
UNIVERSITETET I BERGEN

# LISTER

INF100

HØST 2023

Torstein Strømme
David Grellscheid

# KODESPORING
## funksjonskall

```
def f(x):
    print(f"f-{x}")
    x += 1
    return 2*x

def g(x):
    y = f(x)
    y += f(x)
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x = 1
x = f(x)
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print(x)
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VARIABLER

UTSKRIFT

VERDIER

# KODESPORING

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VARIABLER

VERDIER

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1
2

UTSKRIFT

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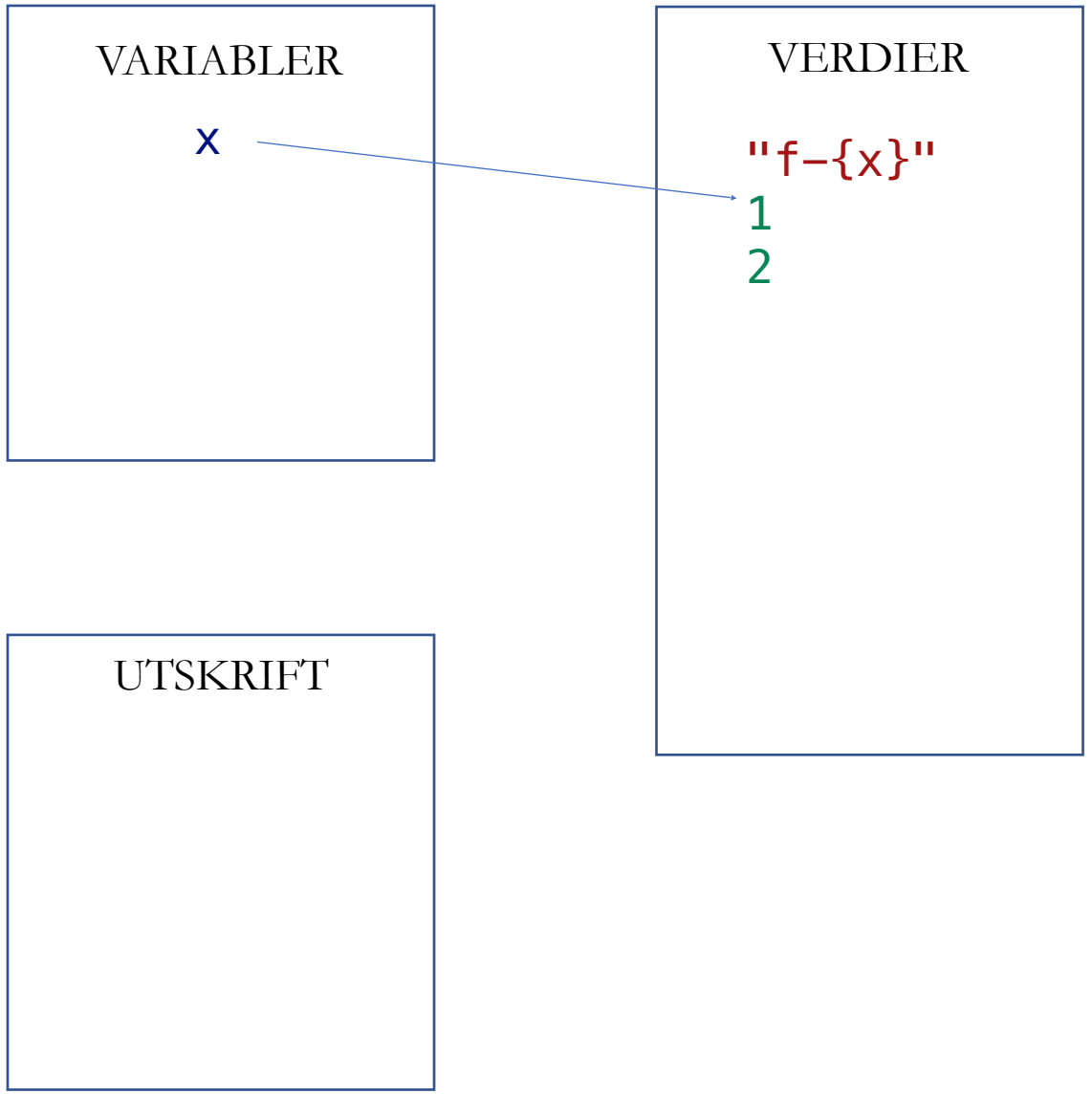

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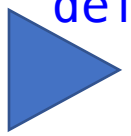

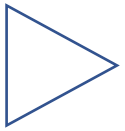

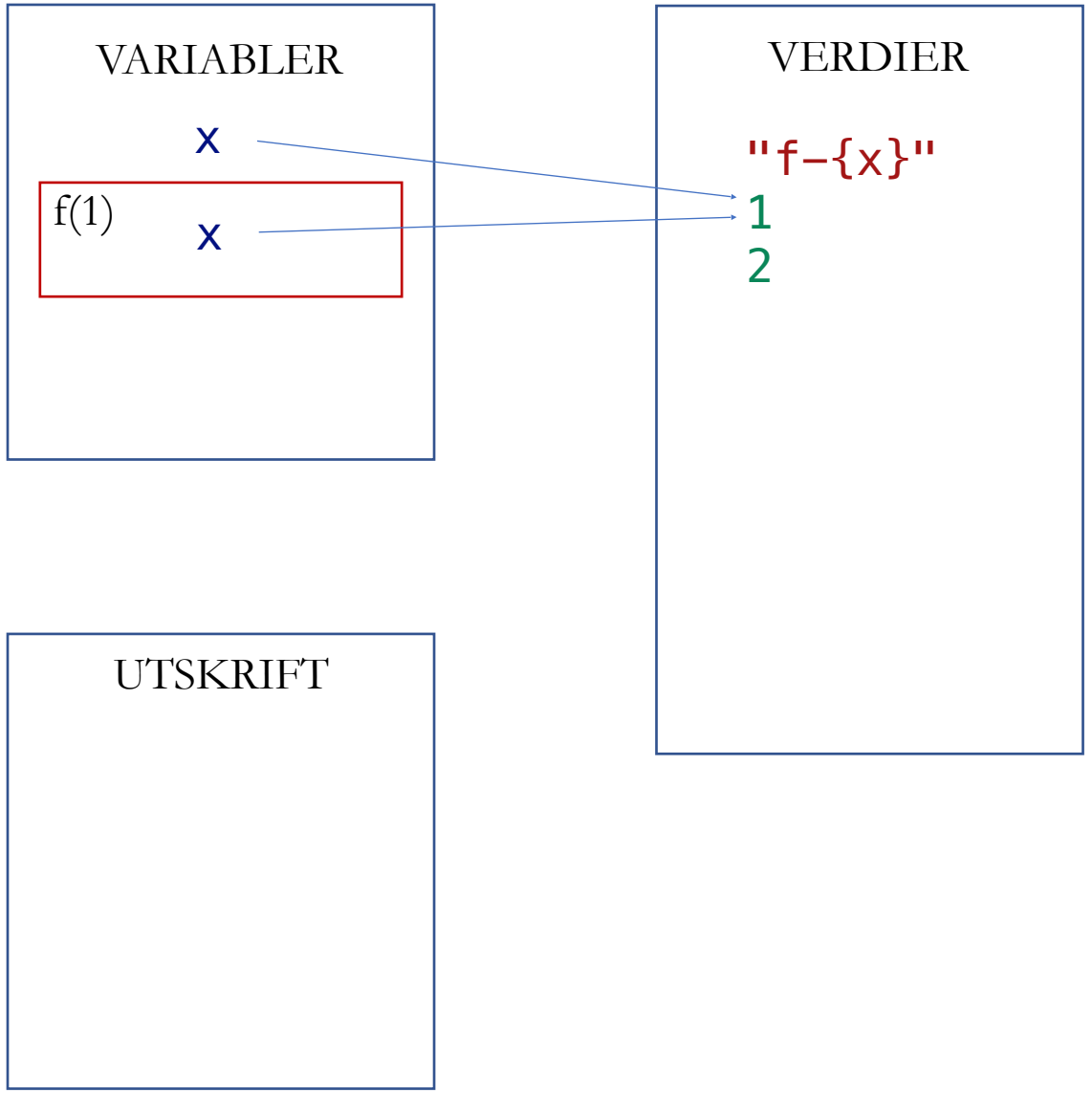

