VŠB TECHNICKÁ UNIVERZITA OSTRAVA | FAKULTA ELEKTROTECHNIKY A INFORMATIKY

Komponenta výukového serveru TI NP-úplné problémy 2

Component of Learning Server for Theoretical Computer Science NP-complete problems 2

Bakalářská práce

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Ostrava, 2025

Abstrakt

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Abstract

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Keywords: Lorem, ipsum, dolor, sit, amet,, consectetur, adipiscing, elit,, sed, do, eiusmod, tempor, incididunt, ut, labore, et, dolore, magnam, aliquam, quaerat.

Poděkování

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Seznam použitých zkratek a symbolů

GCC	– GNU C Compiler
GNU	– GNU Is Not Linux
NPTIME	– Non-Deterministic Polynomial Time

Obsah

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Úvod

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Kapitola 1

Math

$$\sum_{i=1}^{n} i = 1 + 2 + 3 + \ldots + n$$

$$\begin{pmatrix} 1 & 2 & \ldots & 10 \\ 2 & 2 & \ldots & 10 \\ \vdots & \vdots & \ddots & \vdots \\ 10 & 10 & \ldots & 10 \end{pmatrix}$$

$$\begin{bmatrix} 1 & * & * \\ * & 1 & * \\ * & * & 1 \end{bmatrix}$$

1.1 Math Shortcuts

$$\leq \pm$$

1.2 Random Text

1.2.1 Prokázání netranzitivity

První úkolem je ukázat, že vztahy mezi kostkami nejsou tranzitivní, to znamená, že vztahy mezi kostkami jsou tzv. cyklické[1] Tvrdíme totiž, že platí $B > A$, $C > B$ a současně $A > C$. To znamená, že žádná kostka není „nejlepší“ ve všech případech.

Pro každou dvojici kostek vypočítáme pravděpodobnost vítězství jedné kostky nad druhou, konkrétně $P(B > A)$, $P(C > B)$ a $P(A > C)$, a ověříme, že všechny tyto pravděpodobnosti jsou větší než $\frac{1}{2}$.

$$\begin{aligned} \Omega = \{&(2,1), (2,1), (5,1), (5,1), \\ &(2,4), (2,4), (5,4), (5,4), \\ &(2,4), (2,4), (5,4), (5,4), \\ &(2,4), (2,4), (5,4), (5,4)\} \end{aligned}$$

[1]Wikipedia, *Intransitivity*: `https://en.wikipedia.org/wiki/Intransitivity`

Velikost pravděpodobnostního prostoru je $|\Omega| = 16$. Z rozepsané Ω vidíme, že počet případů, kdy kostka B vyhraje nad A je vyšší (10) než počet, kdy prohraje (6). Pravděpodobnost vypočteme jako:

$$P(B > A) = \frac{2 + 4 \cdot 2}{|\Omega|} = \frac{10}{16} = \underline{\underline{0.625}}$$

Jelikož základ nehomogenní funkce je roven jedné, počet výskytů (násobnost) tohoto základu v multimnožině kořenu charakteristické rovnice je roven jedné a největší exponent n-ka nehomogenní funkce je taktéž roven jedné, je tvar obecného partikulárního řešení rekurentí rovnice p_n roven:

$$\begin{aligned} p_n^{(p)} &= n^1(\beta_1 n^1 + \beta_0)1^n \ = \ n(\beta_1 n + \beta_0) \ = \ \beta_1 n^2 + \beta_0 n \\ p_n^{(p)} &= \varphi n^2 + \gamma n \qquad\qquad\qquad (\gamma = \beta_0, \varphi = \beta_1). \end{aligned}$$

Neznámé γ a φ nalezneme substitucí členů p_n v původní rekurentní rovnici:

$$p_n = 3p_{n-1} - 2p_{n-2} - 10n.$$

partikulárním řešením $p_n^{(p)}$ a vyřesíme soustavu dvou rovnic (dvě kvůli dvěma neznámým), kde si za n zvolíme jakékoliv čísla z $\mathbb{N}_0$.

