

# Ketapele

Mekgwa e e tlwaelegileng ya go ruta ka dipalopalo le ditseroganyo e akaretsa (e bile e tsepame thata mo go) go tlhalosa kgopolo le go dirisa dikakanyo tsa dipalopalo tsa tshimologo. Ke ba se kae fela ba ba tlhomang mogopolo mo go tokafatseng dikakanyo tse di akarediawang mo dithutong tse di kwa godimo tsa dikirii ya ntlha. Bagatise ba buka eno ba lemogile gore go na le phatlha e e ka nnang teng mo go tsa tlhaloganyo le mo go kwaleng le go buisa dibuka mo kharikhulamong ya dipalopalo tsa thuto e e kwa godimo ya Aforika Borwa. Ba ne ba ikaelela go tlaleletsa mo dikgopolong tsa setso (le tiragatso), mokgwa wa go ruta le ditlwaello tse di dirisiwang mo thutong ka pono e ntšhwa.

Buka eno e tswa mo porojekeng ya go tlhabolola le go rulaganya dikakanyo tse di itlhametsweng tse di ikaegileng ka diteng tsa tshekatsheko ya metseletsele ya nako go tswa mo dithutong tsa bogolo jwa pele kwa University of Pretoria (UP). Dipolelo tsa porojeke eno di ka nna tsa nna jaaka motswedi wa thuto o baithuti ba UP (le ba bangwe) ba ka o dirisang go tsoseletsa kgatlhego e, e le go fokotsa go sa tlhomamang go go dikologileng dikakanyo tse di rutiwang mo tshekatshekong ya metseletsele ya nako.

Tlhatlhobo ya metseletsele ya nako ke modutu wa ngwaga wa boraro o o tserweng ngwaga le ngwaga ke baitlhoki ba ba ka nna 300, o o nang le baithuti ba ba tswang kwa BSc Mathematical Statistics, BSc Actuarial le Financial Mathematics, BCom Statistics le Data Science, le BCom Economics, gareng ga tse dingwe. Diteng tsa yone di akaretsa metseletsele ya nako e e sa fetogeng, dilo tse di dirwang ke dikala tsa palogare tse di tsamayang ka go boela morago, go fopholediswa ga dimotele tse di sekasekwang, go bonela pele le go sekaseka dilo tse di setseng.

Mo go nngwe ya dikgwedithataro (disemesetara), baithuti ba ne ba ithaopela go nna le seabe mo tirong ya go anela dikgang tse mo go tsone go neng go dirisiwa dikakanyo tsa konokono tsa go sekaseka tatelano ya ditiragalo tsa nako jaaka batho ba ba tlhalosiwang. Baithuti ba ne ba neelwa kaedi e e sa gagamalang, kgotsa kaelo ya go kwala kgangkhutswe e e itlhametsweng, ka maikaelelo a go batlisisa

go tsoselediwa ga mafelo a tlhaloganyo a a neng a sa akanyediwa pele, a a ka oketsang mafelo a mangwe a a ntseng jalo go itlhaganedisa go ithuta le go fokotsa tlhobaelo e e bonwang e e amanang le go sekaseka metseletsele ya dinako. Ka tsela eno, bokgoni jwa go ruta le go dira patlisiso bo nonotshiwa mo mmojulong o ngwaga le ngwaga o gwetlhang baithuti ba BCom, segolobogolo ka go oketsa didirisiwa tsa go ruta baithuti ba mo isagweng. Tse di kwadilweng ke baithuti le go rulaganngwa ke batlhatlheledi (batlhotlhomisi ba bagolo mo porojekeng eno). Ka jalo, go ithuta ka tsela e e rulagantsweng go akareditswe mo go ithuteng ka tsela e e sa rulaganngwang ya go ithuta mo dithakeng ka maiteko ano a a tshegetsang go ithuta ka tsela e e itlhametsweng, e e ikaegileng ka porojeke le go ithuta mo kharikhulamong tse di rutang dilo tse di tshwanang.

**Ditlhaloso (Cryer and Chan 2008):**

## Metseletsele ya nako

Tshedimosetso e e bonweng go tswa mo tshekatshekong e e kgobokantsweng ka tatelano mo tsamaong ya nako, gantsi ka dipaka tse di lekanang tse di fa gare (seka, ditlhwatlhwa tsa letsatsi le letsatsi tsa dikuno, lebelo la phefo ka ura, le dipalo-palo tsa ngwaga le ngwaga tsa ntshokuno ya dijalo kgotsa leruo). Boleng gantsi bo emelwa ke  $X_t$ , e e supang boleng jwa metseletsele ya nako, mme letshwao la  $t$  le supa nako ya tshekatsheko. Ka kakaretso, go na le polelwana ya phoso ya tlaleletso e e supilweng ka  $a_t$ , e e emelang tiragalo e e sa rulaganngwang e e sa tlhalosiweng ke mofuta ka boone. Phoso eno e e oketsegang gantsi e bidiwa “white noise.”