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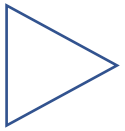

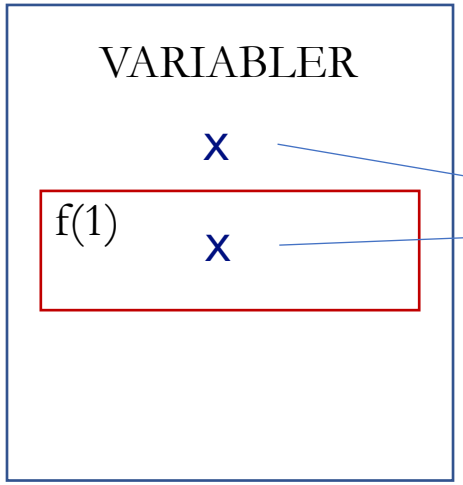


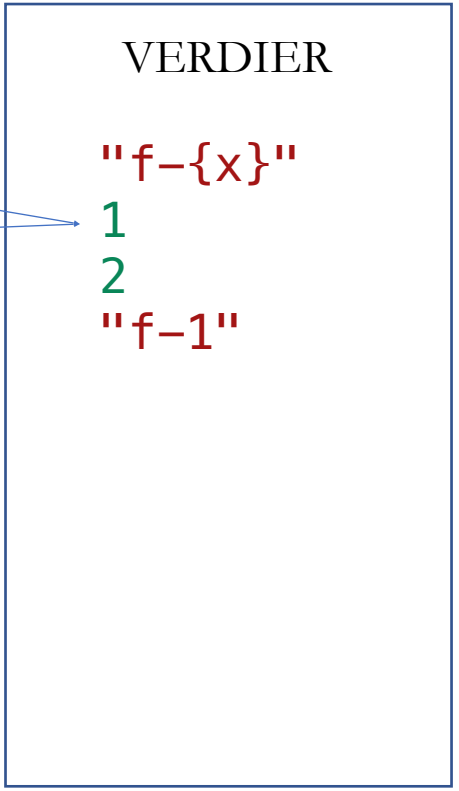


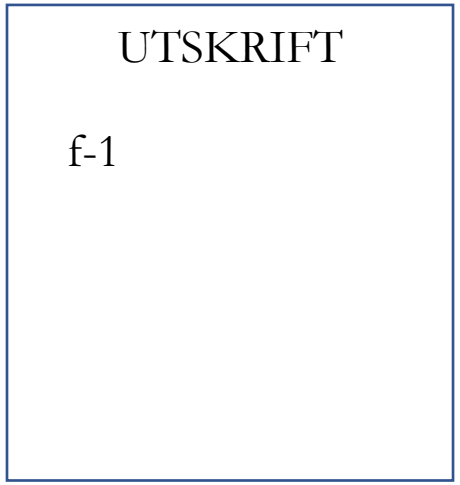

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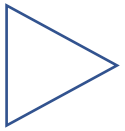

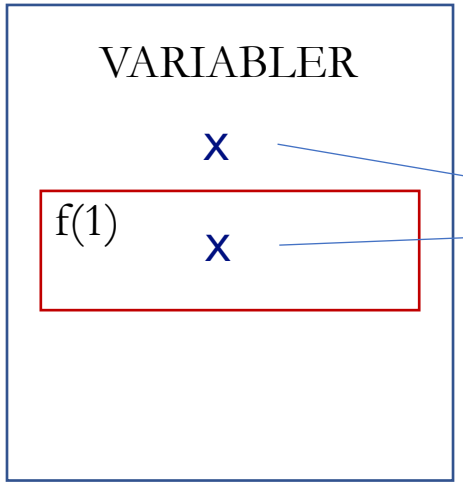


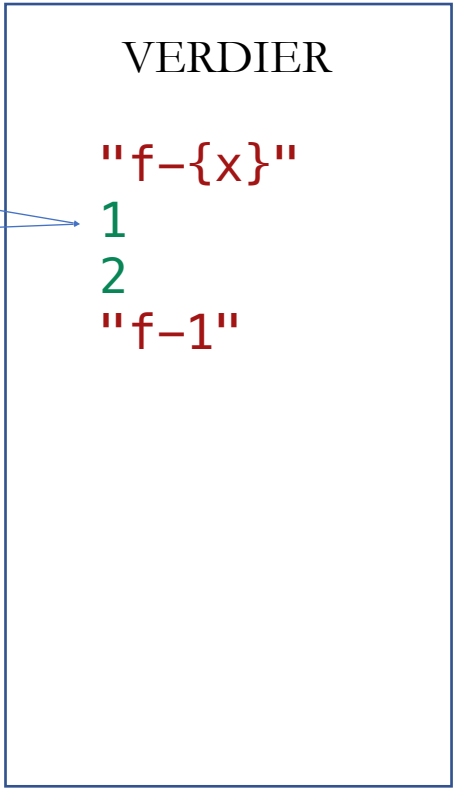


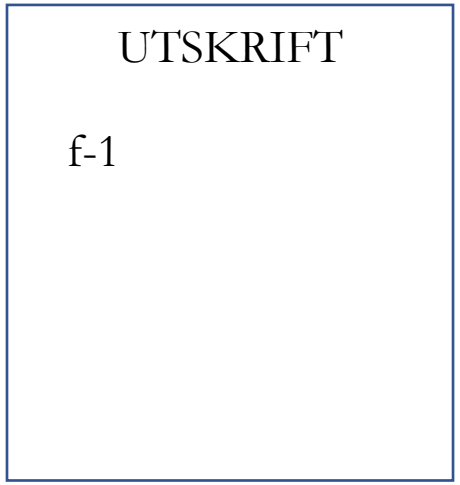

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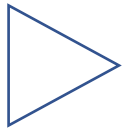

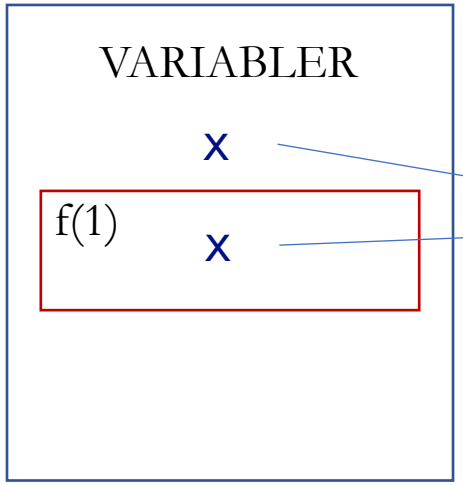


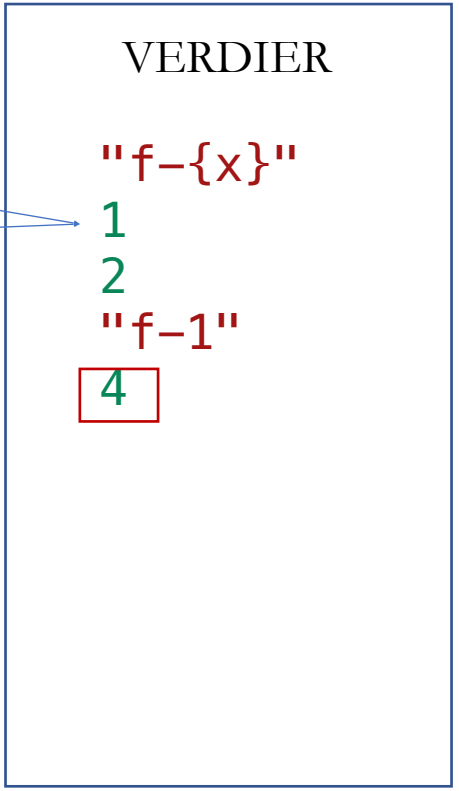


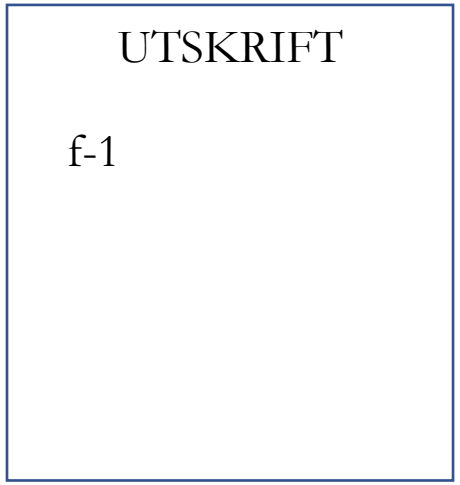

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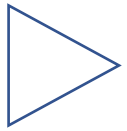

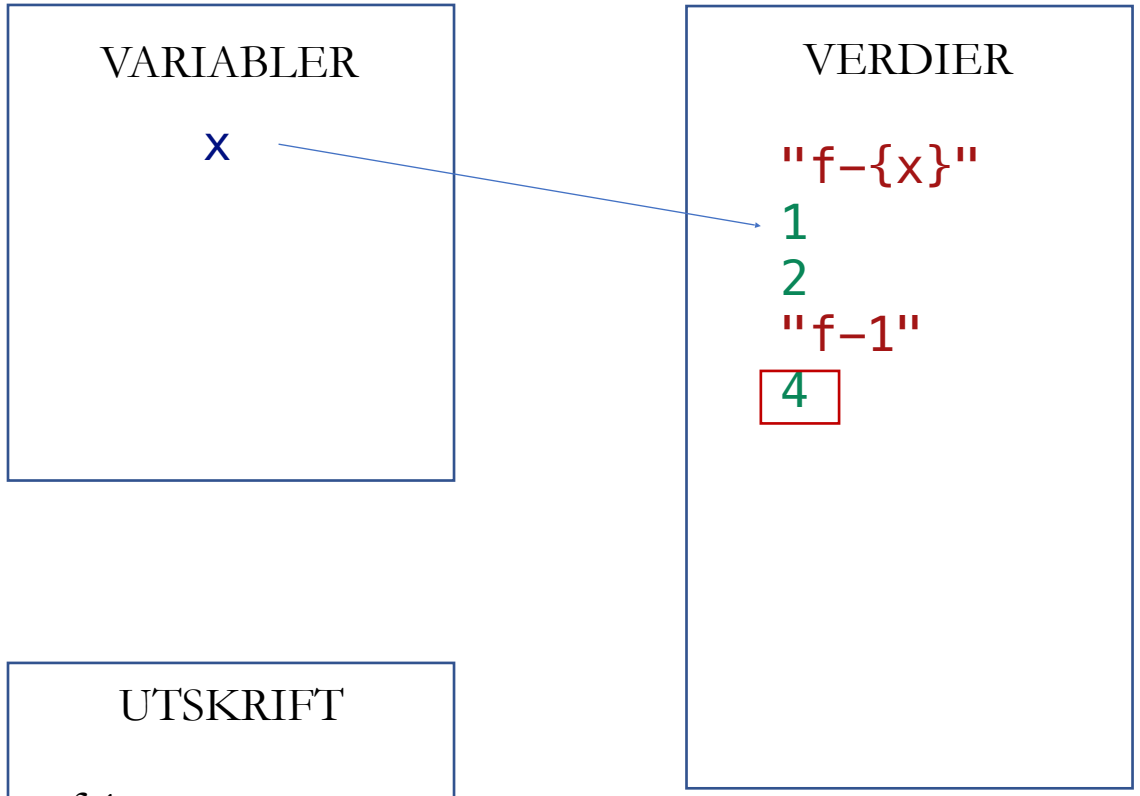

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VARIABLER

x

VERDIER

"f-{x}"
1
2
"f-1"
4

UTSKRIFT

f-1

