1. siis konstruqtoris gamoyenebiT gansazRvreT gamosaxuleba, romelic pirveli asi mTeli ricxvis kvadratebis 12 + 22 + *. . .* +1002 jams angariSobs. *sum* [*x ↑* 2 *| x ←* [1 *. .* 100]]

2. *length* funqciis analogiurad, uCveneT, rogor SeiZleba iyos gansazRvruli siis konstruqtoris saSualebiT sabiblioTeko *replicate* :: *Int → a →* [*a*] funqcia, romelic gvaZlevs Sedegs erTnairi elementebis siis saxiT. magaliTad:

*> replicate* 3 *True*

[*True, True, True* ]

*replicate n x* = [*x | \_  ←* [1 *. . n* ]]

3. (*x, y, z*) dadebiTi mTeli ricxvebis sameuls piTagoras[[1]](#footnote-1) sameuli ewodeba, Tu x2 + y2 = z2. siis konstruqtoris saSualebiT gansazRvreT *pyths* :: *Int →* [(*Int, Int, Int*)] funqcia, romelic gvibrunebs piTagoras yvela sameuls, romelTa komponen­te­bi mocemul zRvrul sidides ar aRemateba. magaliTad:

*> pyths* 10

[(3*,* 4*,* 5)*,* (4*,* 3*,* 5)*,* (6*,* 8*,* 10)*,* (8*,* 6*,* 10)]

*pyths n* = [(*x , y, z* ) *| x ←* [1 *. . n* ]*,*

*y ←* [1 *. . n* ]*,*

*z ←* [1 *. . n* ]*,*

*x ↑* 2 + *y ↑*2 *==* *z ↑* 2]

4. dadebiTi mTeli ricxvi *srulyofilia*[[2]](#footnote-2) (*perfect number*), Tu igi udris yvela sa­kuTari (magram Tavad misgan gansxvavebuli) faqtoris (gamyofis) jams. siis kon­struqtorisa da *factors* funqciis saSualebiT gansazRvreT *perfects*:: *In  →*[*Int*] funqcia, roelic gvibrunebs yvela srulyofili ricxvis sias mocemul miSvne­lo­bamde. magaliTad:

*> perfects* 500

[6*,* 28*,* 496]

*perfects n* = [*x | x ←* [1 *. . n* ]*, sum* (*init* (*factors x* )) *==* *x* ]

5. uCveneT, rogor SeiZleba erTi [(*x , y*) *| x ←* [1*,* 2*,* 3]*, y ←* [4*,* 5*,* 6]] kon­struq­tori ori generatoriT xelaxla ganisazRvros ori kon­struq­to­ris saSualebiT, romlebsac TiTo-TiTo konstruqtori aqvs.

rCeva: ga­mo­i­yeneT sabiblioTeko *concat* funqcia da CaalageT erTi konstruq­to­ri me­o­reSi.

*concat* [[(*x , y*) *| y ←* [4*,* 5*,* 6]] *| x ←* [1*,* 2*,* 3]]

6. gansazRvreT *positions* funqcia *find* funqciis saSualebiT.

*positions x xs* = *find x* (*zip xs* [0 *. . n* ])

**where** *n* = *length xs −* 1

7. mTel ricxvTa ori *xs* da *ys* erTisa da imave *n* sigrZis siis *skalaruli namravli* moicema Sesabamisi mTeli ricxvebis namravlebis jamiT:



analogiurad imisa, rogorc es gakeTda *chisqr* funqciasTan mimarTebaSi, uCveneT, rogor SeiZleba siis konstruqtoris gamoyeneba *scalarproduct*:: [*Int*] *→*[*Int*] *→ Int* funqciis gansazRvrisaTvis, romelic gvibrunebs ori siis skalarul namravls. magaliTad:

*> scalarproduct* [1*,* 2*,* 3] [4*,* 5*,* 6]

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*scalarproduct xs ys* = *sum* [*x* ∗ *y |* (*x , y*) *← zip xs ys* ]

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davasruloT es nawili magaliTiT, romelic martiv ricxvebs exeba. mexuTe Tav­Si moyvanili iyo funqciebi martivi ricxvebis Sesaqmnelad mocemul zRvrul si­di­dem­de. aq ki ganvixiloT elementaruli procedura yvela martivi ricxvis usa­srulo mimdevrobis generirebisaTvis (gansxvavebiT aseTi mimdevrobis sa­sru­li prefiqsisagan, anu nawilisagan mis dasawyisSi, rac mexuTe TavSi xorciel­de­bo­da):

*•* CawereT usasrulo 2*,* 3*,* 4*,* 5*,* 6*, · · ·* mimdevroba;

*•* aRniSneT pirveli elementi am mimdevrobaSi rogorc martivi *p* ricxvi;

*•* amoiReT mimdevrobidan *p* ricxvis jeradi yvela sidide;

*•* daubrundiT meore bijs.

