

# **Komponenta výukového serveru TI – NP-úplné problémy 2**

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

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Bakalářská práce

Vedoucí práce: Borivoj Gulas

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## Zadání bakalářské práce

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Studijní program:

B0613A140014 Informatika

Téma:

Komponenta výukového serveru TI - NP-úplné problémy 2  
Component of Learning Server for Theoretical Computer Science - NP-complete problems 2

Jazyk vypracování:

čeština

Zásady pro vypracování:

V rámci diplomových a bakalářských prací vzniká výukový server pro předměty teoretické informatiky. Jedná se o sadu dynamických webových stránek umožňujících studentům pochopení různých typů úloh a problémů tím, že si mohou zadat na stránce libovolné zadání a zobrazí se jim řešení včetně postupu. Cílem této práce je vytvořit komponentu (tedy sadu webových stránek) pro výuku vybraných NP-úplných problémů a převodů mezi nimi.

1. Nastudujte si problematiku tříd složitosti problémů a s tím souvisejícím převodem mezi problémy.
2. Vytvořte dynamické webové stránky umožňující uživateli následující:
  - a) Nechat si zobrazit postupně po krocích postup algoritmu s polynomiální časovou složitostí převádějícího zadanou instanci jednoho problému na instanci jiného problému (budou implementovány alespoň 3 různé převody mezi problémy).
  - b) Zadat libovolnou instanci každého z problémů vyskytujících se v těchto převodech.
  - c) Zobrazit odpověď na otázku daného problému pro zadanou instanci, v případě kladné odpovědi i se zdůvodněním.
3. Není cílem mít co nejefektivněji implementován samotný převod, ale mít jej implementován tak, aby uživateli byla myšlenka tohoto převodu co nejsrozumitelněji ukázána.
4. Vytvořte i ukázkové vstupní instance pro implementované problémy tak, aby uživatel mohl vše vyzkoušet i bez zadávání vlastních vstupů (alespoň 5 instancí pro každý problém).

Studenti řešící toto zadání s rozdílným číslem v názvu mohou (ale nemusí) spolupracovat tak, že výsledek může mít společné uživatelské rozhraní apod. Ale každý bude implementovat jiné 3 převody mezi problémy.

Seznam doporučené odborné literatury:

- [1] Sipser, M.: Introduction to the Theory of Computation, PWS Publishing Company, 1997.
- [2] Papadimitriou, C.: Computational Complexity, Addison Wesley, 1993.
- [3] Sawa, Z.: Prezentace přednášek předmětu Teoretická informatika, dostupné online <https://www.cs.vsb.cz/sawa/ti/index.html>

Formální náležitosti a rozsah bakalářské práce stanoví pokyny pro vypracování zveřejněné na webových stránkách fakulty.

Vedoucí bakalářské práce: **Ing. Martin Kot, Ph.D.**

Datum zadání:

Datum odevzdání:

Garant studijního programu: doc. Mgr. Miloš Kudělka, Ph.D.

V IS EDISON zadáno:

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E

A

R

D

# 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

WTF	– What the fuck
DPC	– Do $x^2$ pice
KDPC	– Kurva do pice → aaaah

# Obsah

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# Úvod

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saluto: 'chaere,' inquam, 'Tite!' lictores, turma omnis chorusque: 'chaere, Tite!' hinc hostis mi Albucius, hinc inimicus. Sed iure Mucius. Ego autem mirari satis non queo unde hoc sit tam insolens domesticarum rerum fastidium. Non est omnino hic docendi locus; sed ita prorsus existimo, neque eum Torquatum, qui hoc primus cognomen invenerit, aut torquem illum hosti detraxisse, ut aliquam ex eo est consecutus? – Laudem et caritatem, quae sunt vitae sine metu degendae praesidia firmissima. – Filium morte multavit. – Si sine causa, nollem me ab eo delectari, quod ista Platonis, Aristoteli, Theophrasti orationis ornamenta neglexerit. Nam illud quidem physici, credere aliquid esse minimum, quod profecto numquam putavisset, si a Polyaeo, familiari suo, geometrica discere maluisset quam illum etiam ipsum dedocere. Sol Democrito magnus videtur, quippe homini erudito in geometriaque perfecto, huic pedalis fortasse; tantum enim esse omnino in nostris poetis aut inertissimae segnitiae est aut fastidii delicatissimi. Mihi quidem videtur, inermis ac nudus est. Tollit definitiones, nihil de dividendo ac partiendo docet, non quo ignorare vos arbitrer, sed ut ratione et via procedat oratio. Quaerimus igitur, quid sit extremum et ultimum bonorum, quod omnium philosophorum sententia tale debet esse.

