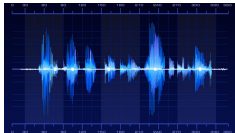
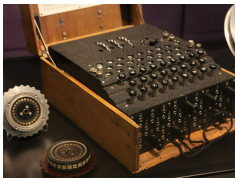
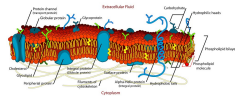


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I certify that on July 2nd 1985 I surveyed the property shown in this plot that the property here and better of all structures are correctly shown here that no structure located in this property encroaches in any adjacent street or property and that no structure or adjacent property encroaches in the premises surveyed except as shown
Charles E. Whicker



Skriti markovski modeli v časovnih vrstah

Fakulteta za matematiko in fiziko, Univerza v Ljubljani

10. december 2018

Martin Praček

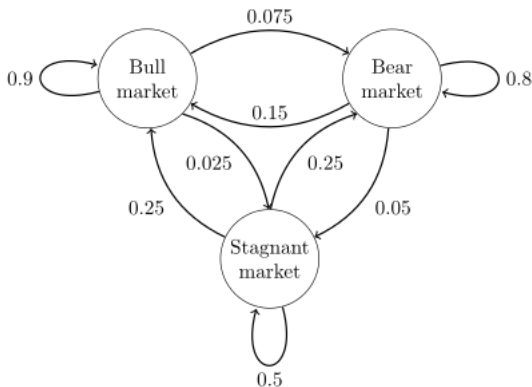
Mentor: izr. prof. dr. Damjan Škulj

Markovski model

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- Markovska lastnost je lastnost slučajnega procesa, da je njegova vrednost v času t odvisna le od njegove vrednosti v času $t - 1$.
- Ločimo v celoti opazovan in delno opazovan ter
- Avtonomen in kontroliran sistem.



Delitev markovskih modelov

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	V celoti opazovan	Le delno opazovan
Avtonomen	Markovska veriga	Skriti markovski model
Kontorliran	Markovski proces odločanja	Delno opazovalen proces odločanja

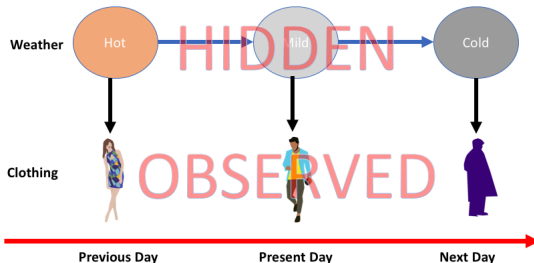
Skriti markovski model

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Skriti markovski model je statistični markovski model, kjer predpostavljamo, da je modelirani sistem markovski proces z skritimi stanji.

Gre torej za tip modela, kjer lahko razberemo rezultat, ne moremo pa ugotoviti, kakšna je bila funkcija, ki nam ga je dala.

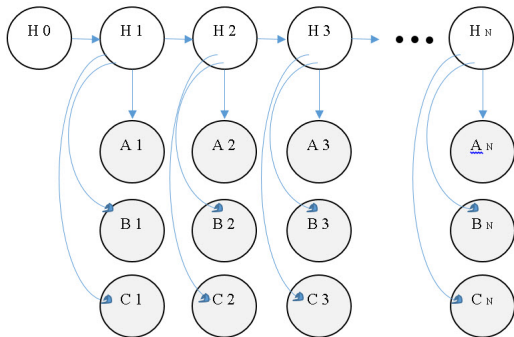


Zahteve

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- Markovska lastnost
- Enaki razdeljeni časi signalov
- Sistem ima N stanj, vsako določa slučajna spremenljivka S



Hidden States:

$$H_i = \{x, y, z, \underline{e}\}$$

Observations:

$$A = \{\text{discrete number from 1 to } U_A\}$$

$$B = \{\text{discrete number from 1 to } U_B\}$$

$$C = \{\text{discrete number from 1 to } U_C\}$$

- Slučajnih spremenljivk v nobenem času ne poznamo, poznamo pa slučajni proces Q , ki predstavlja signale
- Porazdelitveno funkcijo vsakega stanja i označimo z $b_i(x)$
- Vektor začetnih stanj je Π
- Prehodna matrika A , ki je neodvisna od časa

