**rekomendaciebi rekursiis sakiTxebze**

rekursiuli funqciebis gansazRvra velosipedis tarebas gvagonebs: gamo­i­yureba martivad, roca amas vinme sxva akeTebs, SeiZleba ganuxorcielebeli mo­ge­CvenoT, Tu amis gakeTebas damoukideblad Tavad moindomebT pirvelad, ma­gram martivi da bunebrivi xdeba praqtikis miRebis Semdeg. am nawilSi Cven rekomendacias viZleviT saerTod funqciaTa gansazRvris sakiTxebze da kerZod, rekursiul funqciaTa aRweris problemebze. amisaTvis miv­mar­TavT *xuTetapian process*, romelsac avsaxavT *sami konkretuli maga­li­Tis* safuZvelze.

**magaliTi I -** *product*

pirveli martivi magaliTis saxiT aRvweroT, rogor xdeba etapobrivad am TavSi adre mocemuli *product* sabiblioTeko funqciis gansazRvra, romelic angariSobs ricxvTa siis namravls.

**etapi 1: tipis aRwera**

dafiqreba tipebis Taobaze SeiZleba Zalian sasargeblo aRmoCndes funqciaTa gan­sa­­zRvrisas. ase rom funqciis tipis gansazRvra sakuTriv funqciis gansazRvris da­wyebamde \_ kargi da misasalmebeli Cvevaa. gansaxilveli magaliTis SemTxvevaSi vi­wyebT funqciis formiT:

*product* :: [*Int*] *→ Int*

am struqturidan Cans, rom *product* funqcia iRebs Sesasvlelze mTeli ricxvebis si­as da gamoaqvs gamosasvlelze ganmxoloebuli mTelricxva mniSvneloba. am ma­ga­­liTis msgavsad, sadac saubaria *Int* tipze, xSirad sasargebloa ganxilvis da­wye­ba swored aseTi martivi tipiT, romelic mogvianebiT SeiZleba dazustdes an ga­nzogaddes aucileblobis SemTxvevaSi.

**etapi 2: SemTxvevaTa CamoTvla**

argumentTa tipebis umravlesobisaTvis arsebobs rigi standartuli SemTxveva da ma­Ti ganxilva aucilebelia. saxeldobr, siebisaTvis standartuli SemTxvevebia ca­ri­eli sia da aracarieli siebi. amitom SegviZlia CavweroT Semdegi sqematuri gan­sazRvreba SablonTan Sedarebis gamoyenebiT:

*product* [] =

*product* (*n* : *ns*) =

arauaryofiTi mTeli ricxvebisaTvis standartuli SemTxvevebia 0 da *n*+ 1, lo­gi­kuri mniSvnelobebisaTvis aseTia *False* da *True* da ase Semdeg. mo­gvianebiT, ti­pe­bis msgavsad, SeiZleba dagvWirdes SemTxvevaTa da­zus­te­bac, magram maTi gan­xil­va sasargebloa standartuli SemTxvevebiT dai­wyos.

**etapi 3: martiv SemTxvevaTa gansazRvra**

mTeli ricxvebis namravli, roca am ricxvebis raodenoba nuls Seadgens, iZleva erTs, vinaidan erTiani ar arRvevs gamravlebis operaciaSi gamosaxulebis uc­vle­lo­bas. amitom carieli siis SemTxvevaSi bunebrivia ganisazRvros, rom:

*product* [] = 1

*product* (*n* : *ns*) =

am magaliTis msgavsad, martivi SemTxveva xSirad iZens ZiriTadi, sabazo SemTxvevis mniSvnelobas.

**etapi 4: sxva SemTxvevaTa gansazRvra**

rogor SeiZleba gamoviangariSoT mTeli ricxvebis aracarieli siis namravli? am etapze sasargeblo iqneba jer ganvixiloT Semadgeneli nawilebi, romlebic SeiZleba iqnes gamoyenebuli. aseTia, magaliTad, sakuTriv funqcia (*product*), argumentebi (*n* da *ns*) da Sesabamisi tipis (+, *−*, ∗ da a.S.) sabiblioTeko funqciebi. am SemTxvevaSi Cven mxolod vamravlebT pirvel mTel ricxvs da mTeli ricxvebis darCenili siis namravls:

*product* [] = 1

*product* (*n* : *ns*) = *n* ∗ *product ns*

am magaliTis msgavsad, sxva SemTxvevebi xSirad iZens rekursiul xasiaTs.

