Aarhus Universitet, Science and Technology, Computer Science

# Exam

Introduction to Programming with Scientific Applications

Tuesday 11 June 2019, 14:00–16:00

Allowed aid: **None**

The exam questions are answered on the problem statement that is handed in at the end of the exam

*Tilladte hjælpemidler:* ***Ingen***

*Eksamensspørgsmålene besvares på opgaveformuleringen, som afleveres ved eksamenens slutning*

Student ID/*årskort* _____

Name/*navn* _____

## Information

The exam consists of a set of multiple-choice questions. The questions are answered on the problem statement **that is handed in**. For each question is stated the weight of the question compared to the full exam. Each sub-question has exactly one correct answer. You can select **at most one** answer for each sub-question, by marking the corresponding box with a cross. A sub-question is scored as follows:

- Marking the correct answer gives you 1 point.
- If you do not mark any answer you get 0 points.
- Marking a wrong answer gives you $-\frac{1}{k-1}$ point, where $k$ is the number of answer options.

For a question with weight $v\,\%$ containing $n$ sub-questions, where you score a total of $s$ points, your score for the question will be $\frac{s}{n} \cdot v\ \%$. Note that is possible to get a negative score for a question.

*Dette eksamenssæt består af en mængde multiple-choice-opgaver. Opgaverne besvares på opgaveformuleringen **som afleveres**. For hver opgave er angivet opgavens andel af det samlede eksamenssæt. Hvert delspørgsmål har præcist et rigtigt svar. For hvert delspørgsmål, må man vælge **max ét svar** ved at afkrydse den tilsvarende rubrik. Et delspørgsmål bedømmes som følgende:*

- *Hvis du sætter kryds ved det rigtige svar, får du 1 point.*
- *Hvis du ikke sætter nogen krydser, får du 0 point.*
- *Hvis du sætter kryds ved et forkert svar, får du $-\frac{1}{k-1}$ point, hvor $k$ er antal svarmuligheder.*

*For en opgave med vægt $v\,\%$ og med $n$ delspørgsmål, hvor man opnår samlet $s$ point, beregnes pointene for besvarelse af opgaven som $\frac{s}{n} \cdot v\ \%$. Bemærk at det er muligt at få negative point for en opgave.*

## Python version

In the following Python refers to Python 3.7.
*I det følgende antages at Python refererer til Python 3.7.*

## Question 1 (Expressions, 4 %)

What is the result of each of the below expressions ?

*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | `0` | `0.0` | `1` | `1.0` | `ZeroDivisionError` |
|---|---|---|---|---|---|
| `0 / 1` | A | B | C | D | E |
| `1 / 0` | A | B | C | D | E |
| `0 // 1` | A | B | C | D | E |
| `1 // 0` | A | B | C | D | E |
| `1 # 0` | A | B | C | D | E |
| `0 # 1` | A | B | C | D | E |
| `1 % 0` | A | B | C | D | E |
| `0 % 1` | A | B | C | D | E |

## Question 2 (Conditional, 4 %)

```
def f(x):
    if x < 0:
        x = -x
    elif x == -1:
        x = 2
    else:
        x = 2 * x
    return x
```

What is the result of each of the below expressions ?

*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | `-5` | `-4` | `-3` | `-2` | `-1` | `0` | `1` | `2` | `3` | `4` | `5` |
|---|---|---|---|---|---|---|---|---|---|---|---|
| `f(-2)` | A | B | C | D | E | F | G | H | I | J | K |
| `f(-1)` | A | B | C | D | E | F | G | H | I | J | K |
| `f(0)` | A | B | C | D | E | F | G | H | I | J | K |
| `f(1)` | A | B | C | D | E | F | G | H | I | J | K |
| `f(2)` | A | B | C | D | E | F | G | H | I | J | K |

## Question 3 (Boolean operations, 4 %)

What is the result of each of the below expressions ?

*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | `True` | `False` | `0` | `1` | `2` | `3` | `ZeroDivisionError` |
|---|---|---|---|---|---|---|---|
| `True and False` | A | B | C | D | E | F | G |
| `not True` | A | B | C | D | E | F | G |
| `1 == 2 and 3` | A | B | C | D | E | F | G |
| `1 == 2 or 3` | A | B | C | D | E | F | G |
| `1 == 2 == 3` | A | B | C | D | E | F | G |
| `3 < 2 > 1 / 0` | A | B | C | D | E | F | G |

## Question 4 (Dictionaries, 4 %)

```
D = {'a key': 'a value'}
```

Which of the below are valid dictionary updates ?