## Kapitola 1

# Heading Level 1

QQ *hello* ja fi diofjosdfodsjsodslsdlkdjflskdjklffffffffffffffffffffffff kldkjksdfjlsdfljjjj.j..jll jsem k a v o.

$$f(x) = y$$

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

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### 1.1 Heading Level 2

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

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

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

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## Kapitola 2

# OFDM - Orthogonal Frequency Division Multiplexing

## 2.1 Introduction

In Kapitola 2.1, we see how to turn Sections into Chapters. And in kapitole 2.1, it is done manually.

$$\leq \pm$$

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do. [1]. Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do. [2].

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

Code snippet in C programming language:

---

```
1  #include <stdio.h>
2
3  int main() {
4      printf("hello, world!\n");
5      return 0;
6  }
```

---

Seznam 1: Computer program in C language

More simple language, for example SQL:

---

```
1  SELECT
2      c.customer_id,
3      c.fname,
4      c.lname,
5      c.email
6  FROM customer c
7  WHERE EXISTS (
8      SELECT *
9      FROM purchase p
10     WHERE p.customer_id = c.customer_id
11 )
```

---

Seznam 2: Simple SQL query



## 2.2 Subheading Level 2

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

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## 2.3 Prokázání netranzitivity

První úkolem je ukázat, že vztahy mezi kostkami nejsou tranzitivní, to znamená, že vztahy mezi kostkami jsou tzv. cyklické<sup>1</sup> 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  $\frac{1}{2}$ .

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## 2.4 Subheading Level 2

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---

```

1  #show "ArtosFlow": name => box[
2    #box(image(
3      "logo.svg",
4      height: 0.7em,
5    ))
6    #name
7  ]
8
9  This report is embedded in the
10 ArtosFlow project. ArtosFlow is a
11 project of the Artos Institute.
```

---

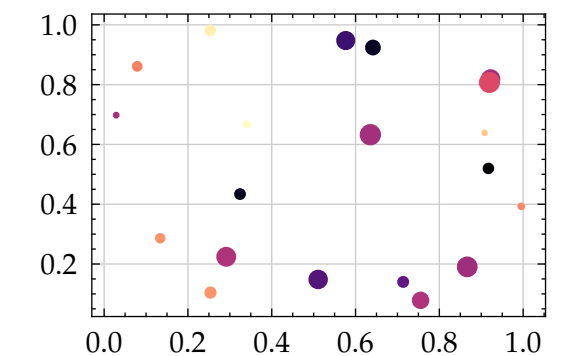


---

<sup>1</sup>Wikipedia, *Intransitivity*: <https://en.wikipedia.org/wiki/Intransitivity>

### 2.4.1 Subheading Level 3

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Obrázek 1: Some random data visualisation

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## Kapitola 3

# Heading Level 1

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### 3.1 Subheading Level 2

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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
1	10
2	11
3	12
4	13
1	10
2	11

Index	Value
3	12
4	13
1	10
2	11
3	12
4	13
1	10
2	11
3	12
4	13
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 looong table

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## 3.2 Subheading Level 2

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Shape	Area
Circle	$\pi r^2$
Square	$a^2$
Rectangle	$ab$

Tabulka 2: A simple table

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## Kapitola 4

# Heading Level 1

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## 4.1 Heading Level 2

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### 4.1.1 Heading Level 2

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## 4.2 Heading Level 3

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# Závěr

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insolens domesticarum rerum fastidium. Non est omnino hic docendi locus; sed ita prorsus existimo, neque eum Torquatum, qui hoc primus cognomen invenerit, aut torquem illum hosti detraxisse, ut aliquam ex eo est consecutus? – Laudem et caritatem, quae sunt vitae sine metu degendae praesidia firmissima. – Filium morte multavit. – Si sine causa, nollem me ab eo delectari, quod ista Platonis, Aristoteli, Theophrasti orationis ornamenta neglexerit. Nam illud quidem physici, credere aliquid esse minimum, quod profecto numquam putavisset, si a Polyaeo, familiari suo, geometrica discere maluisset quam illum etiam ipsum dedocere. Sol Democrito magnus videtur, quippe homini erudito in geometriaque perfecto, huic pedalis fortasse; tantum enim esse omnino in nostris poetis aut inertissimae segnitiae est aut fastidii delicatissimi. Mihi quidem videtur, inermis ac nudus est. Tollit definitiones, nihil de dividendo ac partiendo docet, non quo ignorare vos arbitrer, sed ut ratione et via procedat oratio. Quaerimus igitur, quid sit extremum et ultimum bonorum, quod omnium philosophorum sententia tale debet esse.