$p_n \leftarrow p_n^{(p)}$:

$$p_n^{(p)} = 3p_{n-1}^{(p)} - 2p_{n-2}^{(p)} - 10n$$

$$\begin{aligned} \varphi n^2 + \gamma n &= 3\big(\varphi(n-1)^2 + \gamma(n-1)\big) \\ &\quad - 2\big(\varphi(n-2)^2 + \gamma(n-2)\big) - 10n \\ \varphi n^2 + \gamma n &= 3\big(\varphi\big(n^2 - 2n + 1\big) + \gamma n - \gamma\big) \\ &\quad - 2\big(\varphi\big(n^2 - 4n + 4\big) + \gamma n - 2\gamma\big) - 10n \\ \varphi n^2 + \gamma n &= 3\big(\varphi n^2 - 2\varphi n + \varphi + \gamma n - \gamma\big) \\ &\quad - 2\big(\varphi n^2 - 4\varphi n + 4\varphi + \gamma n - 2\gamma\big) - 10n \\ \varphi n^2 + \gamma n &= 3\varphi n^2 - 6\varphi n + 3\varphi + 3\gamma n - 3\gamma \\ &\quad - 2\varphi n^2 + 8\varphi n - 8\varphi - 2\gamma n + 4\gamma - 10n \end{aligned}$$

$$\begin{aligned} \varphi n^2 + \gamma n &= \varphi n^2 + 2\varphi n - 5\varphi + \gamma n + \gamma - 10n \\ 0 &= 2\varphi n - 5\varphi + \gamma - 10n \end{aligned}$$

Nyní si za n zvolíme například nulu a jedničku.

$$\begin{aligned} n = 0: &\quad 0 = 2\varphi \cdot 0 - 5\varphi + \gamma - 10 \cdot 0 \\ n = 1: &\quad 0 = 2\varphi \cdot 1 - 5\varphi + \gamma - 10 \cdot 1 \end{aligned}$$

$$\begin{cases} 0 = -5\varphi + \gamma \\ 0 = 2\varphi - 5\varphi + \gamma - 10 \end{cases}$$

$$\begin{cases} 0 \ \ = \gamma - 5\varphi \\ 10 = \gamma - 3\varphi \end{cases}$$

$$\left(\begin{array}{cc|c} 1 & -5 & 0 \\ 1 & -3 & 10 \end{array}\right) \overset{R_2 \leftarrow R_2 - R_1}{\sim} \left(\begin{array}{cc|c} 1 & -5 & 0 \\ 0 & 2 & 10 \end{array}\right) \overset{R_2 \leftarrow \frac{1}{2} R_2}{\sim} \left(\begin{array}{cc|c} 1 & -5 & 0 \\ 0 & 1 & 5 \end{array}\right)$$

$$\varphi = 5$$

$$\gamma - 5 \cdot \varphi = 0 \Leftrightarrow \gamma = 25$$

Tudíž řešení partikulární rovnice $p_n^{(p)}$ je:

$$p_n^{(p)} = \varphi n^2 + \gamma n$$

$$\underline{p_n^{(p)} = 5n^2 + 25n}.$$

Kapitola 2

Raw Code Listing

2.1 Listing

```
#show "ArtosFlow": name => box[
  #box(image(
    "logo.svg",
    height: 0.7em,
  ))
  #name
]

This report is embedded in the
ArtosFlow project. ArtosFlow is a
project of the Artos Institute.
```

2.2 Listing in a Figure

Code snippet in C programming langauge:

```c
#include <stdio.h>

int main() {
  printf("hello, world!\n");
  return 0;
}
```

Výpis 1: Computer program in C language

More simple langauge, for example SQL:

```sql
SELECT
  c.customer_id,
  c.fname,
  c.lname,
  c.email
FROM customer c
WHERE EXISTS (
  SELECT *
  FROM purchase p
  WHERE p.customer_id = c.customer_id
)
```

Výpis 2: Simple SQL query

Kapitola 3

Odkazy na objekty

Zde jsou demonstrace odkazů, `ref` v Typst, na různé objekty v dokumentu.

