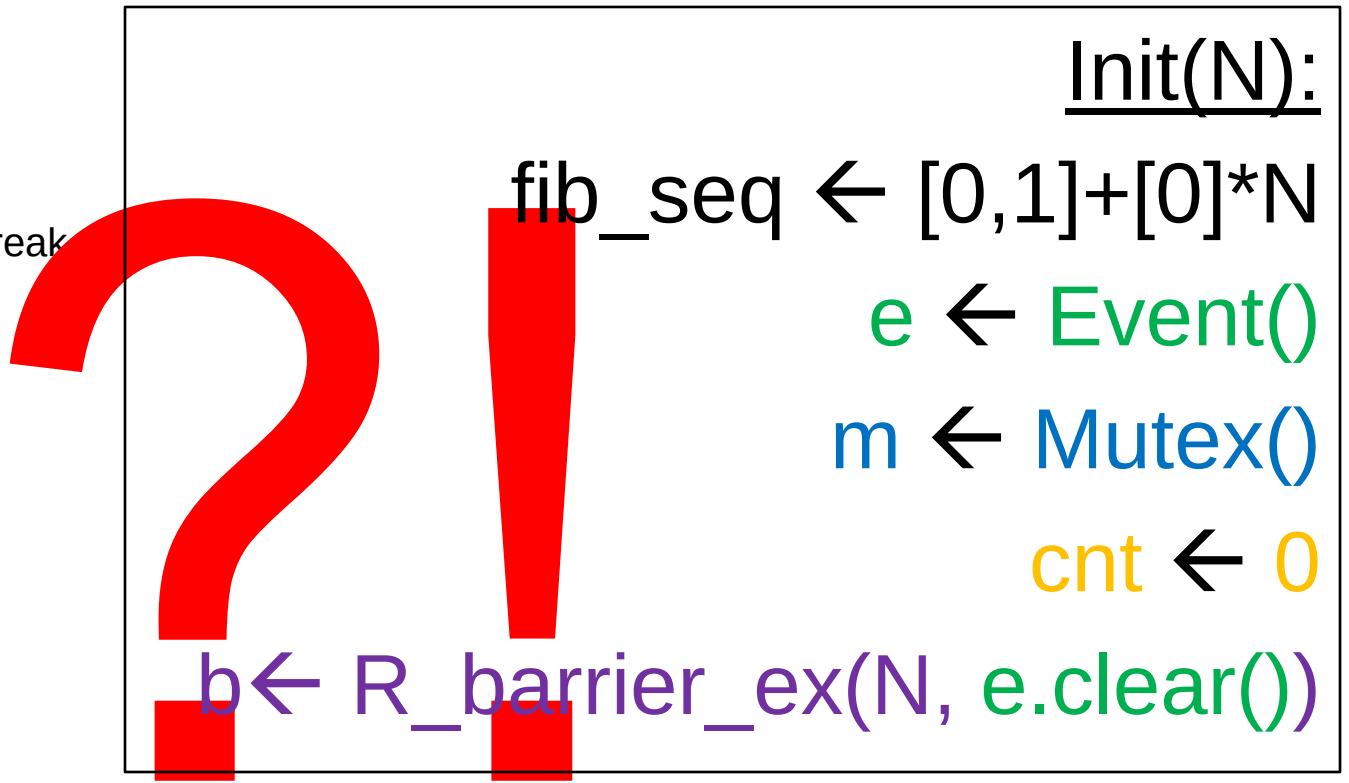
```



Fibonacci s udalostou hardened

```
1)    while True:
2)        e.wait()
3)        b.wait(N-cnt)
4)        m.lock()
5)        if cnt == this_id: break
6)        m.unlock()
7)    m.unlock()
8)    fib_seq[i+2] = ..
9)    m.lock()
10)   cnt += 1
11)   m.unlock()
12)   e.signal()
```

Init(N):

fib_seq ← [0,1]+[0]*N

e ← Event()

m ← Mutex()

cnt ← 0

b← R_barrier_ex(N, e.clear())

Riesi to nas problem???

Cvicenie

- Navrhnite ulohu Fib_seq pomocou synchronizacie

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- Navrhnite ulohu Fib_seq pomocou synchronizacie
  - s udalostou
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  - s udalostou tak, aby bolo VZDY zabezpecene, ze pred kazdym signal() je prave jeden clear()
  - Vlakno, ktore vypocita svoje Fib. cislo, nech skonci!

Cvicenie

- Navrhnite ulohu Fib_seq pomocou synchronizacie
  - s udalostou
  - s udalostou OK clear() – signal()
- Odhalte (pripadne opravte) chyby navrhu

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