**etapi 5: ganzogadeba da gamartiveba**

mas Semdeg, rac funqcia ganisazRvreba zemoT aRwerili procesis gamoyenebiT, xSirad naTeli xdeba, rom igi SeiZleba ganzogaddes an gamartivdes. magaliTad, *product* funqcia damokidebuli ar aris im ricxvTa zust saxeze, romelTa mimarT igi gamoiyeneba. amitom misi tipi SeiZleba ganzogaddes da mTeli ricxvebidan savsebiT dasaSvebia nebismier ricxviT tipze gadasvla:

*product* :: *Num a* ⇒[a] *→ a*

rac Seexeba gamartivebas, me-7 TavSi vnaxavT, rom *product* funqciaSi gamoyenebuli rekursiis Sabloni inkafsulirebulia (e.i. kidev raRacas Seicavs sakuTar TavSi) *foldr* dasaxelebis sabiblioTeko funqciiT, romelsac *product* funqcia iyenebs. amitom *product* funqcia SeiZleba xelaxla ganisazRvros erTi gantolebiT

*product* = *foldr* (∗) 1

amrigad, saboloo gansazRvrebas *product* funqciisaTvis Semdegi saxe aqvs:

*product* :: *Num a* ⇒ [*a*] *→ a*

*product* = *foldr* (∗) 1

es aris *product* funqciis zusti ganmarteba A danarTSi mocemuli standartuli prelude failidan, imis gamoklebiT, rom efeqturobis mosazrebiT *foldr* funqciis gamoyeneba iq Canacvlebulia monaTesave *foldl* sabiblioTeko funqciiT, romelic aseve me-7 TavSia ganxiluli.

**magaliTi II - *drop***

axla ufro arsebiT magaliTze vuCvenoT, rogor SeiZleba xuTetapiani procesis gamoyenebiT avagoT sabiblioTeko *drop* funqciisaTvis adre mocemuli gansazRvreba. rogorc viciT, es funqcia anadgurebs siaSi elementebis mocemul raodenobas (am siis dasawyisidan).

**etapi 1: tipis aRwera**

daviwyoT tipiT, romelic gveubneba, rom *drop* funqcia iRebs Sesasvlelze mTel ricxvsa da garkveuli *a* tipis mniSvnelobaTa sias, xolo gamosasvlelze amave tipis sidideTa axali siis formirebas axorcielebs:

*drop* :: *Int →* [*a*] *→* [*a*]

yuradReba miaqcieT, rom am tipis gansazRvrebas oTxi Tavisebureba axa­si­a­Tebs, saxeldobr: 1. pirvel argumentad gamoyenebulia mTeli ricxvi da ara ufro zogadi ricxviTi tipi, rac simartivis uzrunvelsayofad keT­de­ba; 2. nacvlad imisa, rom funqcia Sesasvlelze iRebdes Tavis or ar­gu­ments wyvilis saxiT, meti moqnilobisaTvis Seqmnilia karingis ga­mo­ye­ne­bis SesaZlebloba (ix. punqti 3.6); 3. mTelricxva argumenti gan­Tav­se­bu­lia meore argumentamde, romelsac elementTa siis saxe aqvs, rac wa­kiT­xvis moxerxebulobas emsaxureba (*drop n xs* gamosaxuleba SeiZleba ase ikiT­xebodes, magaliTad: «*n* elementis amogdeba *xs* siidan»); 4. iqmneba funq­cia, romelic polimorfulia elementTa siis tipiT (gamoyenebis uni­ver­salobis uzrunvelsayofad).