# Literatura

- [1] MUNROE, Randall. *Types of Editors* [online]. 12. března 2014. Dostupné z: <https://xkcd.com/1341/>
- [2] GÜNTHER-HAUG, Barbara. *Den Boden unter den Füßen verlieren*. B.m.: MVG, 2020.
- [3] STEYERL, Hito. *Drill*. 20. června 2019
- [4] MEHTA, Jiten a Eric KINNEAR. *Boost Performance and Security with Modern Networking* [online]. 26. června 2020 [cit. 2020-09-17]. Dostupné z: <https://developer.apple.com/videos/play/wwdc2020/10111/>
- [5] PREKAS, George, Marios KOGIAS a Edouard BUGNION. ZyGOS: Achieving Low Tail Latency for Microsecond-Scale Networked Tasks. In: *Proceedings of the 26th Symposium on Operating Systems Principles* [online]. B.m.: Association for Computing Machinery, 2017, s. 325–341. Dostupné z: doi:[10.1145/3132747.3132780](https://doi.org/10.1145/3132747.3132780)
- [6] OMAROVA, Saule a Graham STEELE. There's a Lot We Still Don't Know About Libra. *The New York Times* [online]. 2019. Dostupné z: <https://www.nytimes.com/2019/11/04/opinion/facebook-libra-cryptocurrency.html>
- [7] DONNE, John. *The "Anniversaries" and the "Epicedes and Obsequies"*. B.m.: Indiana University Press, 1995. The Variorum Edition of the Poetry of John Donne.
- [8] BROWN, George C., ed. A Swedish Traveller in Early Wisconsin: The Observations of Fredrika Bremer. *Wisconsin Magazine of History*. 2. vyd. 1978, 61–62.
- [9] In: J. K. ROWLING *Harry Potter and the Order of the Phoenix*. cca. 2003, s. 135–139.
- [10] MÄDJE, Laurenz. *Tokenization of + and - with scientific notation* [online]. 18. července 2020. Dostupné z: <https://github.com/typst/typstc/issues/3>
- [11] *Terminator 2: Judgment Day*. Carolco Pictures; Pacific Western Productions; Lightstorm Entertainment; Le Studio Canal+ S.A. 1. července 1991.
- [12] *Conspiracy Theories and Interior Design*. In.: Universal Television; Sony Pictures Television; Krasnoff Foster Productions; Harmonious Claptrap; Russo Brothers Film. 18. listopad 2010.
- [13] *The wire*. Blown Deadline Productions. 2002.
- [14] DOAN, T. D., D. B. TRAN THOAI a Hartmut HAUG. Kinetics and luminescence of the excitations of a nonequilibrium polariton condensate. *Physical Review B* [online]. 2020, 102(16), 165126–165139. Dostupné z: doi:[10.1103/PhysRevB.102.165126](https://doi.org/10.1103/PhysRevB.102.165126)