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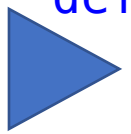

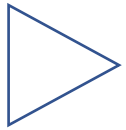

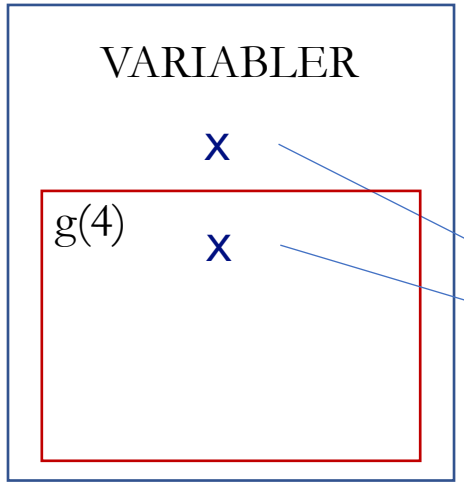


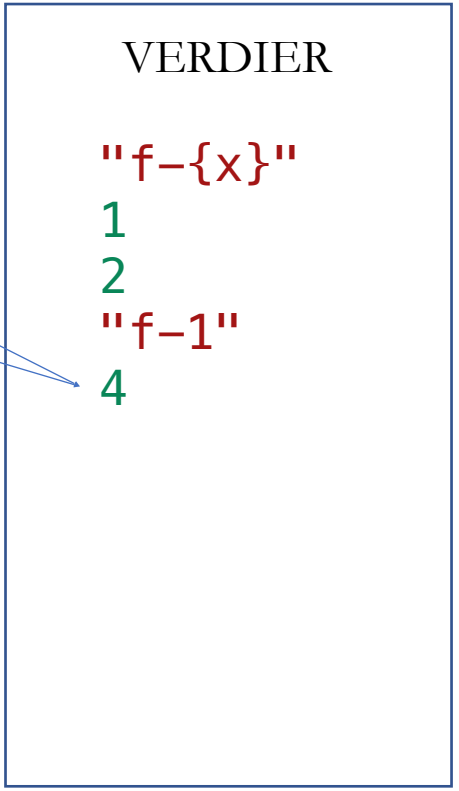


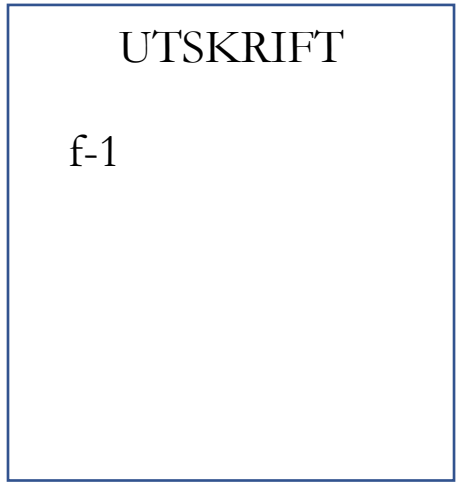

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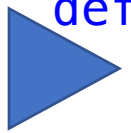

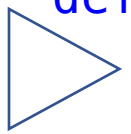

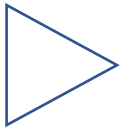

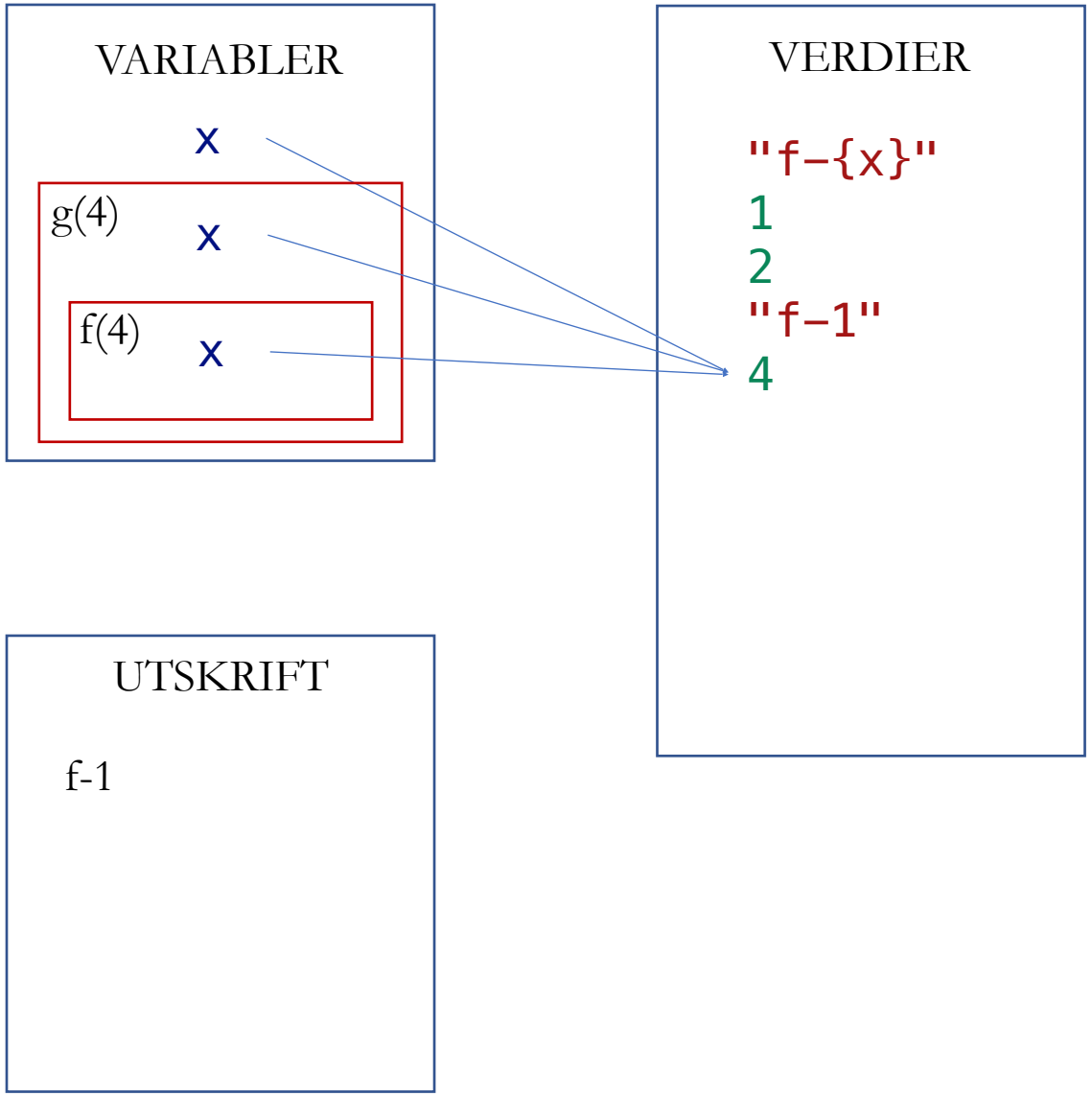

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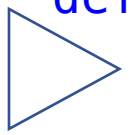

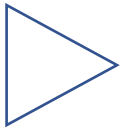

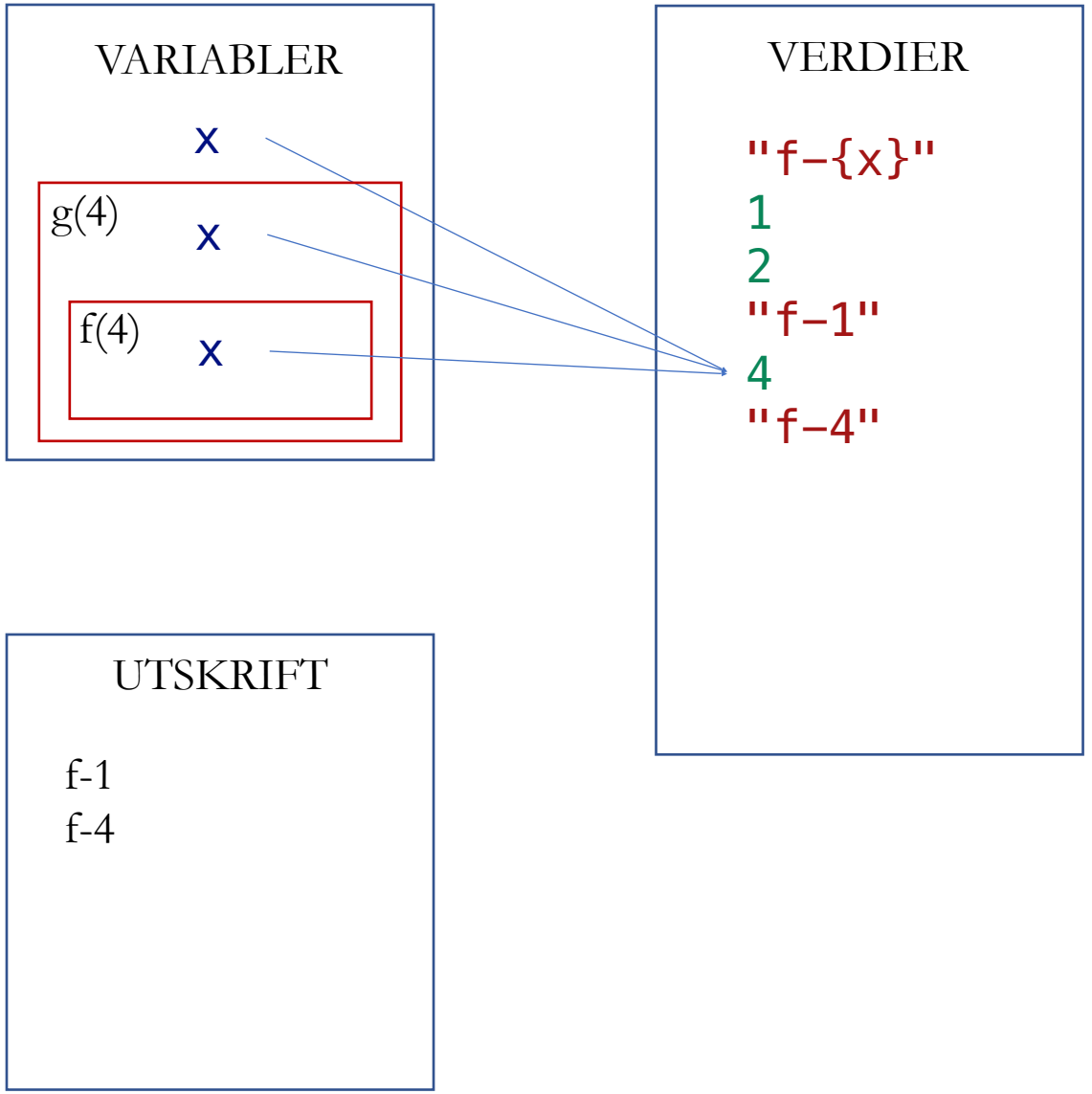


UTSKRIFT

f-1
f-4

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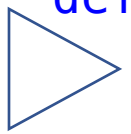

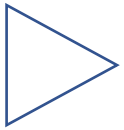

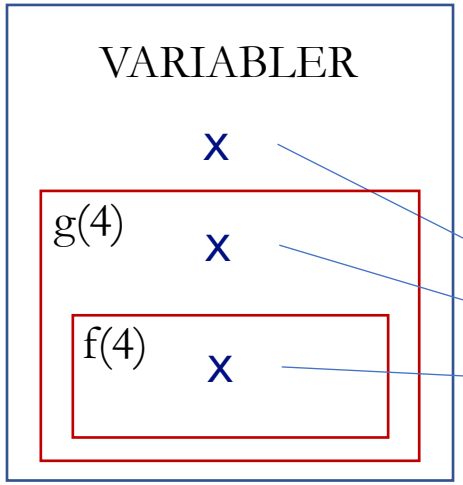


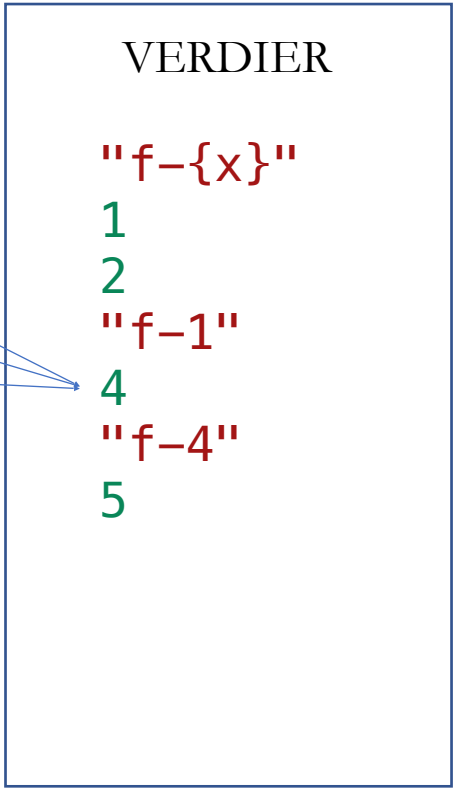