*Hvilke af nedenstående er lovlige "dictionary" opdateringer ?*

| | Valid/*Lovlig* | Invalid/*Ulovlig* |
|---|---|---|
| `D['Python'] = 3` | A | B |
| `D[(1, 2)] = 3` | A | B |
| `D[[1, 2]] = 3` | A | B |
| `D[{1, 2}] = 3` | A | B |
| `D[frozenset({1, 2})] = 3` | A | B |
| `D[None] = True` | A | B |

## Question 5 (`for` loopes, 4 %)

```
for x in range(1, 4):
    for y in range(x, 4):
        print(str(x) + str(y), end=' ')
```

What does the above code print ?

*Hvad udskriver ovenstående kode ?*

| | |
|---|---|
| `11 22 33 12 23 13` | A |
| `11 22 22 33 33 33` | B |
| `11 12 13 22 23 33` | C |
| `13 12 11 23 22 33` | D |
| `11 14 44 44` | E |

## Question 6 (List indexing, 4 %)

```
x = ['a', 'b', 'c']
```

What is the result of each of the below expressions ?

*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | `'a'` | `'b'` | `'c'` | `[]` | `['a']` | `['b']` | `['c']` | `['a','b']` | `['b','c']` | `IndexError` |
|---|---|---|---|---|---|---|---|---|---|---|
| `x[1]` | A | B | C | D | E | F | G | H | I | J |
| `x[1:1]` | A | B | C | D | E | F | G | H | I | J |
| `x[1:2]` | A | B | C | D | E | F | G | H | I | J |
| `x[-2]` | A | B | C | D | E | F | G | H | I | J |
| `x[:-2]` | A | B | C | D | E | F | G | H | I | J |
| `x[1::2]` | A | B | C | D | E | F | G | H | I | J |
| `x[3]` | A | B | C | D | E | F | G | H | I | J |

## Question 7 (Lists, 4 %)

```
A = [[1,2],[3,4]]
B = A
B[1] = 5
C = A[:]
C[1] = 6
A[0][0] = 7
```

What is the value of `A`, `B` and `C` after executing the above code ?

*Hvad er værdien af* `A`*,* `B` *og* `C` *efter udførslen af ovenstående kode ?*

| | `[[7,2],[3,4]]` | `[[1,2],5]` | `[[7,2],5]` | `[[1,2],6]` | `[[7,2],6]` |
|---|---|---|---|---|---|
| `A` | A | B | C | D | E |
| `B` | A | B | C | D | E |
| `C` | A | B | C | D | E |

## Question 8 (List comprehension, 4 %)

```
print([x + x for x in [[1, 2], [3, 4]]])
```

What does the above code print ?

*Hvad udskriver ovenstående kode ?*

| | |
|---|---|
| `[4, 6]` | A |
| `[3, 6]` | B |
| `[2, 4, 6, 8]` | C |
| `[1, 2, 1, 2, 3, 4, 3, 4]` | D |
| `[[1, 2, 1, 2], [3, 4, 3, 4]]` | E |
| `[[1, 2, 3, 4], [1, 2, 3, 4]]` | F |

## Question 9 (Function call, 4 %)

```
def f(x, y, z):
    return x + 2 * y - z
```

What is the result of each of the below expressions ?
*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | −2 | −1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | SyntaxError/ TypeError |
|---|---|---|---|---|---|---|---|---|---|---|---|
| `f(1, 2, 3)` | A | B | C | D | E | F | G | H | I | J | K |
| `f(1, z=2, y=3)` | A | B | C | D | E | F | G | H | I | J | K |
| `f(x=1, 2, 3)` | A | B | C | D | E | F | G | H | I | J | K |
| `f(z=1, y=2, x=3)` | A | B | C | D | E | F | G | H | I | J | K |
| `f(1, 2, x=3)` | A | B | C | D | E | F | G | H | I | J | K |

## Question 10 (Recursion, 4 %)

```
def f(x):
    return 0 if x == 0 else x + f(x - 1)
```

What is the result of each of the below expressions ?
*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | −1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | RecursionError |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| `f(-1)` | A | B | C | D | E | F | G | H | I | J | K | L |
| `f(0)` | A | B | C | D | E | F | G | H | I | J | K | L |
| `f(1)` | A | B | C | D | E | F | G | H | I | J | K | L |
| `f(2)` | A | B | C | D | E | F | G | H | I | J | K | L |
| `f(3)` | A | B | C | D | E | F | G | H | I | J | K | L |

