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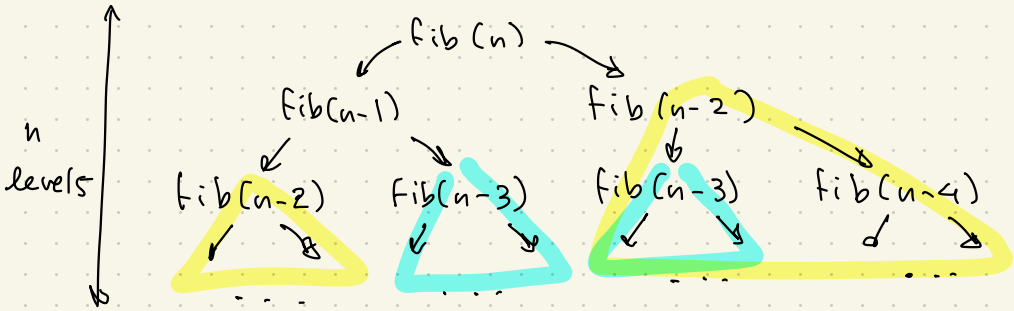
SciComp Ex. 04

1. Big-*O* notation
   Find the time complexity of the different versions of the Fibonacci number computation given `fibonacci.rs` on ISIS with the slides from the lecture.

- `fib_recursive1`, `fib_recursive2` are equivalent and both are $O(2^n)$:

  The recursive calls produce recomputing multiple fibonacci sequences, e.g. fib(n-2) and fib(n-1) both will compute the whole sequence fib(n-3):



- `fib_iterative_*` are all $O(n)$ since they all do constant operations in a loop of ~n iterations.

- `fib_direct` equal to the time complexity of the powf64 function

2. Sort the sequence of functions below: (i) assuming asymptotic growth, where $g \in O(f)$ holds true for the functions g, f in a sorted sequence, and (ii) for $n = 42$.

- $2\sqrt{n}$ — $n=42 \Rightarrow$ 12.96
- $3n^3 + n^2 + 1000$ — 225,028
- $\frac{n}{1000}\log_2 n$ — ~0.2265
- $\frac{1}{10}n!$ — a very big number (order of 10^{50})
- $25\log_2 n^2 + 3$ — ~272.616
- 1 — 1
- $10^{100}n + 100$ — ~42×10^{100}
- $10n + 3^n$ — ~ Order of 10^{20}

i)

1) 1
2) $25\log_2 n^2 + 3$
3) $\frac{n}{1000}\log_2 n$
4) $2\sqrt{n}$

$n\log_2 n > \log_2 n^2 = 2\log_2 n$
$\Rightarrow O(\frac{n}{1000}\log_2 n) > O(25\log_2 n^2)$
$n\log_2 n > \sqrt{n}$
$n^2 > 2^{\sqrt{n}}$ false for $n \to \infty$

5) $10^{100}n + 100$
6) $3n^3 + n^2 + 1000$

higher order polynomial grows faster than lower

7) $10n + 3^n$

$3^n > n^3$
$n > 3\log_3 n$ — n grows faster $\Rightarrow 3^n$

8) $\frac{1}{10}n!$

$n!$ grows faster than 3^n

ii)

1) $\frac{n}{1000}\log_2 n$
2) 1
3) $2\sqrt{n}$
4) $25\log_2 n^2 + 3$
5) $3n^3 + n^2 + 1000$
6) $10n + 3^n$
7) $\frac{1}{10}n!$
8) $10^{100}n + 100$

```
excercises/ex04/ex04-492253-sancheztorres-andresalam on  main [?] is 📦 v0.1.0 via 🦀 v1.68.1 via nla
→ cat ./instances/ksp10000_3.dat | cargo run
   Compiling ex04-492253-sancheztorres-andresalam v0.1.0 (/Users/aast/Documents/COSSE/SciComp/excercises/ex04/ex04-492253-sancheztorres-andresalam)
    Finished dev [unoptimized + debuginfo] target(s) in 3.65s
     Running `target/debug/ex04-492253-sancheztorres-andresalam`
Items: 6 81 217 51 461 367 42 66 301 533 383 244 504 373 196 388 95 508 542 102 519 500 73 9 275 80 30 243 255 172 527 282 557 1 559 289 344 510 312 147 412 171 484 100 184 497 135 332 492 98 318 86 370 543 511 148 487 455 393 351 72 307 183 250 35 141 268 384 156 536 478 106 280 159 213 176 201 402 366 387 212 448 378 242 88 253 77 503 175 538 377 21 539 548 545 215 568 299 469 477 467 522 160 203 468 236 222 546 126 499 204 327 491 37 229 534 300 413 569 189 505 561 115 178 63 25 28 462 479 43 200 96 547 438 443 218 459 97 161 136 157 112 286 407 105 46 529 181 470 29 85 205 356 359 34 342 369 414 325 320 337 313 316 481 214 90 169 428 298 119 363 131 418 507 108 216 466 297 426 284 303 319 374 364 133 458 444 16 423 326 231 49 417 226 394 155 340 406 295 223 525 391 24 302 435 473 352 464 410 198 425 456 76 41 254 245 152 130 180 125 99 405 144 273 104 237 265 224 294 140 460 457 454 259 117 401 167 39 509 463 328 31 526 3 71 279 75 59 249 122 514 415 355 187 210 2 191 168 164 494 372 188 15 173 151 11 195 498 93 537 335 110 421 396 230 336 56 87
Total: 260380
Time : 156.58754s
```

Runtime for my code for the biggest case.