**etapi 2: SemTxvevaTa CamoTvla**

vinaidan mTelricxva argumentisaTvis ori (0 da *n* + 1) standartuli Sem­Txve­va ar­sebobs, xolo argumentebis siisaTvis aseve or ([] da *x* : *xs*) gan­sa­kuTrebul mniS­vnelobasTan gvaqvs saqme, qvemoT mocemuli sqematuri Ca­na­weri gan­sa­zRvre­bi­sa­Tvis saerTo jamSi oTx gamosaxulebas moiTxovs:

*drop* 0 [] =

*drop* 0 (*x* : *xs*) =

*drop* (*n* + 1) [] =

*drop* (*n* + 1) (*x* : *xs*) =

**etapi 3: martiv SemTxvevaTa gansazRvra**

logikurad, nebismieri siis dasawyisidan misi nuli elementis amogdeba imave si­as iZleva. ase rom pirveli ori SemTxvevis gansazRvra uSualod xdeba:

*drop* 0 [] = []

*drop* 0 (*x* : *xs*) = *x* : *xs*

*drop* (*n* + 1) [] =

*drop* (*n* + 1) (*x* : *xs*) =

carieli siidan erTi an ramdenime elementis amogdebis mcdeloba dauSvebelia. amitom mesame SemTxveva unda iqnes gamotovebuli. magram es gamoiwvevs Secdomis gaCenas, Tu aseTi situacia warmoiqmneba. magram praqtikaSi miiReba gadawyvetileba Secdomis gaCenis asacileblad, risTvisac am SemTxvevaSi carieli siis dabruneba xdeba:

*drop* 0 [] = []

*drop* 0 (*x* : *xs*) = *x* : *xs*

*drop* (*n* + 1) [] = []

*drop* (*n* + 1) (*x* : *xs*) =

**etapi 4: sxva SemTxvevaTa gansazRvra**

rogor amovagdoT erTi an ramdenime elementi aracarieli siidan? erTiT naklebi raodenobis elementis martivi amoRebiT siis kudidan:

*drop* 0 [] = []

*drop* 0 (*x* : *xs*) = *x* : *xs*

*drop* (*n* + 1) [] = []

*drop* (*n* + 1) (*x* : *xs*) = *drop n xs*

**etapi 5: ganzogadeba da gamartiveba**

*drop* funqcia damokidebuli ar aris im mTeli ricxvis zust saxeze, ro­mel­sac igi pirvel argumentad iRebs. amitom xsenebuli ricxvis tipi Se­i­Zleba ganzogaddes da nebismier *Integral* mTelricxva tipad ga­mo­cxad­des, romlis standartul egzemplarebs[[1]](#footnote-1) *Int* da *Integer* tipebi war­mo­a­d­gens:

*drop* :: *Integral b* ⇒ *b →* [*a*] *→* [*a*]

magram efeqturobis mosazrebebiT aseTi ganzogadeba faqtobrivad ar xdeba stan­dar­tul prelude failSi, rogorc es aRiniSneboda punqtSi 3.9. gamartivebis Tval­sazrisiT ki pirveli ori gantoleba *drop* funqciisaTvis SeiZleba erT gan­to­lebad Caiweros, romelic gveubneba, rom nebismieri siidan nulovani rao­de­no­bis ele­ment­Ta amogdeba imave sias iZleva:

*drop* 0 *xs* = *xs*

*drop* (*n* + 1) [] = []

*drop* (*n* + 1) (*x* : *xs*) = *drop n xs*

garda amisa, *x* cvladi ukanasknel gantolebaSi SeiZleba SevcvaloT Cas­mis SabloniT, vinaidan es cvladi gantolebis tanSi ar gamoiyeneba:

*drop* 0 *xs* = *xs*

*drop* (*n* + 1) [] = []