## Question 11 (Scope, 4 %)

```
def fn(x):
    def fn(x):
        return 2 * fn(x - 1) if x > 1 else 1
    return fn(x) + fn(x - 1)
```

What is the result of each of the below expressions ?
*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | RecursionError |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| `fn(1)` | A | B | C | D | E | F | G | H | I | J | K | L |
| `fn(2)` | A | B | C | D | E | F | G | H | I | J | K | L |
| `fn(3)` | A | B | C | D | E | F | G | H | I | J | K | L |

## Question 12 (Recursive data, 4 %)

```
def flip(tree):
    if type(tree) is not tuple:
       return tree
    else:
       return tuple(flip(c) for c in reversed(tree))

print(flip((((1,2),3),4,(5,(6,7)))))
```

What does the above program print?

*Hvad udskriver ovenstående program?*

```
((5, (6, 7)), 4, ((1, 2), 3))   A
(((7, 6), 5), 4, (3, (2, 1)))   B
(((7, 6), 5), 4, (3, (1, 2)))   C
(((6, 7), 5), 4, (3, (1, 2)))   D
((((7, 6), 5), 4, 3), (2, 1))   E
```

## Question 13 (Generators, 4 %)

```
def a(n):
    for x in range (1, n + 1):
        yield x * x

def b(a):
    for x in a:
        yield x
        yield x * x

print(list(b(a(3))))
```

What does the above code print ?

*Hvad udskriver ovenstående kode ?*

```
[1, 2, 3, 1, 4, 9]              A
[1, 4, 9, 1, 16, 81]            B
[1, 1, 2, 4, 3, 9]              C
[1, 1, 4, 16, 9, 81]            D
[(1, 1), (2, 4), (3, 9)]        E
[(1, 1), (4, 16), (9, 81)]      F
```

## Question 14 (Generator expression, 4 %)

```
g = (x**2 for x in range(1, 5))

print(next(g), end=' ')
for e in g:
    print(e, end=' ')
print(list(g))
```

What does the above code print ?

*Hvad udskriver ovenstående kode ?*

| | |
|---|---|
| `1 1 4 9 16 [1, 4, 9, 16]` | A |
| `1 1 4 9 16 [4, 9, 16]` | B |
| `1 1 4 9 16 []` | C |
| `1 4 9 16 [1, 4, 9, 16]` | D |
| `1 4 9 16 [4, 9, 16]` | E |
| `1 4 9 16 []` | F |

## Question 15 (`lambda`, 4 %)

```
def partial(f, *args):
    return lambda *more_args : f(*args, *more_args)

def linear(a, b, x):
    return a + b * x

f = partial(linear, 1)
```

What is the result of each of the below expressions ?

*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | `5` | `7` | `TypeError` |
|---|---|---|---|
| `f(2, 3)` | A | B | C |
| `f(1, 2, 3)` | A | B | C |

## Question 16 (Class, 4 %)

```
class A():
    x = 0

    def __init__(self, x=1):
        self.x = x

a = A()
b = A(x=2)
```

What is the result of each of the below expressions ?

*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | 0 | 1 | 2 | NameError |
|---|---|---|---|---|
| a.x | A | B | C | D |
| a.__class__.x | A | B | C | D |
| b.x | A | B | C | D |
| A.x | A | B | C | D |

## Question 17 (Inheritance, 4 %)

```
class A:
    def f(self, x):
        return self.g(x) * self.g(x)

    def g(self, x):
        return x + 1

class B(A):
    def g(self, x):
        return x - 1
```

What is the result of each of the below expressions ?

*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | AttributeError |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A().f(2) | A | B | C | D | E | F | G | H | I | J | K | L |
| B().f(2) | A | B | C | D | E | F | G | H | I | J | K | L |
| A().g(2) | A | B | C | D | E | F | G | H | I | J | K | L |
| B().g(2) | A | B | C | D | E | F | G | H | I | J | K | L |

## Question 18 (Sorted, 4 %)

```
S = [{1, 2}, {3, 4}, {2}, {2, 3}, {1}, {2, 1}, {1, 1}]
S = { frozenset(s) for s in S }
S = sorted(S, key=sorted)
S = [ set(s) for s in S ]
print(S)
```

What does the above code print ?