- [15] JERRENTUP, Andreas, Tobias MUELLER, Ulrich GLOWALLA, Meike HERDER, Nadine HENRICHS, Andreas NEUBAUER a Juergen R. SCHAEFER. Teaching medicine with the help of "Dr. House". *PLoS ONE* [online]. 2018, **13**(3). Dostupné z: [doi:10.1371/journal.pone.0193972](https://doi.org/10.1371/journal.pone.0193972)
- [16] *Informational plaque about Jacoby's 1967 photos*. B.m.: Stiftung Reinbeckhallen. 2020
- [17] *L'oiseau rare, de l'hirondelle au kakapo* [online]. 18. prosinec 2020 [cit. 2020-11-04]. Dostupné z: <https://www.museedesconfluences.fr/fr/evenements/l%E2%80%99oiseau-rare-de-l%E2%80%99hirondelle-au-kakapo>
- [18] DUVAL, Fred. *Renaissance, Les Déracinés*. 1. vyd. Přel. EMEM a Fred BLANCHARD. B.m.: Dargaud, 2018.
- [19] MOORE, Edward F. *Gedanken-experiments on sequential machines*. B.m.: NBS. duben 1956. *Annals of Mathematics Studies*
- [20] SILVER, Nate. Trump's claim to have won Georgia is highly dubious. No network has called it. He's only ahead by 2.5 points there, and the outstanding votes are mostly mail votes in very blue counties, likely very Democratic. Biden may even be a slight favorite there. In: [online]. 4. listopad 2020. Dostupné z: <https://twitter.com/NateSilver538/status/1323889051037028353>
- [21] PEDBOST, Marven F., Trilleen POMALGU, Chris LINTOTT, Nora EISNER a Belinda NICHOLSON. *Defining the Really Habitable Zone* [online]. 2020. Dostupné z: <https://arxiv.org/abs/2003.13722>
- [22] ISHKUR. *Ishkur's Guide to Electronic Music* [online]. [cit. 2020-11-12]. Dostupné z: <http://www.techno.org/electronic-music-guide/>
- [23] MATTERMOST. Mattermost Privacy Policy. *Policies* [online]. [cit. 2020-11-29]. Dostupné z: <https://mattermost.com/privacy-policy/>
- [24] WORTH, Jon. *Jon Worth Euroblog* [online]. Dostupné z: <https://jonworth.eu/>
- [25] PROKOPOV, Nikita. It is fast or it is wrong. *tonsky.me* [online]. 29. prosinec 2018. Dostupné z: <https://tonsky.me/blog/slow-wrong/>
- [26] UNITED NATIONS DEVELOPMENT PROGRAMME. *Human Development Report 2019* [online]. 2019. Dostupné z: <http://hdr.undp.org/sites/default/files/hdr2019.pdf>
- [27] BARROWS, Miellyn Fitzwater. Audio Descriptions. In: [online]. 7. únor 2017. Dostupné z: <https://www.20k.org/episodes/audio>
- [28] *authoritative* [online]. nedatováno [cit. 2020-11-29]. Dostupné z: <https://dictionary.cambridge.org/dictionary/english/authoritative>
- [29] *Logician* [online]. nedatováno [cit. 2019-12-02]. Dostupné z: <http://image-net.org/api/text/wordnet.structure.hyponym?wnid=n10269785>
- [30] INTERNET ENGINEERING TASK FORCE. *Secret Key Transaction Authentication for DNS* [online]. 2000. Dostupné z: <https://tools.ietf.org/html/rfc2845>
- [31] *Roe v. Wade*. 1973

- [32] *Freedom of Information Act*. 1967
- [33] JOHN. Celebrating over five million users, a quarter million daily actives, and over five years of dedicated user support. *Overleaf Blog* [online]. 8. listopad 2019. Dostupné z: <https://de.overleaf.com/blog/celebrating-over-five-million-users-and-a-quarter-million-daily-actives>
- [34] PEPE, Alberto. *How many scholarly articles are written in LaTeX?* [online]. 21. únor 2017. Dostupné z: doi:[10.22541/au.148771883.35456290](https://doi.org/10.22541/au.148771883.35456290)

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## A Qsort implementation

Implementation is in Haskell.

---

```
1 quicksort [] = []
2 quicksort (p:xs) = (quicksort lesser) ++ [p] ++ (quicksort greater)
3   where
4     lesser = filter (< p) xs
5     greater = filter (>= p) xs
```

---

Yes. Very cool.

---

### Algorithm 1: Binary Search

---

```
1: procedure BINARY-SEARCH( $A, n, v$ )
2:    $\triangleright$  Initialize the search range
3:    $l \leftarrow 1$ 
4:    $r \leftarrow n$ 
5:
6:   while  $l \leq r$  do
7:      $mid \leftarrow \text{floor}(\frac{l+r}{2})$ 
8:     if  $A[mid] < v$  then
9:        $l \leftarrow m + 1$ 
10:    else if  $A[mid] > v$  then
11:       $r \leftarrow m - 1$ 
12:    else
13:      return  $m$ 
14:    end
15:  end
16:  return null
17: end
```