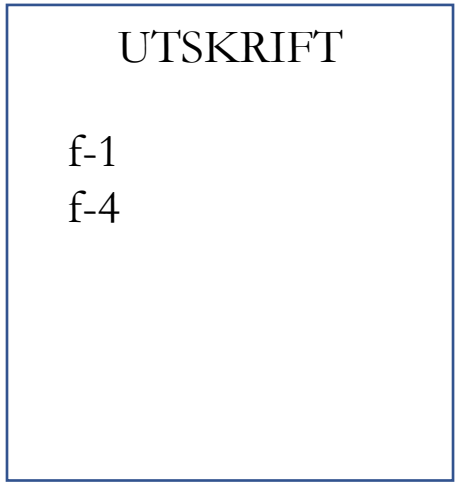

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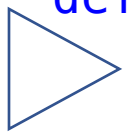

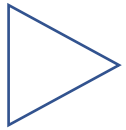

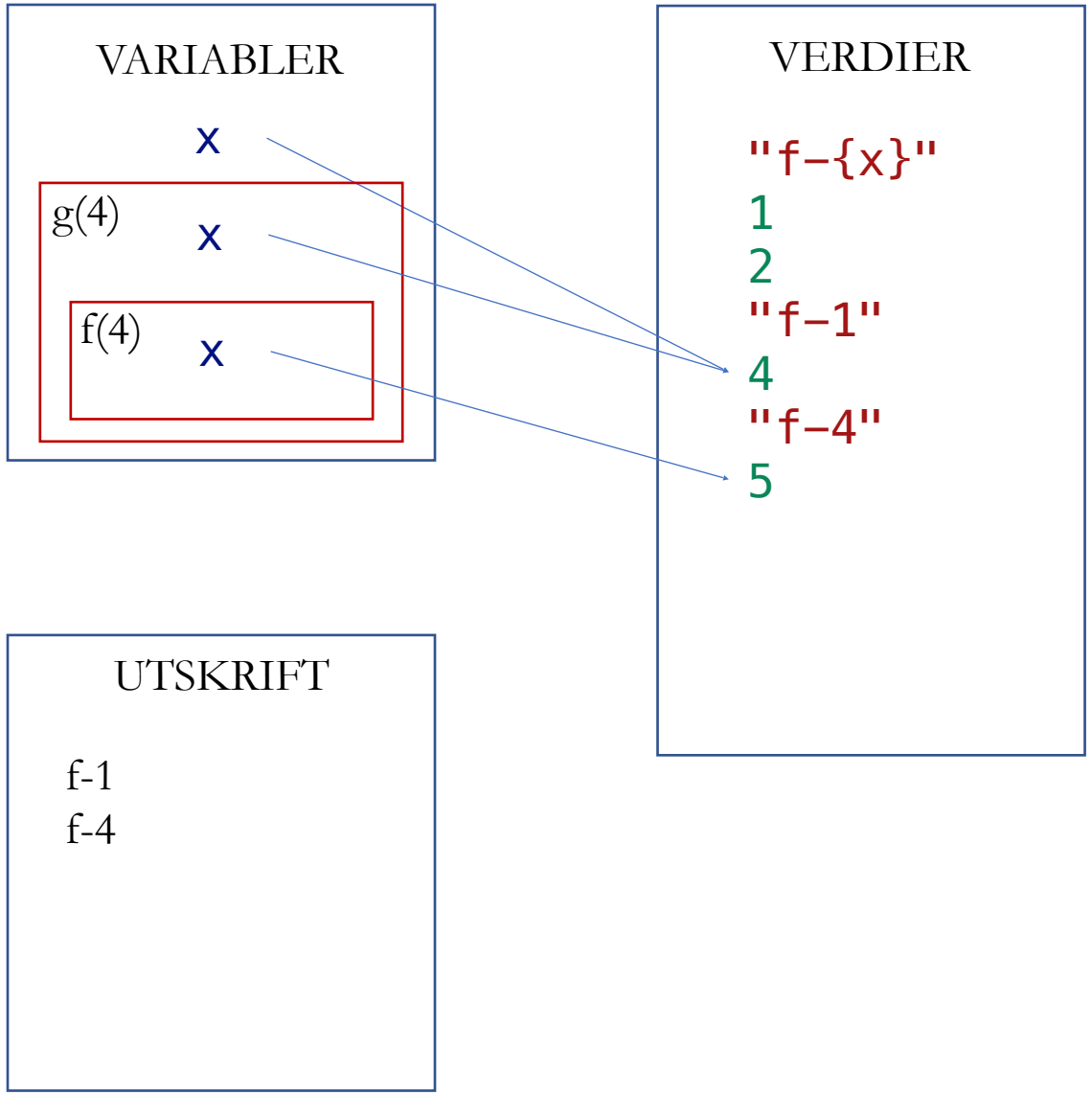

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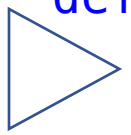

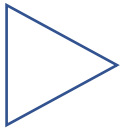

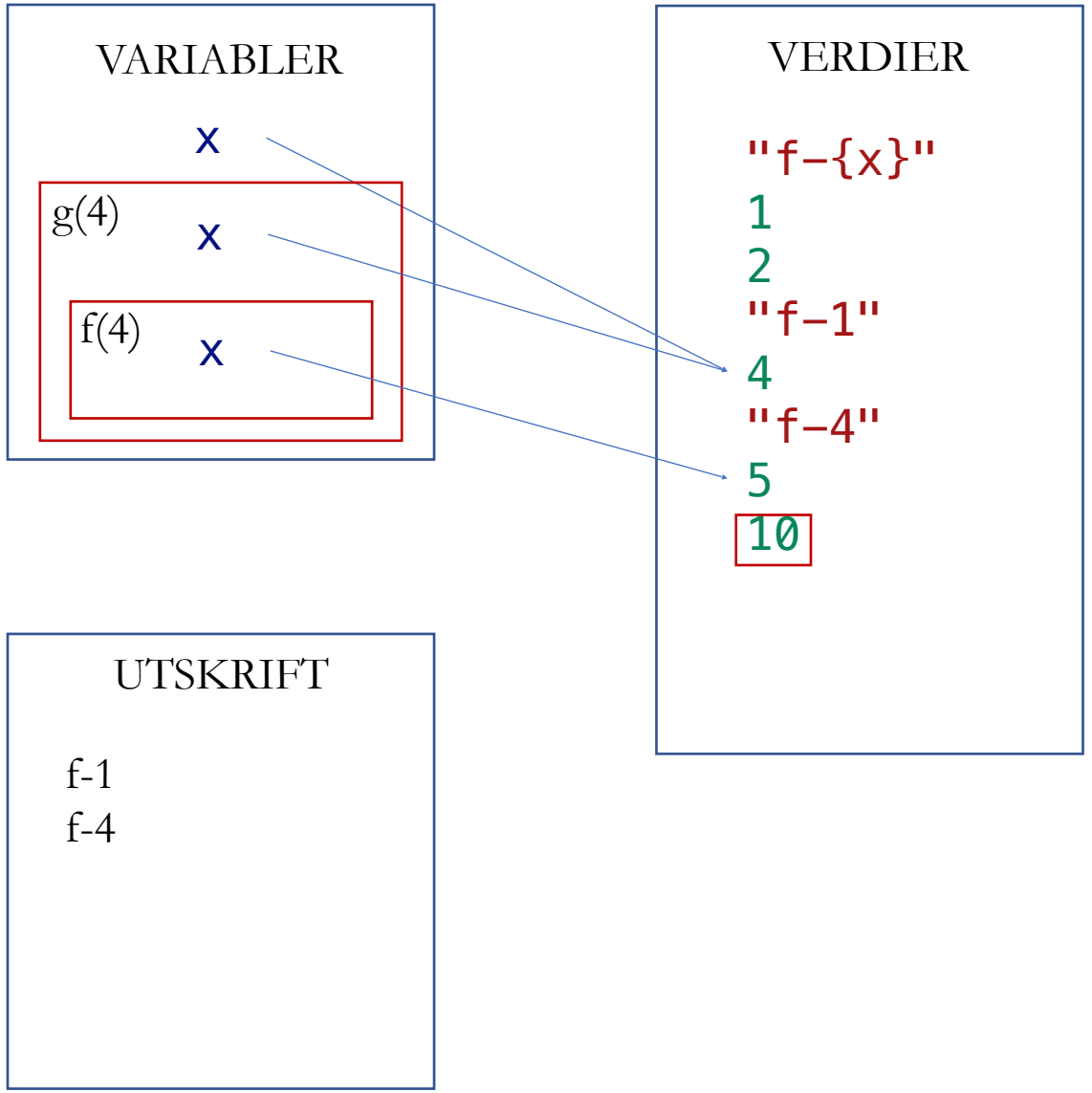

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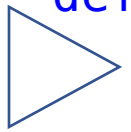

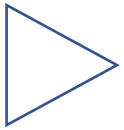

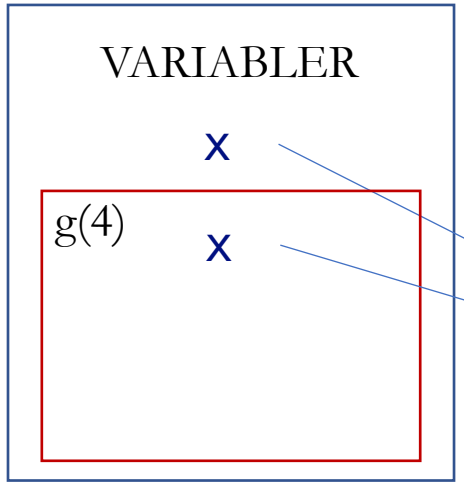


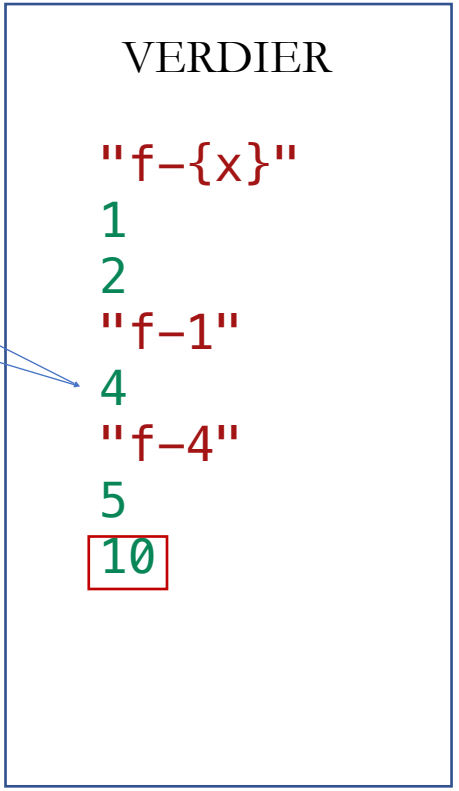


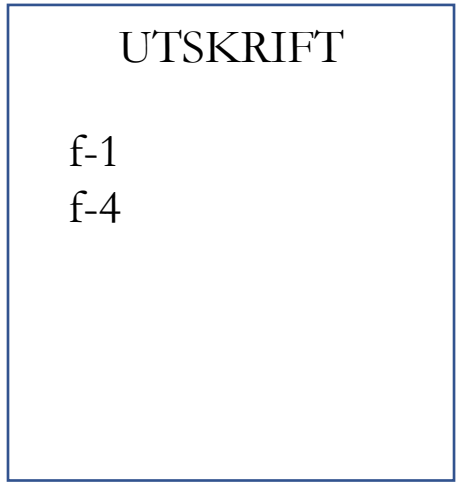

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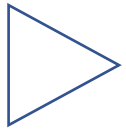

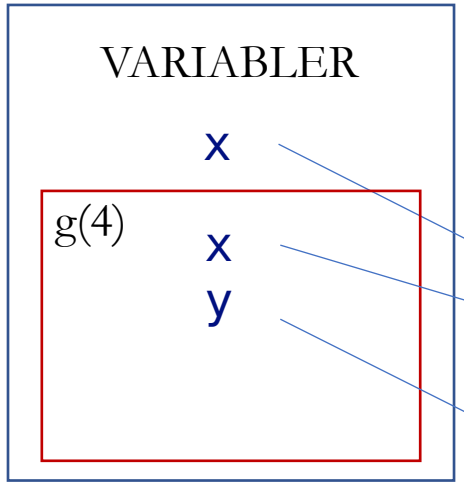


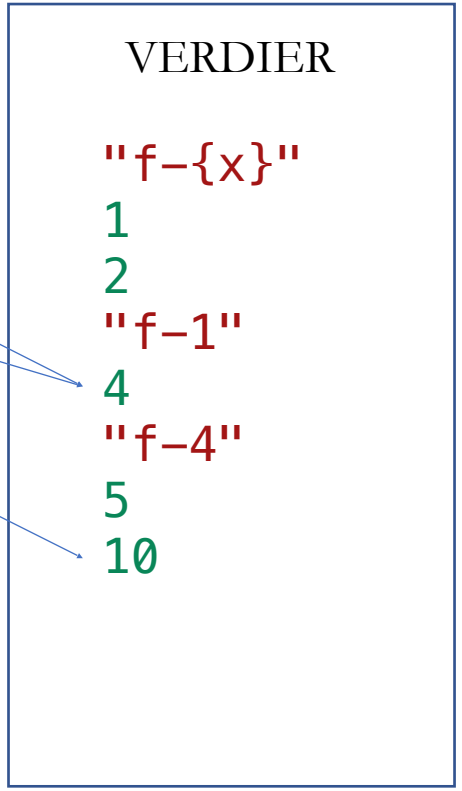


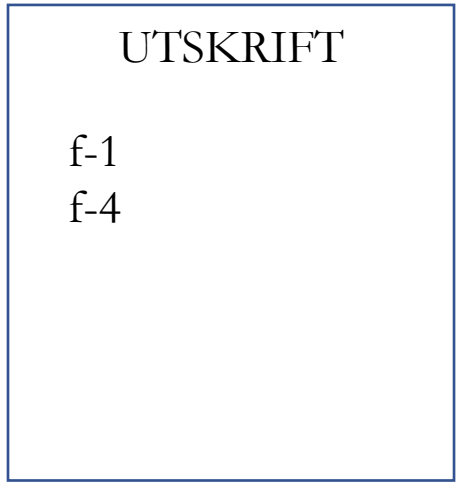

# KODESPORING