Porazdelitvena funkcija

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- Gaussova mešanica
- $b_i = \sum_{j=1}^M c_{ij} N(x; \mu_j, \sigma_j^2)$
- Število mešanic M
- Matrika Γ , μ_{ij} predstavlja pričakovano vrednost mešanice j v stanju i
- Matrika Σ , kjer σ_{ij} predstavlja varianco mešanice j v stanju i
- Matrika C , koeficienti c_{ij} iz Gaussove mešanice

Osnovanje modela

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Da bomo lahko delali z našim modelom, moramo najprej izvesti t.i. trening modela.

- šop k -povprečij
- Akaikov informacijski kriterij



Izračun $P(O|\lambda)$

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Z λ označimo vse ostale parametre $\lambda = (\Pi, A, C, \Gamma, \Sigma)$. Za učinkovit izračun le teh delamo *naprej – nazaj*.

$$\alpha_1(i) = \pi_i b_i(O_1) = \pi_i b_i = \sum_{k=1}^M c_{ik}$$

\Downarrow

$$P(O|\lambda) = \sum_{i=1}^N \alpha_T(i)$$

Trening modela

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Google search results for "model training".

Search bar: model training

Filters: Vse, **Slike**, Videoposnetki, Novice, Zemljevidi, Več, Nastavitve, Orodja

Tags: kirkpatrick, addie, transitional, addie model, tensorflow, development, machine learning, runway, fitness model, sagemaker, sce, photoshoots, valida

Results:

- Mental Health-Carers Project**
careerproject.yolasite.com
Diagram showing a process flow: Readiness (yellow) → Planning (orange) → Training (red) → Implementation (green) → Maintenance and Training (blue). A green oval labeled "Continuous Improvement" is at the bottom, with arrows pointing to the Training and Implementation steps.
- Model Training - Irina**
showmutagoon.net
Image of a group of models walking on a runway.
- model training | Ewing Fashion**
ewingfashionagency.wordpress.com
Image of two models walking on a runway.
- Model Training 10 Weeks Course - SCE Ag...**
sceagency.com
Image of a group of models walking on a runway.
- RBI Inc. - Training Mo...**
rbiintl.com
Diagram showing a process flow: Readiness (yellow) → Planning (orange) → Training (red) → Implementation (green) → Maintenance and Training (blue). A green oval labeled "Continuous Improvement" is at the bottom, with arrows pointing to the Training and Implementation steps.
- model training - fashionmodel101**
fashionmodel101.wordpress.com
Image of a group of models walking on a runway.
- PROFESSIONAL RUNWAY MODEL TRAINING**
modeloftheyearcompetition.com
Image of a group of models walking on a runway.
- ADDIE Model: 5 Steps To Build Effective Training Program...**
learnup.com
Diagram showing the ADDIE model steps: ANALYSIS, DESIGN, DEVELOPMENT, IMPLEMENTATION, EVALUATION.
- 8-Step Training Model - Mana ging ...**
slideplayer.com
Diagram showing the 8-Step Training Model steps: 1. Needs Assessment, 2. Learning Objectives, 3. Content Development, 4. Instructional Materials, 5. Delivery, 6. Evaluation, 7. Feedback, 8. Revision.
- Systematic Model**
naultrub.com
Diagram showing a process flow: Readiness (yellow) → Planning (orange) → Training (red) → Implementation (green) → Maintenance and Training (blue). A green oval labeled "Continuous Improvement" is at the bottom, with arrows pointing to the Training and Implementation steps.

Trening modela

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Da bomo lahko $P(O|\lambda)$ maksimizirali, potrebujemo začetne ocene parametrov. Za to ne poznamo analitičnega postopka, lahko pa lokalno maksimiziramo, z naprimer, Baum-Welchovim algoritmom. Pri tem nas ne skrbijo ocene za A ter Π , kjer moramo paziti le na neničelnost le teh. Več problemov nam povzročajo C , Σ in Γ .