3.1 Odkazy na kapitoly

In Kapitola 3.1, we see how to turn Sections into Chapters [1]. And in kapitole 3.1, it is done manually [2].

3.2 Odkazy na tabulky

Něco je znázorněno v tabulce 1. Tady jsme před tabulkou 1.

Index	**Value**
1	10
2	11
3	12
4	13
1	10
2	11
3	12
4	13
1	10
2	11
3	12
4	13

Tabulka 1: A long table

A tu jsme za tabulkou 1.

Zde je tabulka 2. Prohlídnutím tabulky 2 si můžete všimnout něco.

Shape	Area
Circle	πr^2
Square	a^2
Rectangle	ab

Tabulka 2: A simple table

3.3 Odkazy na rovnice

Nechť:

$$\phi := \frac{1+\sqrt{5}}{2} \tag{1}$$

Pomocí rovnice 1, dostaneme:

$$F_n = \left\lfloor \frac{1}{\sqrt{5}} \phi^n \right\rceil$$

Takto se dělají vnitřní jmenovky (`label`) v `$ ... $` blocích, na které lze potom odkazovat.

$$\begin{aligned} E &= mc^2 && (2.1) \\ &= \sqrt{p^2c^2 + m^2c^4} && (2.2) \end{aligned}$$

3.3.1 Příklad odkazování na vnitřní jmenovky

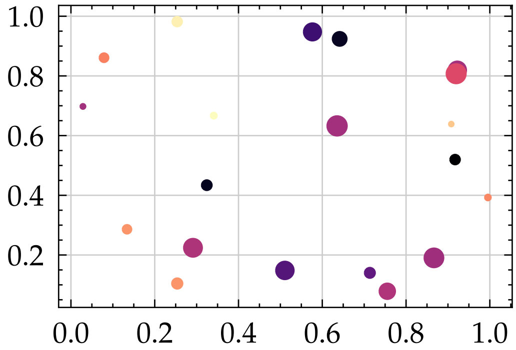
Skalární součin dvou vektrorů $\vec{a}$ a $\vec{b}$ je znázorněn rovnicí 3.

$$\begin{aligned} \langle a, b \rangle &= \vec{a} \cdot \vec{b} \\ &= a_1 b_1 + a_2 b_2 + \ldots a_n b_n \\ &= \sum_{i=1}^{n} a_i b_i. && (3.1) \end{aligned}$$

Notace sumy v rovnici 3.1 je užitečný způsob zápisu skalárního součinu dvou vektorů.

3.4 Odkazy na obrázky

Na obrázku 1 je zobrazeno bla bla.



Obrázek 1: Some random data visualisation

Závěr

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Příloha A

Quick-Sort Implementation

Implementation is in Haskell.

```
quicksort [] = []
quicksort (p:xs) = (quicksort lesser) ++ [p] ++ (quicksort greater)
  where
    lesser = filter (< p) xs
    greater = filter (>= p) xs
```

Yes. Very cool.

Příloha B

Binary Search

Algorithm 1: Binary Search

```
procedure Binary-Search(A, n, v)
    ▷ Initialize the search range
    l ← 1
    r ← n

    while l ≤ r do
        mid ← floor((l+r)/2)
        if A[mid] < v then
            l ← m + 1
        else if A[mid] > v then
            r ← m − 1
        else
            return m
        end
    end
    return null
end
```