```
def f(x):
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    x += 1
    return 2*x

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    y = f(x)
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x = 1
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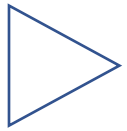

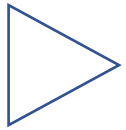

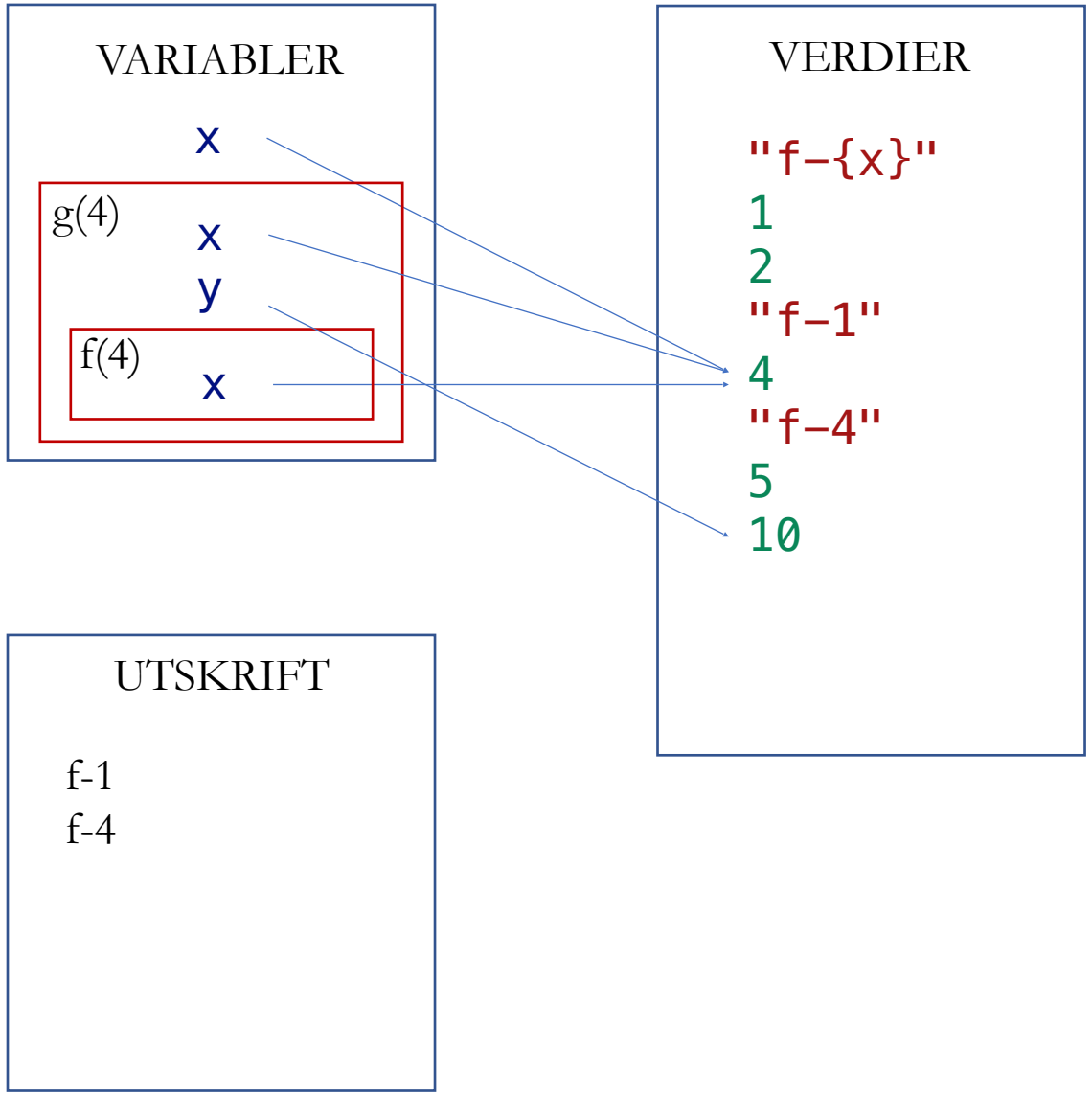

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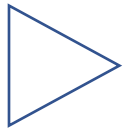

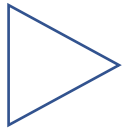

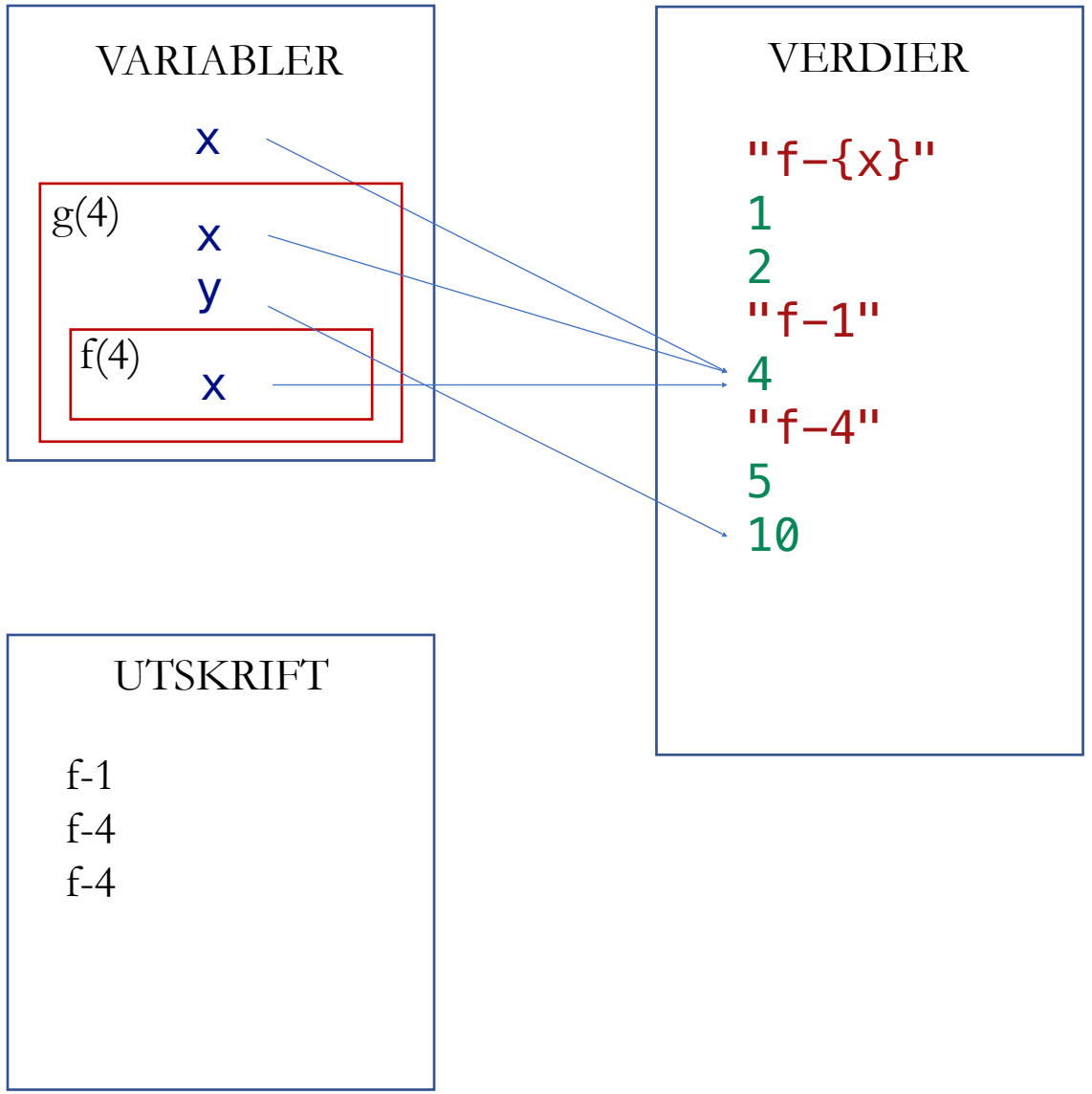

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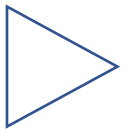

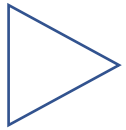

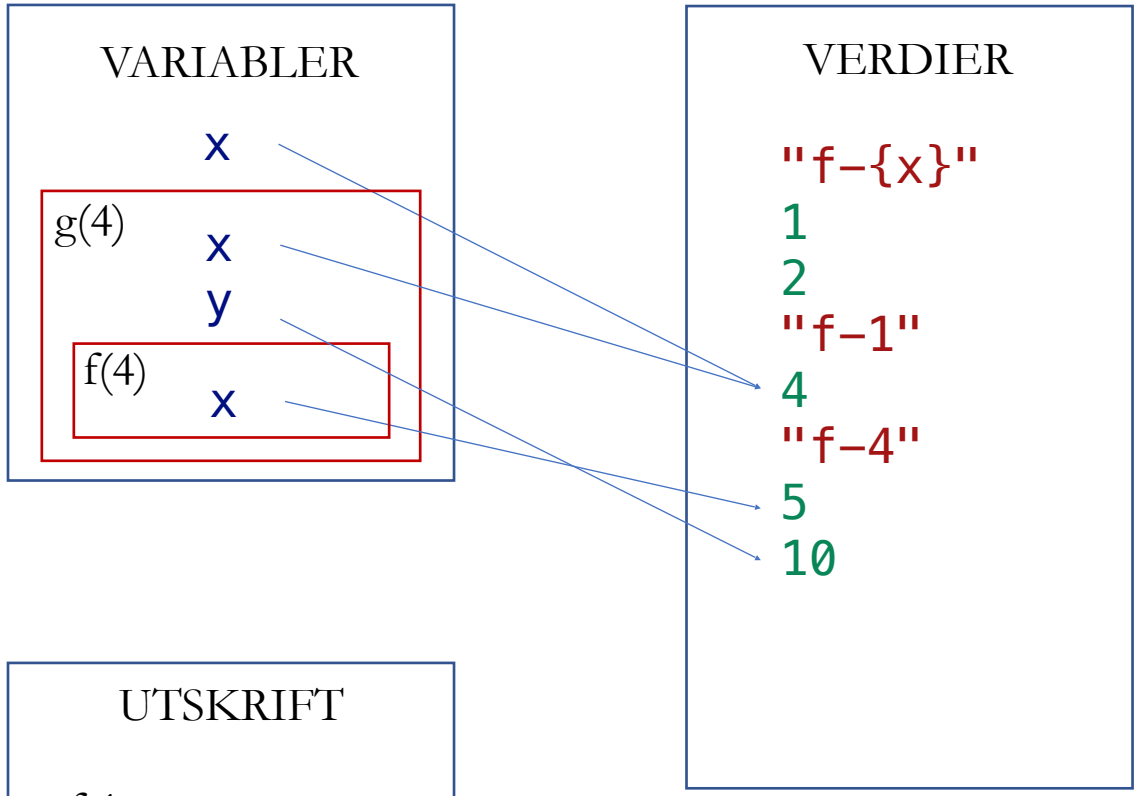


UTSKRIFT

f-1
f-4
f-4

# KODESPORING

```
def f(x):
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    return 2*x

def g(x):
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x = 1
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print(x)
```