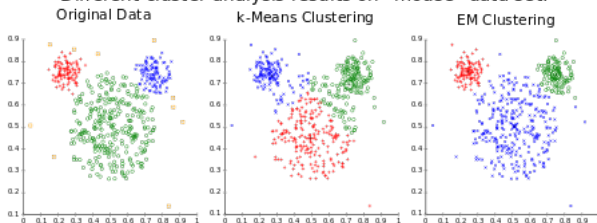
C, Σ in Γ

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Za dobro začetno oceno si lahko pomagamo z šopom k -povprečij. Za C to pomeni, da bo element $c_{ij} = 1/k$ za vsak par ij , kjer je k število šopov povprečij. Pričakovane vrednosti in variance nato pridobimo iz vrednosti teh šopov povprečij.

Different cluster analysis results on "mouse" data set:



Lokalno maksimiziranje

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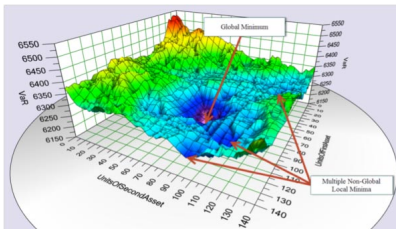
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Za potrebe lokalne maksimizacije določimo dodatne funkcije:

$$\xi_t(i, j) = \frac{\alpha_t(i) a_{ij} b_j(O_t) \beta_{t+1}(j)}{P(O|\lambda)}$$

$$\gamma_t(i) = \frac{\alpha_t(i) \beta_t(i)}{P(O|\lambda)}$$

$$\gamma_t(j, k) = \gamma_t(j) \frac{c_{jk} N(x; \mu_{jk}, \sigma_{jk}^2)}{\sum_{m=1}^M c_{jm} N(x; \mu_{jm}, \sigma_{jm}^2)}$$



Lokalno maksimiziranje

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Prek dodatnih funkcij definiramo iteracijske postopke za naše spremenljivke:

$$\overline{\Pi}_i = \gamma_1(i)$$

$$\overline{a_{ij}} = \frac{\sum_{t=1}^{T-1} \xi_t}{\sum_{t=1}^{T-1} \gamma_t(i)}$$

$$\overline{c_{jk}} = \frac{\sum_{t=1}^T \gamma_t(j, k)}{\sum_{t=1}^T \sum_{m=1}^M \gamma_t(j, m)}$$

$$\overline{\mu_{jk}} = \frac{\sum_{t=1}^T \gamma_t(j, k) O_t}{\sum_{t=1}^T \gamma_t(j, k)}$$

Začetno stanje in Viterbijev algoritem

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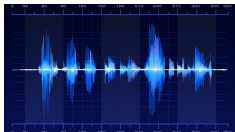
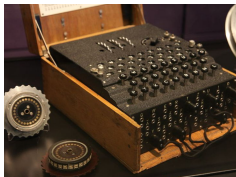
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Za delo s tem algoritmom moramo definirati $\delta_t(i)$, ki za vsako stanje i vrne največjo verjetnost vzdolž poti v času t . Prek $\delta_t(i)$ nato induktivno izvedemo algoritem.

Viterbijev algoritem nam vrne p^* , ki je največja verjetnost in q_{T^*} , ki nam pove stanje v času T , ki nam to verjetnost vrne.

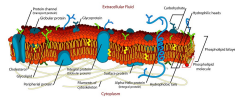
Uporaba

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Skriti
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I readily also in July 20 1905 I surveyed the property shown in this plot that the property here and location of all structures are correctly shown hence that no structure located in this property encroaches on any adjacent street or property and so that no structure or adjacent property encroaches on the premises herein shown as shown
Charles E. Whelan



V dolgi predstavitvi se bom bolj posvetil sami finančni analizi, ki sem jo tokrat zaenkrat pustil pri miru. V prihodnje bom tudi sam poizkusil določiti skriti markovski model na svojem setu podatkov.