*drop* (*n* + 1) ( \_ : *xs*) = *drop n xs*

amis msgavsad, Cndeba mosazreba, rom meore gantolebaSi *n* sidide unda iyos Canacvlebuli ( \_ ) CanaweriT, magram es dauSvebel da mcdar saxes aZlevs gansazRvrebas, vinaidan *n* + *k* formis Sablonebi moiTxovs, rom *n* si­di­de warmoadgendes cvlads. am SezRudvis Tavidan acileba Se­sa­Zle­be­li iqneba, Tu meore gantolebaSi mTlianad CavanacvlebT *n* + 1 Sablons ( \_ ) CanaweriT. magram es funqcis qcevasac Secvlis. magaliTad, *drop* (*−*1) [] gamosaxulebis gamoTvla am dros carieli siis SemTxvevaSic moxdeba, ma­Sin roca axla es Secdomas iwvevs, vinaidan ( \_ ) CanawerTan Se­sa­ba­mi­so­ba­Si nebismieri mTeli ricxvis moyvana SeiZleba, xolo (*n* + 1) Canawers mxo­lod iseTi mTeli ricxvebi Seesabameba, romlebic erTze naklebi ar aris (≥ 1).

dasasrul, saboloo gansazRvreba *drop* funqciisaTvis swored im saxes iRebs, romelic mas A danarTis prelude standartul failSi aqvs:

*drop* :: *Int →* [*a*] *→* [*a*]

*drop* 0 *xs* = *xs*

*drop* (*n* + 1) [] = []

*drop* (*n* + 1) ( \_ : *xs*) = *drop n xs*

**magaliTi III -** *init*

daskvniTi magaliTis saxiT vnaxoT gansazRvrebis ageba xuTetapian procesSi *init* sa­biblioTeko funqciisaTvis, romelic aracarieli siis ukanasknel elements ana­dgurebs.

**etapi 1: tipis aRwera**

daviwyoT tipis aRweriT, romelic gveubneba, rom *init* funqcia iRebs Se­sa­s­vlel­ze garkveuli tipis mniSvnelobaTa sias da agebs aseTive mni­S­vne­lo­bebis sxva si­as:

*init* :: [*a*] *→* [*a*]

**etapi 2: SemTxvevaTa CamoTvla**

vinaidan carieli sia ar aris dasaSvebi argumenti *init* funqciisaTvis, gan­sa­z­Rvre­bis qvemoT naCvenebi sqematuri Canaweri SablonTan Sedarebis gamo­yenebiT mxo­lod erTi SemTxvevis miTiTebas moiTxovs:

*init* (*x* : *xs*) =

**etapi 3: martiv SemTxvevaTa gansazRvra**

maSin, roca or wina magaliTSi es etapi savsebiT cxadi iyo, *init* funqciis Sem­Txve­vaSi odnav meti dafiqreba dagvWirdeba. logikurad, ukanaskneli elementis amo­Reba erTelementiani siidan cariel sias iZleva. amitom SegviZlia mcvelis Se­motana am martivi SemTxvevisaTvis:

*init* (*x* : *xs*) *| null xs* = []

*| otherwise* =

gavixsenoT, rom sabiblioTeko *null* funqcia adgens carielia sia, Tu ara.

**etapi 4: sxva SemTxvevaTa gansazRvra**

rogor SeiZleba ukanaskneli elementis amoReba siidan, romelSic sul cota ori elementi mainc aris? Tavis martivi SenarCunebiT da ukanaskneli elementis amoRebiT kudidan:

*init* (*x* : *xs*) *| null xs* = []

*| otherwise* = *x* : *init xs*

**etapi 5: ganzogadeba da gamartiveba**

*init* funqciisaTvis tipi ukve imdenad zogadia, ramdenadac es Se­sa­Zle­be­lia, magram miuxedavad amisa, Tavad gansazRvreba SeiZleba gamartivdes Sa­blonTan SedarebiT mcvelebis nacvlad da pirvel gantolebaSi Casmis Sa­blonis gamoyenebiT da ara cvladis:

*init* :: [*a*] *→* [*a*]

*init* [ \_ ] = []

*init* (*x* : *xs*) = *x* : *init xs*

am SemTxvevaSic swored aseTia *init* funqciis gansazRvreba prelude standartul failSi.

1. klasis egzemplari (ingl. instance) \_ konkretuli obieqti mocemuli klasis obieqtebis si­mravlidan. sistemaSi, Cveulebriv, sxvadasxva klasis mravali egzemplari funqcio­ni­rebs. erTi klasis yvela egzemplars operaciaTa erTnairi nakrebi aqvs. [↑](#footnote-ref-1)