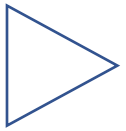

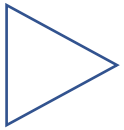

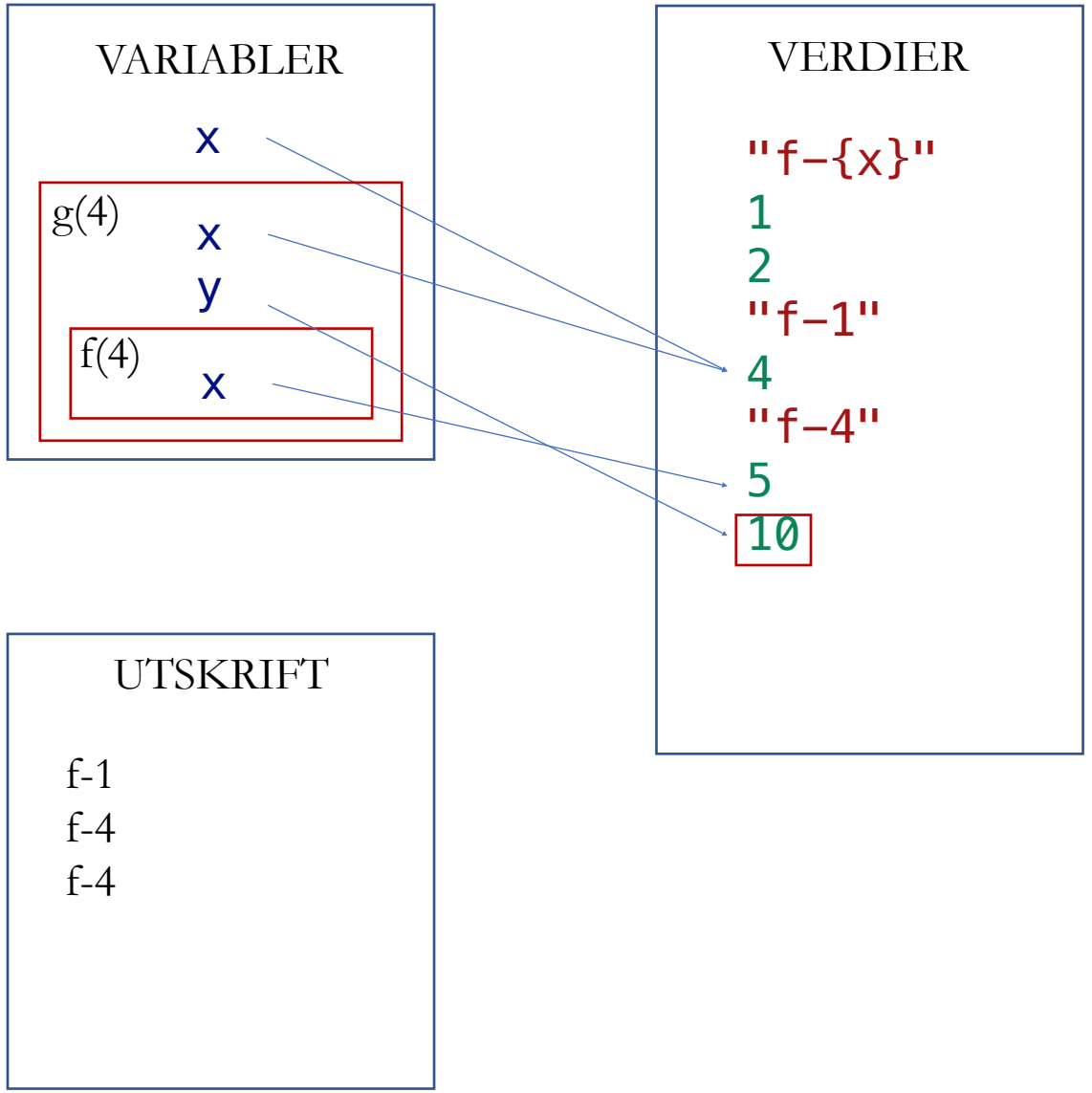

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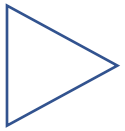

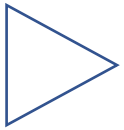

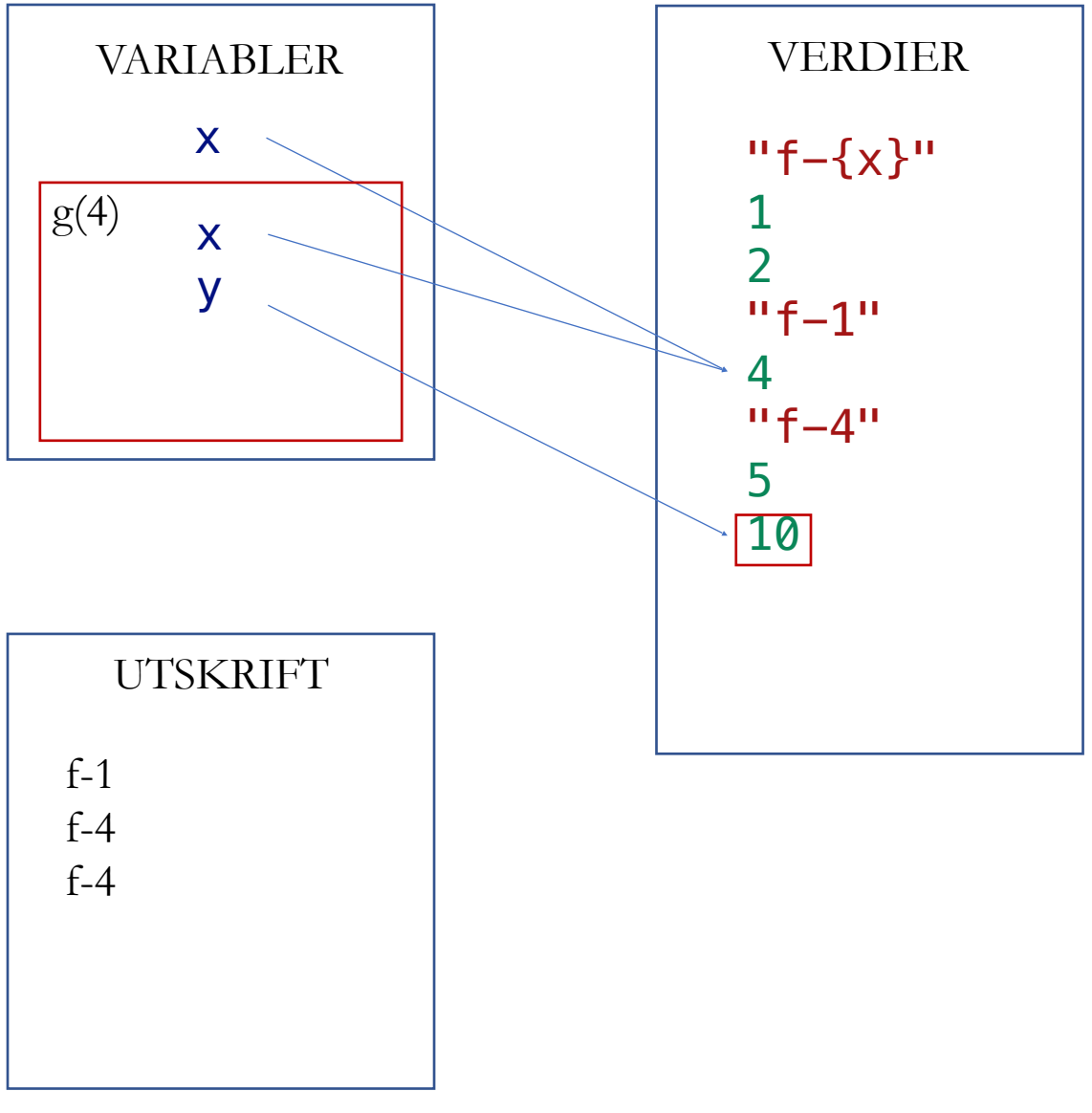

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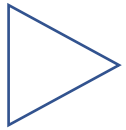

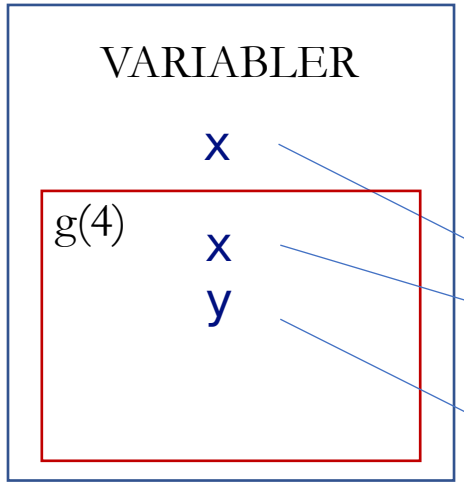


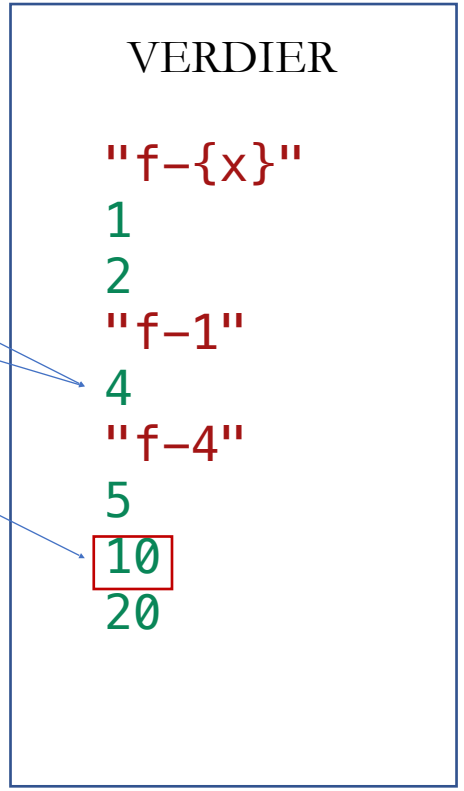


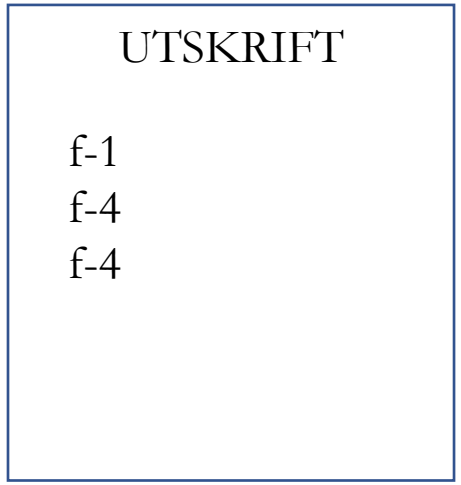

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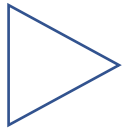