## Ipusetso morago (Autogressive)

Mokgwa wa dipalo wa go dira  $X_t$  e e ikaegileng ka dilo tse e di lemogileng mo nakong e e fetileng, jaaka  $X_{t-1}$ ; tota, go boela morago ga  $X_t$  ka boyone mo nakong e e fetileng.

## Palogare e e sa emang (Moving average)

Mokgwa wa dipalo wa go dira  $X_t$  o o ikaegileng ka tebelelo le temogo ya dipphoso tsa nako e e fetileng, jaaka  $a_{t-1}$ .

### Tiragatso ya boikgolaganyo (Auto Correlation Function - ACF)

Tlhaloso ya dipalopalo e e supang kamano magareng ga tshekatsheko ya  $X_t$  le  $X_k$ . Sekao: Fa tshekatsheko ya tatelano ya nako ya  $X_t$  e kgaogane ka nako ya  $t-k$ .

### Dickey-Fuller e e baakantsweng (ADF)

Teko ya dipalopalo ya botlhokwa go bona gore a tatelano/metselaetsele ya nako ya  $X_t$  e na le modi wa yuniti.

Tlhaloso e nngwe ya ditshupiso tse dipotlana tsa maina a a rileng le ditlhaka tse di khutshwafaditsweng mo bukeng eno di ka fitlhelwa mo go Cryer and Chan (2008).

### Maikaelelo

Maikaelelo a porojeke eno e ne e le go kgobokanya dikwalo tse di tlhamilweng tse di nang le dintlha le dikakanyo tsa go anela dikgang tse di tserweng go tswa mo dithutong tsa bogolo jwa pele tsa silabose ya metselaetsele ya nako.

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### Maitlomo

Maitlomo/maikaelelo a porojeke eno e ne e le:

- go tokafatsa go ithuta ga baithuti ka didiriswa tsa go ruta tse di sa tswang go diriwa;
- go rotloetsa baithuti go nna le seabe ka tsela e e kayang boitlhamelo, le gore maitemogelo a bone a thuto a ka tshegediwa jang fa ba ithuta ka mokgwa o o sa rulaganngwang, o o ikaegileng ka porojeke;
- go fokotsa go sa tlhomamisege le go tlhobaela ka mmojulo mo baithuting ba mo isagweng; le
- go tlhomamisa maitemogelo a baithuti ba ba nang le seabe a a supang diphetogo tsa tlhaloganyo morago ga thulaganyo ya go tlhama go rarabolola bothata jwa go sa tlhomamisege le go ruta ka boleng jwa se se mo teng ga mmojulo.

### Maikaelelo

Maikaelelo a porojeke eno e ne e le go:

- kgobokanya, rulaganya le go rulaganya dipolelo tse di itlhametsweng tse di kwadilweng ke baithuti go tswa mo karolong ya tatelano ya dinako;
- gatisa kgobokanyo eno ya dipolelo ka ESI Press jaaka bolumo ya semmuso ya dikabelo tsa baithuti;
- go tsenya metswedi eno mo dimoduleng tse di maleba gore baithuti ba e dirise le go e oketsa mo isagweng;
- rotloetsa dipholo tsa porojeke eno kwa dikhonferenseng tsa bosetšhaba; le
- tlhaloganya, kwala, le go rulaganya maitemogelo a baithuti ba ba nang le seabe mo thulaganyong ya go tlhama go bona temogo mogo senosetsenyeletsang sese kgabaganyang legotlhamamokhosong ya maemo a a kwa godimo ya diyunibesiti mo go tsa dipalopalo.