Algorithm 2: Variable Assignment

```
x ← y
```

Příloha C

OpenGL Shader Compilation

```cpp
unsigned int OpenGLShader::Compile(
    const std::unordered_map<unsigned int, std::string>& sources
) const {
    EG_PROFILE_FUNCTION();

    EG_CORE_ASSERT(sources.size() >= 0 && sources.size() <= 3,
        "Can only have three shader sources \
        (vertex, geometry, fragment)!");

    unsigned int program;
    EG_OPENGL_CALL(program = glCreateProgram());

    std::vector<unsigned int> shaders(sources.size());
    for (const auto& [type, source] : sources) {
        auto shader = CompileSource(type, source);
        shaders.push_back(shader);
        EG_OPENGL_CALL(glAttachShader(program, shader));
    }

    EG_OPENGL_CALL(glLinkProgram(program));

    int status;
    EG_OPENGL_CALL(glGetProgramiv(program, GL_LINK_STATUS, &status));
    if (status == GL_FALSE) {
        int length;
        EG_OPENGL_CALL(glGetProgramiv(
            program, GL_INFO_LOG_LENGTH, &length));

        std::vector<char> message(length);
        EG_OPENGL_CALL(glGetProgramInfoLog(
            m_RendererID, length, &length, message.data()));

        EG_OPENGL_CALL(glDeleteShader(program));
        for (auto shader : shaders) {
            EG_OPENGL_CALL(glDeleteShader(shader));
        }
        EG_CORE_ERROR("{}", message.data());
        EG_CORE_ASSERT(false, "Shader compilation failed!");
        return 0;
    }

    EG_OPENGL_CALL(glValidateProgram(program));
    for (auto shader : shaders) {
        EG_OPENGL_CALL(glDeleteShader(shader));
    }

    return program;
}
```

Výpis 3: C++ method for GLSL shader compilation

Příloha D

ASP.NET C# code

```csharp
using System.Diagnostics;
using System.Security.Claims;
using CoworkingApp.Models;
using CoworkingApp.Models.Misc;
using CoworkingApp.Models.ViewModels;
using CoworkingApp.Services.Repositories;
using Microsoft.AspNetCore.Authorization;
using Microsoft.AspNetCore.Mvc;

namespace CoworkingApp.Controllers.ViewControllers;

public class HomeController
    (
        IWorkspaceRepository workspaceRepository,
        ICoworkingCenterRepository coworkingCenterRepository,
        IReservationRepository reservationRepository,
        IUserRepository userRepository
    )
    : Controller
{
    [HttpGet]
    public async Task<IActionResult> Index()
    {
        var workspaces = await workspaceRepository.GetWorkspaces(new ()
        {
            HasPricing = true,
            IncludePricings = true,
            IncludeStatus = true,
        });

        var coworkingCenters = await
coworkingCenterRepository.GetCenters(
            new CoworkingCenterFilter());

        return View(new HomeIndexViewModel()
        {
            Workspaces = workspaces,
            CoworkingCenters = coworkingCenters
        });
    }

    [HttpGet]
    [Authorize]
    public async Task<IActionResult> Dashboard(
        [FromQuery] ReservationSort reservationSort =
ReservationSort.None)
    {
        var userId = User.GetUserId();

        if (userId == null)
        {
```

```
            return Unauthorized(new { message = "User not found" });
        }

        var reservations = await reservationRepository
            .GetReservations(new ReservationsFilter
            {
                CustomerId = userId,
                IsCancelled = false,
                IncludeWorkspace = true,
                Sort = reservationSort,
            });

        var user = (await userRepository.GetUsers(new UserFilter
        {
            UserId = userId
        })).Single();

        return View(new HomeDashboardViewModel
        {
            User = user,
            Reservations = reservations,
            ReservationSort = reservationSort,
        });
    }

    [HttpGet]
    public async Task<IActionResult> Privacy()
    {
        return View();
    }

    [ResponseCache(
        Duration = 0,
        Location = ResponseCacheLocation.None, NoStore = true)]
    public IActionResult Error()
    {
        return View(new ErrorViewModel
        {
            RequestId = Activity.Current?.Id ??
HttpContext.TraceIdentifier
        });
    }
}
```

Výpis 4: Computer program in C# language