Optimalių maršrutų paieškos algoritmai

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Keywords: Keliaujančio pirklio problema, Hamiltono ciklas, genetinis algoritmas, skruzdėlių kolonijos algoritmas, simuliuoto atkaitinimo algoritmas

1 Įvadas

Optimalių maršrutų paieškos aktualumas kiekvieno iš mūsų kasdieniniame gyvenime buvo aptartas pirmame moksliniame tiriamajame darbe. Jame buvo susipažinta su keletų heuristinių optimalaus maršruto paieškos algoritmų ir spręstos keliaujančio pirklio problemos pilno grafo atveju [1].

Yra nemažai mokslinių darbų sprendžiančių keliaujančio pirklio problemas naudojant heuristinius algoritmus, juos modifikuojant ir parenkant įvairiausias sąlygas. Tačiau didžioji dali tokių darbų analizuoja pilnus grafus (kiekvienas miestas turi tiesioginį kelią su bet kuriuo kitu miestu), o realiame gyvenime praktiškai nėra didesnių sausumos žemėlapių, kuriuose kiekvienas miestas būtų tiesiogiai susietais keliais su likusiais miestais.

Šio mokslinio tiriamojo darbo projekto tikslas yra naudojant heuristinius algoritmus ir jų modifikacijas ieškoti trumpiausio maršruto tarp miestų aplankant juos bent vieną kartą. Visi analizei naudojami grafai yra panašūs į sausumos miestų žemėlapius – juose įmanoma aplankyti visus miestus, o grafo kraštinės niekur nesusikerta.

1.1 Panašūs darbai

// TODO

2 Dėstymas

Genetinis algoritmas. Genetiniai algoritmai (GA) (angl. genetic algorithm) – vieni iš heuristinių algoritmų, įkvėptų gamtos. Jie yra paremti evoliuciniu gamtos modeliu, kai keičiantis kartoms individai tampa vis tobulesni ir labiau prisitaikę prie aplinkos sąlygų.

Dėl keliaujančio pirklio problemos paprastos formuluotės yra bandoma įvairiausius algoritmus panaudoti sprendžiant šią problemą. Ne išimtis yra ir šie algoritmai, tačiau „grynieji" genetiniai algoritmai, kurti J. H. Holland'o ir jo studentų Mičigano universitete 60-taisiais, 70-taisiais, nebuvo sugalvoti spręsti kombinatorinio optimizavimo problemas. Tai laikais genetiniai algoritmai dažniausiai buvo naudojami sprędžiant įvairias skaitines funkcija, todėl norint rasti keliaujančio pirklio problemos sprendimą, reikia atlikti tam tikrus genetinio algoritmo pakeitimus [2].

Genetinis algoritmas iš esmės operuoja su baigtine chromosomų arba bitų sekų populiacija. Paieškos mechanizmas susideda iš trijų skirtingų fazių: kiekvienos chromosomos tinkamumo (angl. fitness) įvertinimas, tėvinių chromosomų parinkimas ir mutacijos bei rekombinacijos operatorių pritaikymas tėvinėms chromosomoms. Naujos chromosomos, gautos pritaikius genetinius operatorius, dalyvauja tolimesnėje revoliucijos iteracijoje ir pati sistema tobulėja augant kartų skaičiui [2].

Genetinės sistemos supaprastintas pseudo-kodas

1. Sukuriama pradinė P chromosomų populiacija (0 karta).
2. Įvertinamas kiekvienos chromosomos tinkamumas.
3. Pasirenkama P tėvų iš esamos populiacijos pasitelkiant proporcingumo taisykle (angl. proportional selection) (pasirinkimo tikimybė priklauso nuo tinkamumo vertės).
4. Dauginimuisi atsitiktinai pasirenkama pora chromosomų. Atliekama rekombinacijos operacija apkeičiant bitus pasirinktame taške, taip sukuriant vaikines chromosomas.
5. Kiekviena vaikinė chromosoma apdorojama mutacijos operatoriais ir grąžinama į populiaciją.
6. Kartojami 4 ir 5 žingsniai kol visos chromosomos būna parinktos ir paveiktos genetiniais operatoriais.
7. Sena chromosomų populiacija pakeičiama nauja.
8. Įvertinamas kiekvienos chromosomos tinkamumas.
9. Kartojama viskas nuo 3 žingsnio kol pasiekiamas atitinkamas kartų skaičius ar kitokia sąlyga.

Genetinio algoritmo pseudo-kodas [2].

Skruzdėlių kolonijos algoritmas.

Simuliuoto atkaitinimo algoritmas.

2.1 Eksperimentinė dalis

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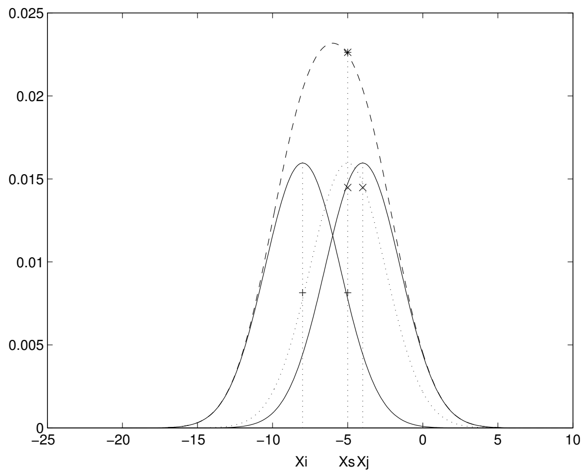

1 pav.. One kernel at x_s (*dotted kernel*) or two kernels at x_i and x_j (*left and right*) lead to the same summed estimate at x_s. This shows a figure consisting of different types of lines. Elements of the figure described in the caption should be set in italics, in parentheses, as shown in this sample caption.

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$$\psi(u) = \int_o^T \left[\frac{1}{2}\left(\Lambda_o^{-1}u, u\right) + N^*(-u)\right] dt \; . \tag{1}$$

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Program listings or program commands in the text are normally set in typewriter font, e.g., CMTT10 or Courier.

Example of a Computer Program

```
program Inflation (Output)
  {Assuming annual inflation rates of 7%, 8%, and 10%,...
   years};
   const
     MaxYears = 10;
   var
     Year: 0..MaxYears;
     Factor1, Factor2, Factor3: Real;
   begin
```

[1] The footnote numeral is set flush left and the text follows with the usual word spacing.

```
    Year := 0;
    Factor1 := 1.0; Factor2 := 1.0; Factor3 := 1.0;
    WriteLn('Year  7% 8% 10%'); WriteLn;
    repeat
      Year := Year + 1;
      Factor1 := Factor1 * 1.07;
      Factor2 := Factor2 * 1.08;
      Factor3 := Factor3 * 1.10;
      WriteLn(Year:5,Factor1:7:3,Factor2:7:3,Factor3:7:3)
    until Year = MaxYears
end.
```

(Example from Jensen K., Wirth N. (1991) Pascal user manual and report. Springer, New York)

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