Mo porojekeng eno, baithuti ba ne ba tlhalosediswa jaana:

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*Kwala tlhamane ya mafoko a ka nna 1000 (e ka nnang ditsebe di le 1.5 tsa A4). E nne tlhamane ya nako ya go robala e e ka buisetswang morwarrago yo o mmotlana kgotsa ntsalao. Buka e e dirang jaaka sedirisiwa sa thuto se se sa tswang go tlhabololwa le go baakanngwa mo teng ga mmojulo wa tlhatlhobo ya matseno ya metsetseleko ya nako. Kgang ya gago e tshwanetse go nna le moanelwamogolo, yo o bosula, mme e diragale mo lefatsheng la ditlhamane/lefatsheng la boammaruri/kwa nageng/lefelong le o le itlhophelang.*

*Dilo dingwe tse ke tla di lebelelang (mme o se ka wa letla gore di kgoreletse bokgoni jwa gago jwa go tlhama):*

1. *Go na le baanelwa/mafelo a a rileng a a amanang ka tlhamalalo le megopolo ya metsetsele ya nako (sekao, ARIMA ((0,1,0) ke moikepi!);*
2. *Go na le kgolagano ya tlhologo magareng ga tlhamane le diteng tsa khoso ya metsetsele ya nako;*
3. *Kgang e rulagantswe sentle; le*
4. *Kgang eno e felela ka gore go nne le tharabololo e e rileng (sekai: mogale*

*o fenyha moloi).*

*Ga go tlhokege gore o bo o le mokwadi yo mogolo gore o nne le seabe mo tirong eno. O tshwanetse go nna wena, mme o leke go nna le bokgoni jwa go tlhama.*

#### **Dintlha dingwe:**

*O ka kwala tlhamane eno ka puo ya gago, kgotsa ka Seesemane. Fa e le gore o kwadilwe ka puo e e farologaneng le Seesemane, ke tla dira bojotle go bona thanolo e e tshwanetseng ya Seesemane. O gololosegile go romela ditlhamane tse di fetang e le nngwe, mme tsweetswee di romele ka bongwe ka bongwe.*

Mokgwa o o neng o latelwa morago ga go amogela ditlhamane tsa baithuti e ne e le go di buisa, go neelana ka maikutlo mo go se se kwadilweng, baakanya dipolelo, o aga le go rulaganya buka e e nang le seabe e seng fela go nna buka ya dipolelo. Buka e e dirang jaaka sedirisiwa sa thuto se se sa tswang go tlhabololwa le go baakanngwa mo teng ga mmojulo wa WST 321/STK 320 (kgotsa go nna mmojulo wa tlhatlhobo ya matseno ya metsetseleko ya nako). Baithuti ba ne ba gololesegile go nna le seabe (go ne go sa patelediwe ope go nna le seabe).

Ba ne ba tshwanetse go dumela ka tlhamalalo gore ditlhamane tsa bone di ka dirisiwa mo dipatlisisong le gore di ka nna tsa gatisiwa. Mo phaposing ya baithuti ba ka nna 300, go ne ga amogelwa dikabelano tse di fetang 30, tse mo go tsone baithuti ba le 23 ba neng ba letla gore tiro ya bone e akarediwe mo bukeng. Bagatise ba ne ba kgaoganya dikwalo tsa bone go nna dikarolo tse pedi tse di farologaneng (Karolo I: Ditlhamane. Karolo II: Ditlhamane –tse e seng tsa boammaruri le Saense e eseng ya boammaruri/Sci-Fi) go ya ka mokgwa o o tlwaelegileng le mo go se go buiwang ka sone mo tirong e e rometsweng, e e tsamaisanang le mefuta e e itsegeng thata ya ditlhamane tse gantsi le tsone di diriwang kgotsa di buisiwang pele ga nako ya go robala.

#### **Tlhotlheletso**

Diphelelo tsa porojeke eno e ne e le tse di latelang:

- Baithuti ba na le metswedi e mešwa e e oketsegileng ya tshedimosetso le ya go ithuta.

- Baithuti ba bašwa ba ka lebelela maitemogelo a baithuti ba pele, mme seno se dira gore ba ithute ka tsela e e sa rulaganngwang.
- Diteng tsa khoso di nna botlhokwa ka go dirisa mokgwa wa go tlhama, go rotloetsa maitemogelo a go kgabaganya dithutego mo tikologong ya tshakatsheko tsa saense.
- Mo ngwageng wa boraro wa go ithuta dipalopalo, baithuti ba nna le seabe mo tirong ya go ithuta ka dikgono (go akanya ka tsela ya boitlhamedi) jo bo sa sekasekiweng gantsi mo karolong eno.