aRsaniSnavia, rom pirveli da mesame bijebi moiTxovs muSaobis usasrulo mo­cu­lo­bas da amitom faqtobrivad bijebi monacvlebadi unda iyos. am proceduris pir­ve­li ramdenime iteracia SeiZleba aseTi saxiT warmovadginoT:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2** | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | ... |
|  | **3** |  | 5 | \_ | 7 |  | 9 |  | 11 | \_ | 13 |  | 15 | ... |
|  |  |  | **5** |  | 7 |  |  | \_ | 11 |  | 13 |  | \_ | ... |
|  |  |  |  |  | **7** |  |  |  | 11 |  | 13 | \_ |  | ... |
|  |  |  |  |  |  |  |  |  | **11** |  | 13 |  |  | ... |
|  |  |  |  |  |  |  |  |  |  |  | **13** |  |  | ... |

yoveli striqoni Seesabameba erT iteracias. pirvel striqonSi warmodgenilia sa­wyisi mimdevroba (biji 1). sqeli SriftiT Cawerili pirveli ricxvi TiToeul stri­qonSi asaxavs imas, rom es sidide martivia (biji 2). misi jeradi yvela ric­xvi xazgasmulia qvemodan maTi amoRebis aucileblobis aRsaniSnavad (biji 3) mom­devno iteraciamde. amrigad, SegviZlia warmovidginoT ricxvebis sawyisi mim­dev­roba, romelic Camodis qveviT. xazgasmis gamoyenebiT TiToeul etapze gar­kve­u­li ricxvebis «gacra» xdeba, xolo «sacerSi» darCenili sqeli SriftiT war­mo­dge­nili sidideebi qmnis martivi ricxvebis usasrulo mimdevrobas:

**2, 3, 5, 7, 11, 13,** *· · ·*

zemoT miTiTebuli procedura martivi ricxvebis generirebisaTvis cnobilia ro­gorc *eratosfenis saceri* (ingl. *Eratosthenes sieve*) \_ Zveli saberZneTis maTema­ti­kosis pativsacemad, romelmac pirvelad aRwera igi. es procedura uSualod Se­i­Zleba warmovadginoT haskelze:

*primes* :: [*Int*]

*primes* = *sieve* [2 *. .*]

*sieve* :: [*Int*] *→* [*Int*]

*sieve* (*p* : *xs*) = *p* : *sieve* [*x | x ← xs, x* `*mod*` *p ≠* 0]

sxva sityvebiT rom vTqvaT, viwyebT usasrulo [2 *. .*] siiT (biji 1) da viyenebT *sieve* funqcias, romelic inaxavs pirvel *p* ricxvs rogorc martivs (biji 2). Sem­deg es funqcia iZaxebs rekursiulad sakuTar Tavs axali siidan, romelic mi­iReba wina siidan *p* ricxvis jeradi yvela sididis filtraciis gziT (biji 3 da biji 4). gadadebuli gamoTvla iZleva imis garantias, rom es programa nam­dvi­­lad axorcielebs yvela martivi ricxvis usasrulo siis generirebas.

*> primes*

[2*,* 3*,* 5*,* 7*,* 11*,* 13*,* 17*,* 19*,* 23*,* 29*,* 31*,* 37*,* 41*,* 43*,* 47*,* 53*,* 59*,* 61*,* 67*, · · ·*

Tu martivi ricxvebis generirebisas uars amboben finiturobasTan (sasrulo­bas­Tan) dakavSirebul SezRudvaze, iReben modulur programas, romelSic marTvis (kon­trolis) calkeuli nawilebis gamoyeneba sxvadasxva viTarebaSi SeiZleba. maga­liTad, pirveli aTi martivi ricxvis da aTze naklebi martivi ricxvebis ge­ne­rireba Semdegi gziT xerxdeba:

*> take* 10 *primes*

[2*,* 3*,* 5*,* 7*,* 11*,* 13*,* 17*,* 19*,* 23*,* 29]

*> takeWhile* (*<*10) *primes*

[2*,* 3*,* 5*,* 7]

1. piTagora (laT. Pythagoras, Zv.w. 570 – Zv.w. 490) \_ Zveli saberZneTis filosofosi da maTematikosi. [↑](#footnote-ref-1)
2. pirveli srulyofili ricxvia 6 (1+2+3=6), Semdegia 28 (1+2+4+7+14=28). roca dade­bi­Ti mTeli ricxvi izrdeba, srulofili ricxvebi sul ufro iSviaTad gvxvdeba. mesame srul­­yofili ricxia 496, meoTxe \_ 8 128. es oTxi ricxvi napovnia berZeni maTema­ti­ko­sis nikomaqusis (laT. Nicomachus, Cv.w. 60 \_ Cv.w. 120) mier.

   mexuTe srulyofili ricxvia 33 550 336. igi aRmoaCina germanelma maTematikosma regio­mon­tanusma (laT.  Regiomontanus; germanulad namdvili saxelia Johannes Müller, 1436 \_ 1476). meeqvse srulyofili ricxvia 8 589 869 056, xolo meSvide \_ 137 438 691 328. isini ipova 1588 wels italielma maTematikosma pietro kataldim (ital. Pietro Antonio Cataldi, 1548 \_ 1626). meoce saukunis dasawyisSi kidev sami srulyofili ricxvi aRmoaCines. amis Semdeg arc erTi srulyofili ricxvi ar aRmouCeniaT me-20 saukunis meore naxevramde, roca kompiuterebis gaCenasTan dakavSirebiT mdgomareoba gamosworda. 2010 wlisaTvis cnobilia sul 47 luwi srulyofili ricxvi. kenti srulyofili ricxvebi dRemde ucnobia, magram arc maTi ararsebobaa damtkicebuli. msoflioSi arsebobs ganawilebuli gamoTvlebis specialuri programa (GIMPS – Great Internet Mersenn Prime Search), romelic srulyofili ricxvebis mopovebiTaa mxolod dakavebuli. [↑](#footnote-ref-2)