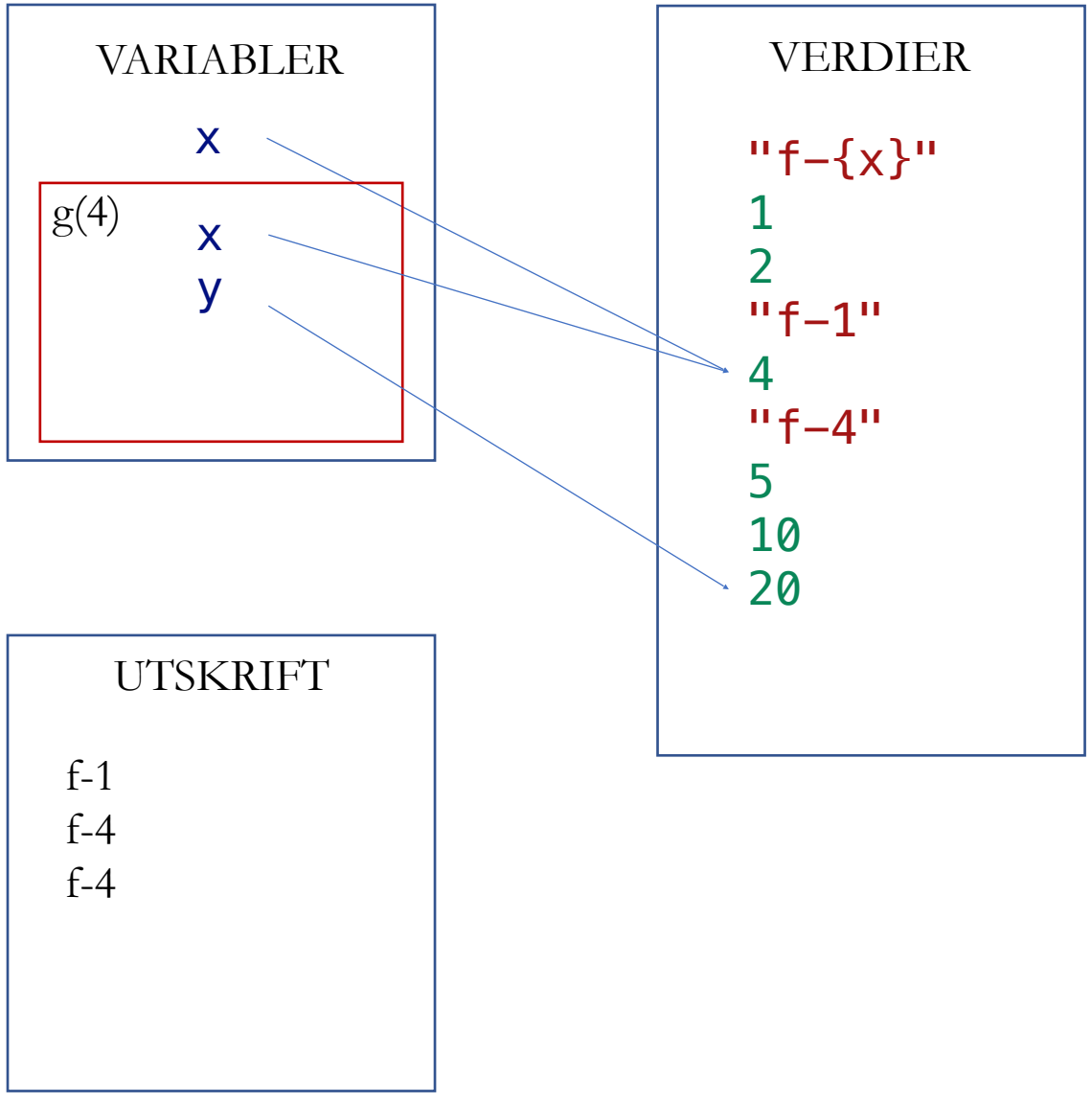

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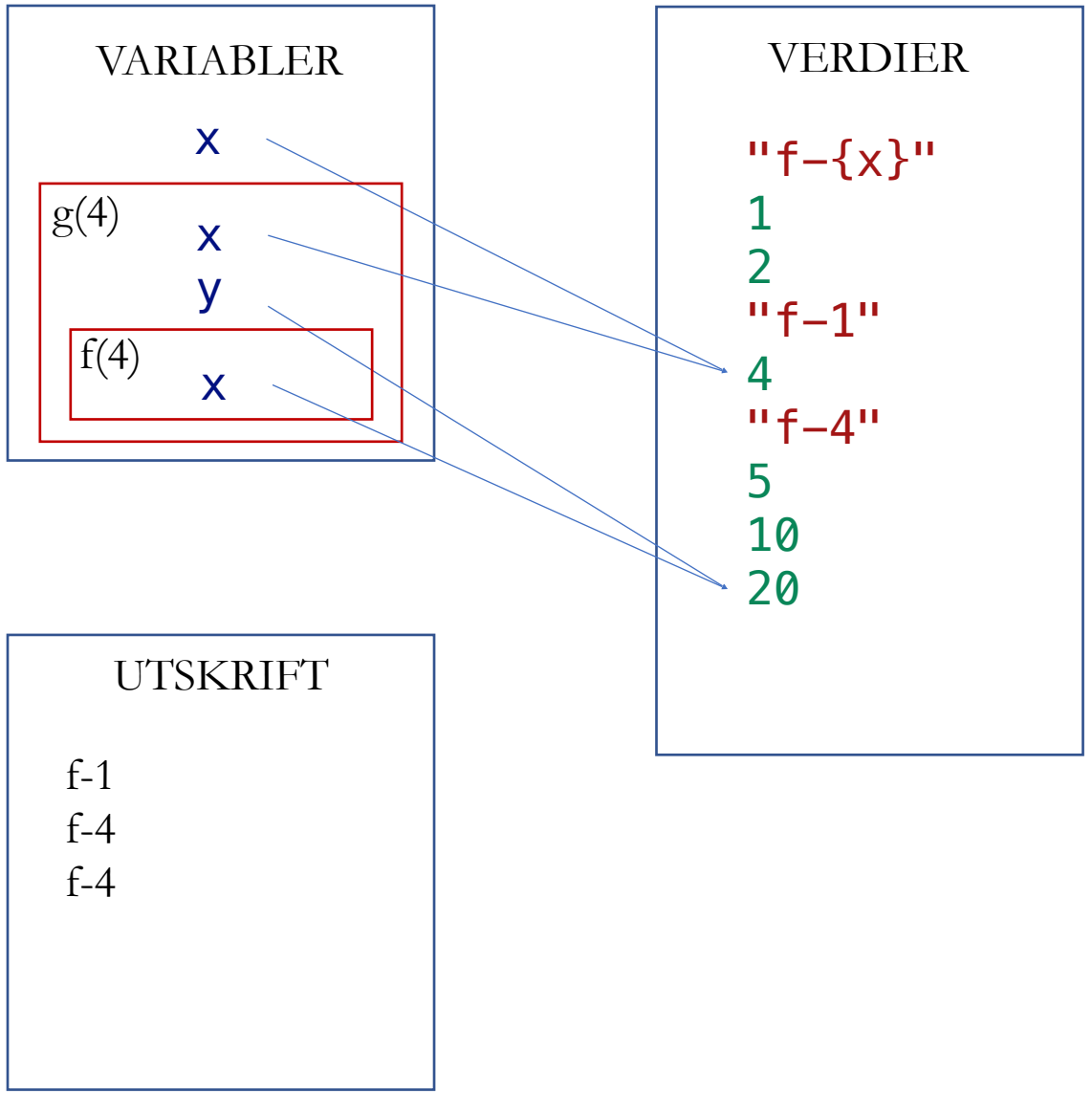

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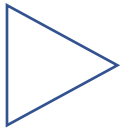