*Hvad udskriver ovenstående kode ?*

| | |
|---|---|
| `[{1}, {2}, {1, 2}, {2, 3}, {3, 4}]` | A |
| `[{1}, {1, 2}, {2}, {2, 3}, {3, 4}]` | B |
| `[{1}, {1, 1}, {1, 2}, {2}, {2, 3}, {3, 4}]` | C |
| `[{1}, {2}, {1, 1}, {1, 2}, {2, 3}, {3, 4}]` | D |
| `[{1}, {1, 1}, {1, 2}, {1, 2}, {2}, {2, 3}, {3, 4}]` | E |
| `[{1}, {2}, {1, 1}, {1, 2}, {1, 2}, {2, 3}, {3, 4}]` | F |

## Question 19 (Decorator, 4 %)

```
def adjust(f):
    return lambda x: 1 + f(x - 1)

@adjust
def square(x):
    return x ** 2
```

What is the result of each of the below expressions ?

*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| `square(1)` | A | B | C | D | E | F | G | H | I | J | K |
| `square(2)` | A | B | C | D | E | F | G | H | I | J | K |
| `square(3)` | A | B | C | D | E | F | G | H | I | J | K |

## Question 20 (`float`, 4 %)

```
def f(alpha):
    apx = 1.0
    i = 1
    while True:
        if apx == apx + alpha ** i:
            break
        apx += alpha ** i
        i += 1
    return apx
```

`f` tries to approximate $\sum_{i=0}^{\infty} \alpha^i = \frac{1}{1-\alpha}$ for $|\alpha| < 1$.
What is the result of each of the below expressions ?

`f` *forsøger at beregne en tilnærmelse til* $\sum_{i=0}^{\infty} \alpha^i = \frac{1}{1-\alpha}$ *for* $|\alpha| < 1$.
*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | `0.0` | `1.0` | `2.0` | `OverflowError` | Infinite loop/ *Uendelige løkke* |
|---|---|---|---|---|---|
| `f(0.0)` | A | B | C | D | E |
| `f(0.5)` | A | B | C | D | E |
| `f(2.0)` | A | B | C | D | E |

## Question 21 (Exceptions, 4 %)

```
try:
    print('A', end='')
    x = 1 / 0
    print('B', end='')
except ZeroDivisionError:
    print('C', end='')
finally:
    print('D', end='')
```

What does the above code print ?

*Hvad udskriver ovenstående kode ?*

| ABC | ABCD | ABD | AC | ACD | AD |
|---|---|---|---|---|---|
| A | B | C | D | E | F |

## Question 22 (zip, 4 %)

```
print(list(zip(*enumerate(['a','b','c']))))
```

What does the above code print ?

*Hvad udskriver ovenstående kode ?*

```
[((0, 'a'),), ((1, 'b'),), ((2, 'c'),)]   A
[('a', 'b', 'c'), (0, 1, 2)]              B
[(0, 1, 2), ('a', 'b', 'c')]              C
[(0, 'a'), (1, 'b'), (2, 'c')]            D
[('a', 0), ('b', 1), ('c', 2)]            E
[(0, 1, 2, 'a', 'b', 'c')]                F
[('a', 'b', 'c', 0, 1, 2)]                G
```

## Question 23 (numpy, 4 %)

```
import numpy as np

a = np.array(range(4)).reshape((2, 2))
b = np.array(range(1, 3)).reshape((2, 1))

print(a @ b)
```

What does the above code print (newlines omitted) ?

*Hvad udskriver ovenstående kode (linjeskift undladt) ?*

```
[[4] [7]]   A
[4 7]       B
[[4 7]]     C
[[2] [8]]   D
[2 8]       E
[[2 8]]     F
```

## Question 24 (Ordering, 4 %)

What is the result of each of the below expressions ?

*Hvad er resultatet af hvert af nedenstående udtryk ?*

| | True | False | TypeError |
|---|---|---|---|
| `(3, 2) < (1, 4, 5)` | A | B | C |
| `'coke' < 'pepsi'` | A | B | C |
| `set('coke') < set('pepsi')` | A | B | C |
| `{1, 3} < {1, 2, 3}` | A | B | C |
| `{1, 3} < {1, 2}` | A | B | C |
| `3 < 3.5` | A | B | C |
| `3 < '3.5'` | A | B | C |

## Question 25 (list, 4 %)

```
x = [0]
x[0] = x
x[0][0] = 1
print(x)
```

What does the above code print ?

*Hvad udskriver ovenstående kode ?*

| `[1]` | `[[1]]` | `[[...]]` | `[0, [1, [...]]]` | `[0, [1]]` | `IndexError` |
|---|---|---|---|---|---|
| A | B | C | D | E | F |