Moithuti mongwe le mongwe o na le bokgoni jwa go ithuta jo bo sa tshwaneng le jwa ba bangwe mo phaposing nngwe le nngwe ya borutelo (e le kgolo kgotsa e le nnye). Ka ntlha ya seno, go dirisa mekgwa e e farologaneng ya go ruta go botlhokwa gore go nne le tikologo e e nang le metswedi ya go ithuta. Go ela tlhoko, puo, kgakologelo, le go akanya ka tsela e e kwa godimo ke dikarolo tse nnè (mo go tse thataro) tsa botlhokwa tse di tlhotlheletsang thulaganyo ya go ithuta. Sedirisiwa sengwe le sengwe kgotsa tikologo e e kopanyang dikarolo tseno tsotlhe tse nnè e botlhokwa thata gore motho a nne le maitemogelo a a molemo a go ithuta. Saense ya go bua dikgang tse di molemo e tlhoka dilo tseno tsotlhe tse nnè, fa e se tsotlhe tse thataro.

Dithuto tse di buang ka go anela dikgang mo go tsa saense ya dipalo di amogetse kgatlhego e e rileng sešweng jaana (Albano and Pierri 2017; D'Andrea and Waters 2002; Lashari et al. 2022; Sherwood 2018). Seno se letla baithuti go tlaleletsa go ithuta ga bone mo karolong e e rileng ya kitso ka bokgoni jo bo nonofileng jo ba setseng ba bo bone mo go e nngwe. Setlhogo se se gatisitsweng ke Harvard Business Publishing (Peterson 2017) se ne sa gatelela saense e e leng kwa morago ga go anela dikgang. Setlhogo seno se umaka gore dikhemikale tsa boboko tse di jaaka cortisol (hormone ya go ngamoga pelo, mme mo kgannyeng eno e dira gore motho a kgone go gakologelwa dilo), oxytocin le dopamine di oketsega fa motho a buisa kang. Dikhemikale tseno tsa boboko di thusa go nonotsha mogopolo, go dira gore motho a nne a tlhomile mogopolo, go laola le go nonotsha maikutlo.

Dipatlisiso di tsepamisitse maikutlo thata mo go diriseng dilo tse di dirisanang le tse dingwe le dikabelo tse e seng tsa mmatotata mo thutong ya pele ga sekontari (Blackburn 2015) le mo thutong ya motheo (Lemonidis le Kaiafa 2019). Babatlisisi bangwe ba lemoga

gore dipolelo tse di itlhametsweng di ka tsosa kgatlhego, tsa fokotsa tlhobaelo, le go rotloetsa go nna le seabe mo thulaganyong ya thuto (D'Andrea le Waters 2002; Lemonidis le Kaiafa 2019). Mo thutong ya maemo a a kwa godimo, go ntse go lebilwe thata dibuka tsa ditshwantsho le metswedi e mengwe ya tshedimosetso ya dijithale (Albano and Pierri 2017; Walters et al. 2018). Karanasiou et al. (2021) ba ne ba batlisisa ka tlhotlheletso ya go anela dipolelo mo dithutong tse di kwa godimo. Mo go se ba se fitlheletseng, go ne ga lemogiwa gore go anela dipolelo ke sedirisiwa se se molemo sa go ruta le go ithuta. Go ne ga fitlhelwa gore se se dira botoka mo baithuting ba ba nang le bokgoni jo bo kwa godimo jwa go gakologelwa. Karanasiou et al. (2021) ba tlhalosa ditlhamane kgotsa go anela dikgang e le tsela ya go tlhaloganya bokao jwa se motho a se tlhaloganyang le maitemogelo a go ithuta.

Bontsi jwa dikabelo tsa baithuti di ka nna le seabe se se botlhokwa le se se nang le bokao mo dibukeng tse di buang ka go anela dikgang jaaka thuto mo go tsa saense ya go sekaseka dilo segolobogolo mo dikhosong tsa maemo a a kwa godimo tsa diyunibesithi tsa dipalopalo. Mo lefatsheng le mo go lone mathata a nnang a raraane thata go ka a rarabolola, dipalopalo e santse e le karolo e e tshosang le e e sa gobeleteng ya saense kwa ntle ga dithuto tsa tshimologo (Kruppa et al. 2021; Lemieux 2020). Kgatlhego e e tlhomologileng ya go batlisisa dipolelo tse di itlhametsweng mo dithutong tse di kwa godimo tsa dipalopalo tsa baithuti ba pele ba dikirii e ka thusa go bona ditsela tse dingwe (tse di seng thata) tsa go ruta le go ithuta. Mo patlisisong eno go buiwa thata ka kgang ya go anela e le tsela e e nang le bokao ya go tlotla ka dipalo. E letla barutabana (batlhatlheledi) le baithuti go abelana kitso e e seng ya tlwaelo ka tsela e e tshwanang le e e farologaneng le go rotloetsa go ithuta ga balekane.

Johan Ferreira le Seite Makgai, 2023

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