---

---

## B Shit table

A	B
B	C
C	D

---

### Algorithm 2: Variable Assignment

---

1:  $x \leftarrow y$

---

## C OpenGL Shader Compilation

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---

```

1  unsigned int OpenGLShader::Compile(
2      const std::unordered_map<unsigned int, std::string>& sources
3  ) const
4  {
5      EG_PROFILE_FUNCTION();
6
7      EG_CORE_ASSERT(sources.size() >= 0 && sources.size() <= 3,
8          "Can only have three shader sources \
9          (vertex, geometry, fragment)!");
10
11     unsigned int program;
12     EG_OPENGL_CALL(program = glCreateProgram());
13
14     std::vector<unsigned int> shaders(sources.size());
15     for (const auto& [type, source] : sources)
16     {
17         auto shader = CompileSource(type, source);
18         shaders.push_back(shader);
19         EG_OPENGL_CALL(glAttachShader(program, shader));
20     }
21
22     EG_OPENGL_CALL(glLinkProgram(program));
23
24     int status;
25     EG_OPENGL_CALL(glGetProgramiv(program, GL_LINK_STATUS, &status));
26     if (status == GL_FALSE)
27     {
28         int length;
29         EG_OPENGL_CALL(glGetProgramiv(
30             program, GL_INFO_LOG_LENGTH, &length));
31
32         std::vector<char> message(length);
33         EG_OPENGL_CALL(glGetProgramInfoLog(
34             m_RendererID, length, &length, message.data()));
35
36         EG_OPENGL_CALL(glDeleteShader(program));
37         for (auto shader : shaders)
38         {
39             EG_OPENGL_CALL(glDeleteShader(shader));
40         }
41         EG_CORE_ERROR("{", message.data());
42         EG_CORE_ASSERT(false, "Shader compilation failed!");
43         return 0;
44     }
45
46     EG_OPENGL_CALL(glValidateProgram(program));
47     for (auto shader : shaders)
48     {
49         EG_OPENGL_CALL(glDeleteShader(shader));
50     }
51
52     return program;
53 }
```

---

Seznam 3: C++ method for GLSL shader compilation

## D C# code

---

```

1  using System.Diagnostics;
2  using System.Security.Claims;
3  using CoworkingApp.Models;
4  using CoworkingApp.Models.Misc;
5  using CoworkingApp.Models.ViewModels;
6  using CoworkingApp.Services.Repositories;
7  using Microsoft.AspNetCore.Authorization;
8  using Microsoft.AspNetCore.Mvc;
9
10 namespace CoworkingApp.Controllers.ViewControllers;
11
12 public class HomeController
13 {
14     IWorkspaceRepository workspaceRepository,
15     ICoworkingCenterRepository coworkingCenterRepository,
16     IReservationRepository reservationRepository,
17     IUserRepository userRepository
18 }
19 : Controller
20 {
21     [HttpGet]
22     public async Task<IActionResult> Index()
23     {
24         var workspaces = await workspaceRepository.GetWorkspaces(new ()
25         {
26             HasPricing = true,
27             IncludePricings = true,
28             IncludeStatus = true,
29         });
30
31         var coworkingCenters = await coworkingCenterRepository.GetCenters(
32             new CoworkingCenterFilter());
33
34         return View(new HomeIndexViewModel()
35         {
36             Workspaces = workspaces,
37             CoworkingCenters = coworkingCenters
38         });
39     }
40
41     [HttpGet]
42     [Authorize]
43     public async Task<IActionResult> Dashboard(
44         [FromQuery] ReservationSort reservationSort = ReservationSort.None)
45     {
46         var userId = User.GetUserId();
47
48         if (userId == null)
49         {
50             return Unauthorized(new { message = "User not found" });
51         }
52
53         var reservations = await reservationRepository
54             .GetReservations(new ReservationsFilter
55             {
56                 CustomerId = userId,
57                 IsCancelled = false,
58                 IncludeWorkspace = true,
59                 Sort = reservationSort,
60             });
61
62         var user = (await userRepository.GetUsers(new UserFilter
63         {
64             UserId = userId

```

---

---

```
65         })).Single();
66
67         return View(new HomeDashboardViewModel
68         {
69             User = user,
70             Reservations = reservations,
71             ReservationSort = reservationSort,
72         });
73     }
74
75     [HttpGet]
76     public async Task<IActionResult> Privacy()
77     {
78         return View();
79     }
80
81     [ResponseCache(
82         Duration = 0,
83         Location = ResponseCacheLocation.None, NoStore = true)]
84     public IActionResult Error()
85     {
86         return View(new ErrorViewModel
87         {
88             RequestId = Activity.Current?.Id ?? HttpContext.TraceIdentifier
89         });
90     }
91 }
```

---

Seznam 4: Computer program in C# language