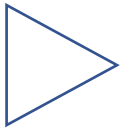

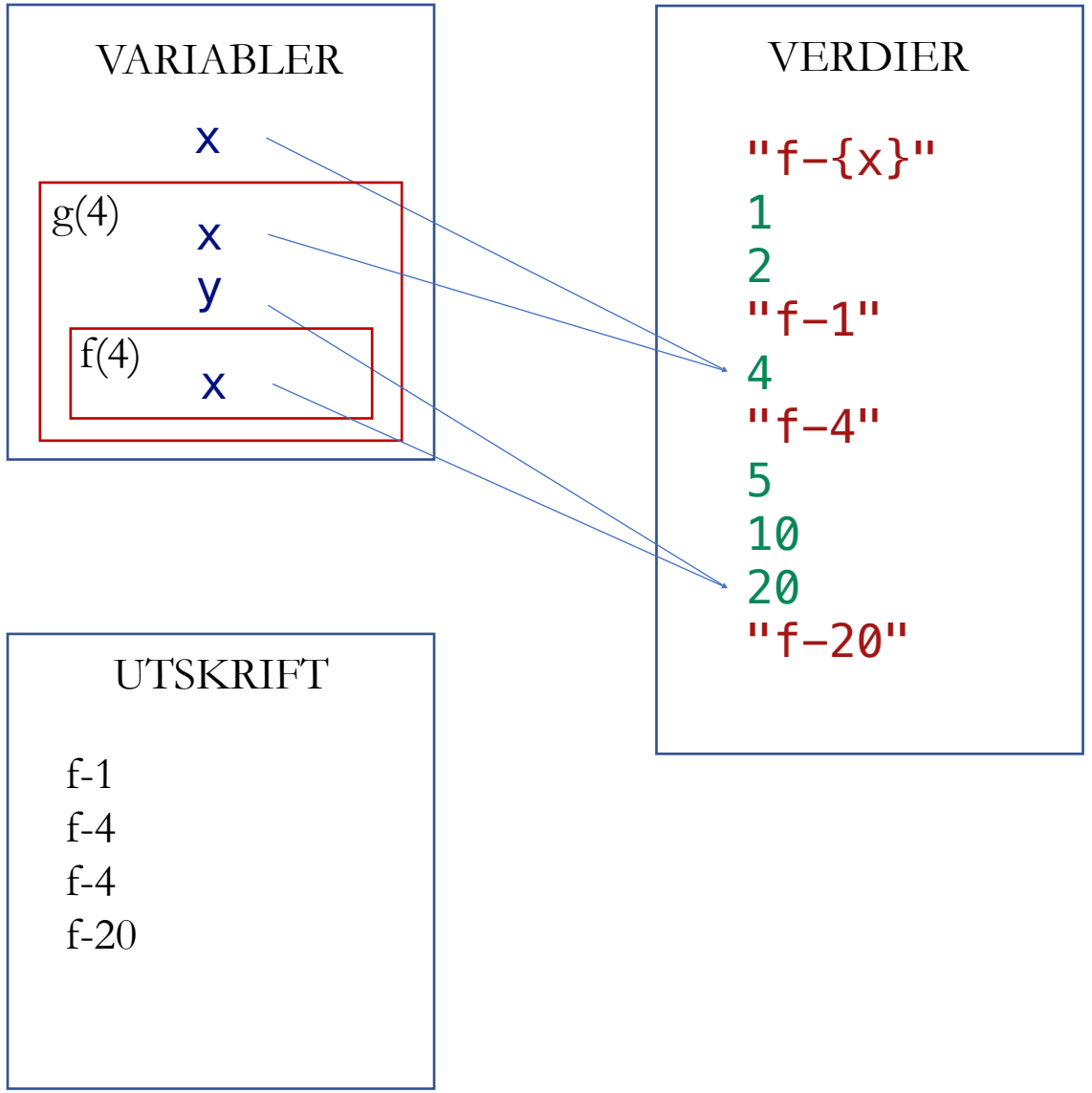


UTSKRIFT

f-1
f-4
f-4
f-20

# KODESPORING

```
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```

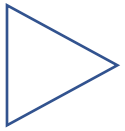

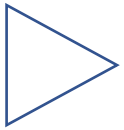

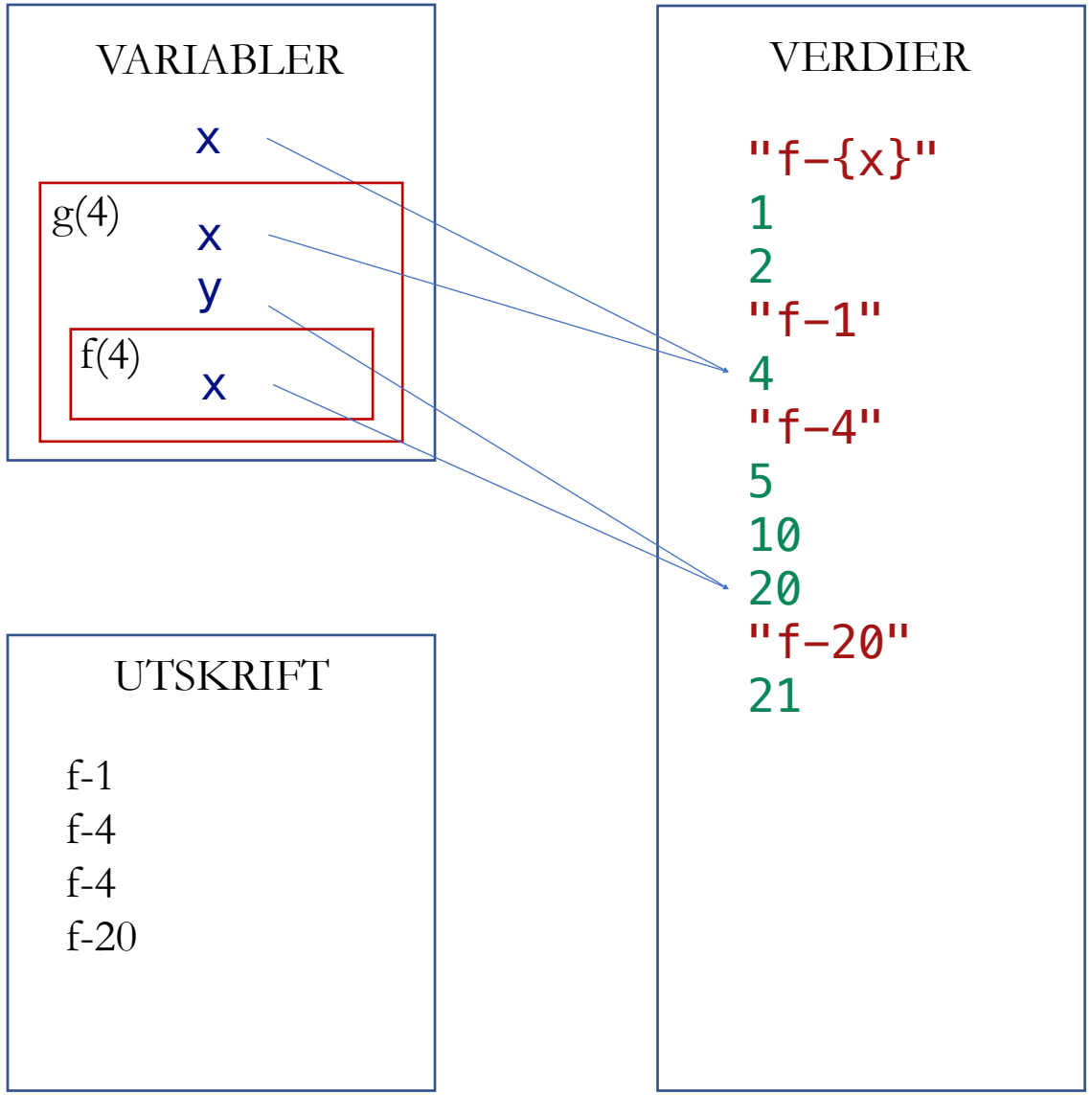

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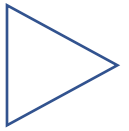

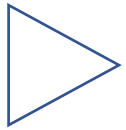

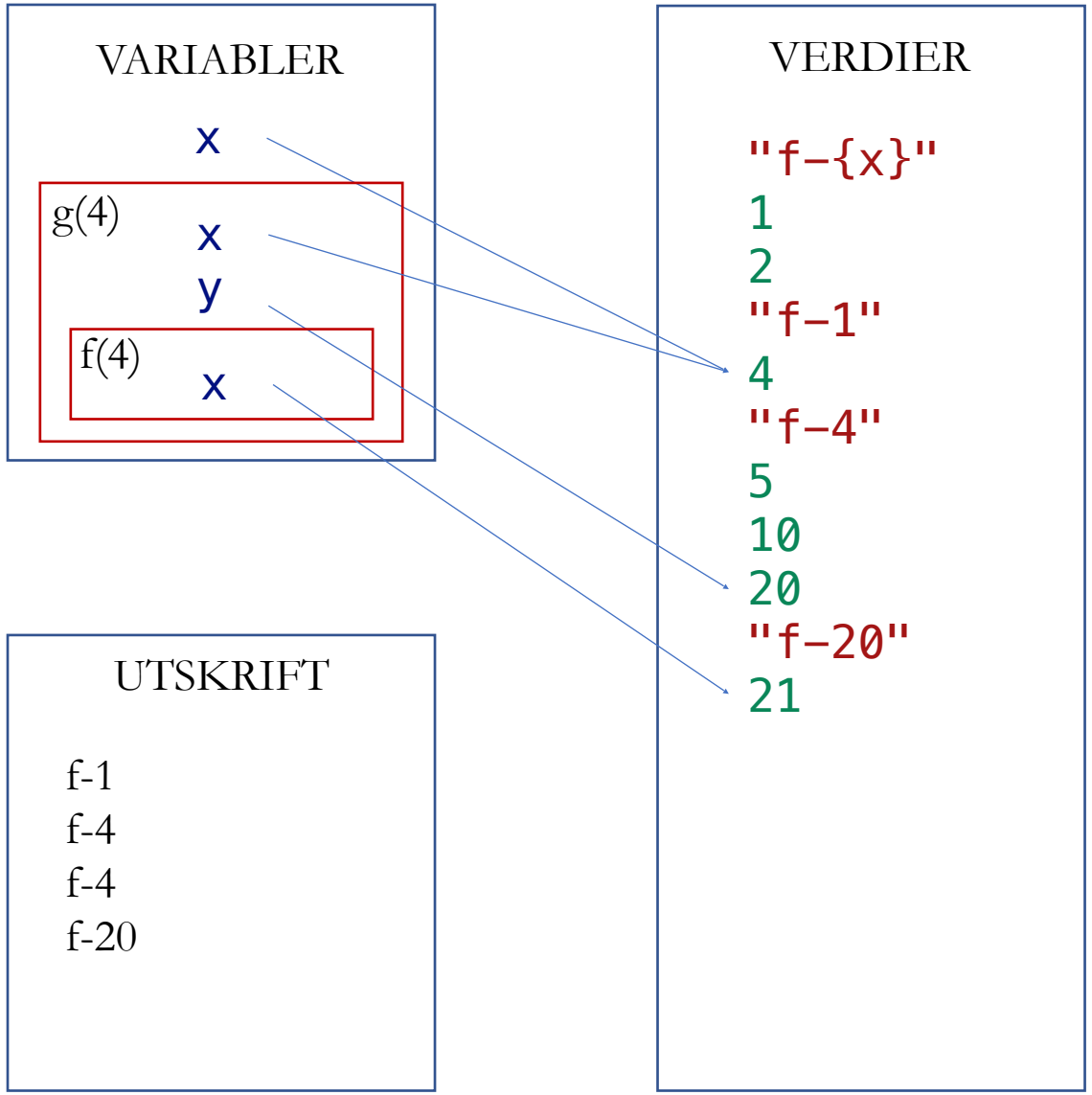

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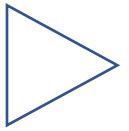

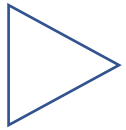

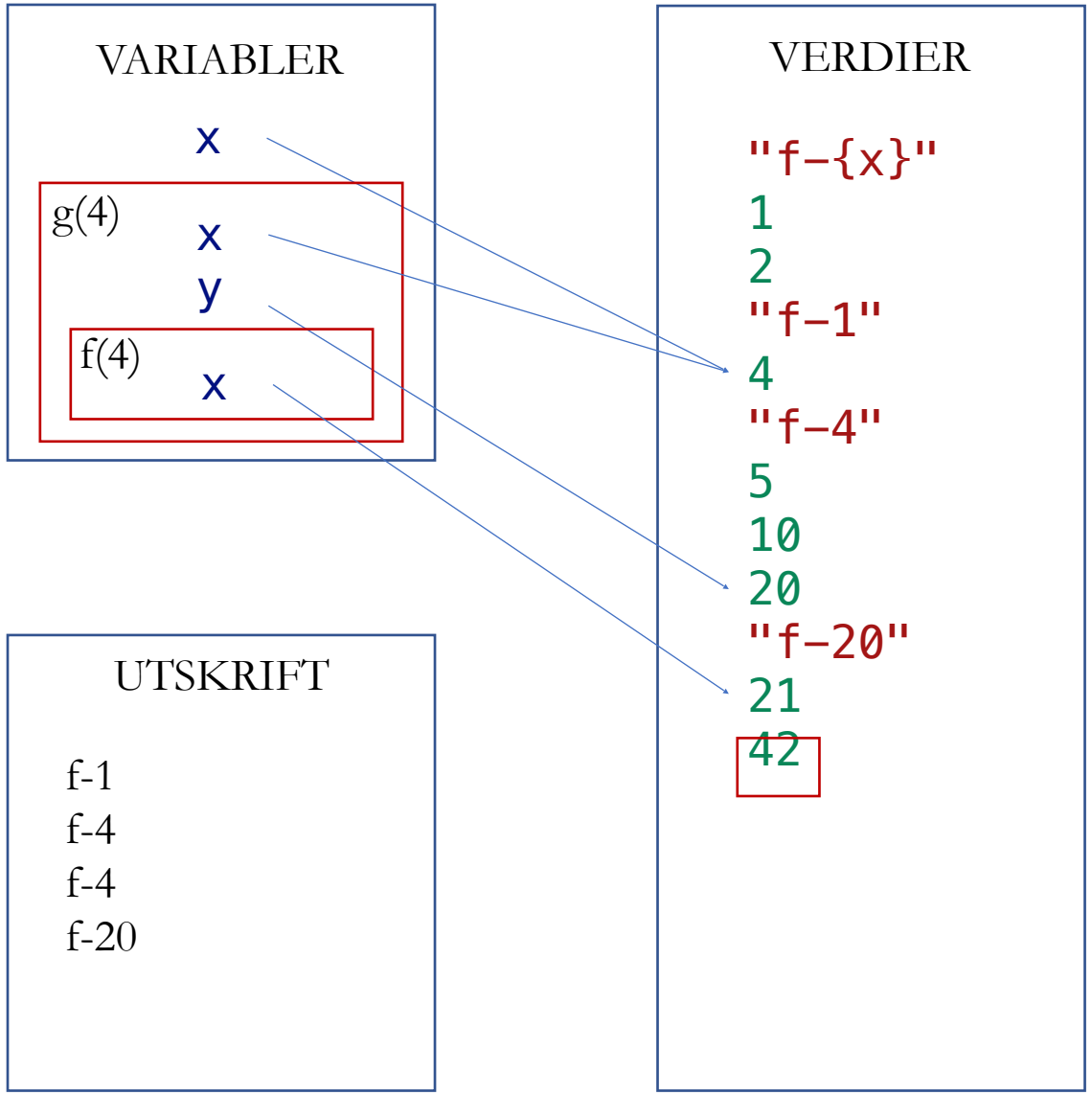

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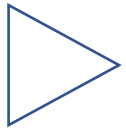

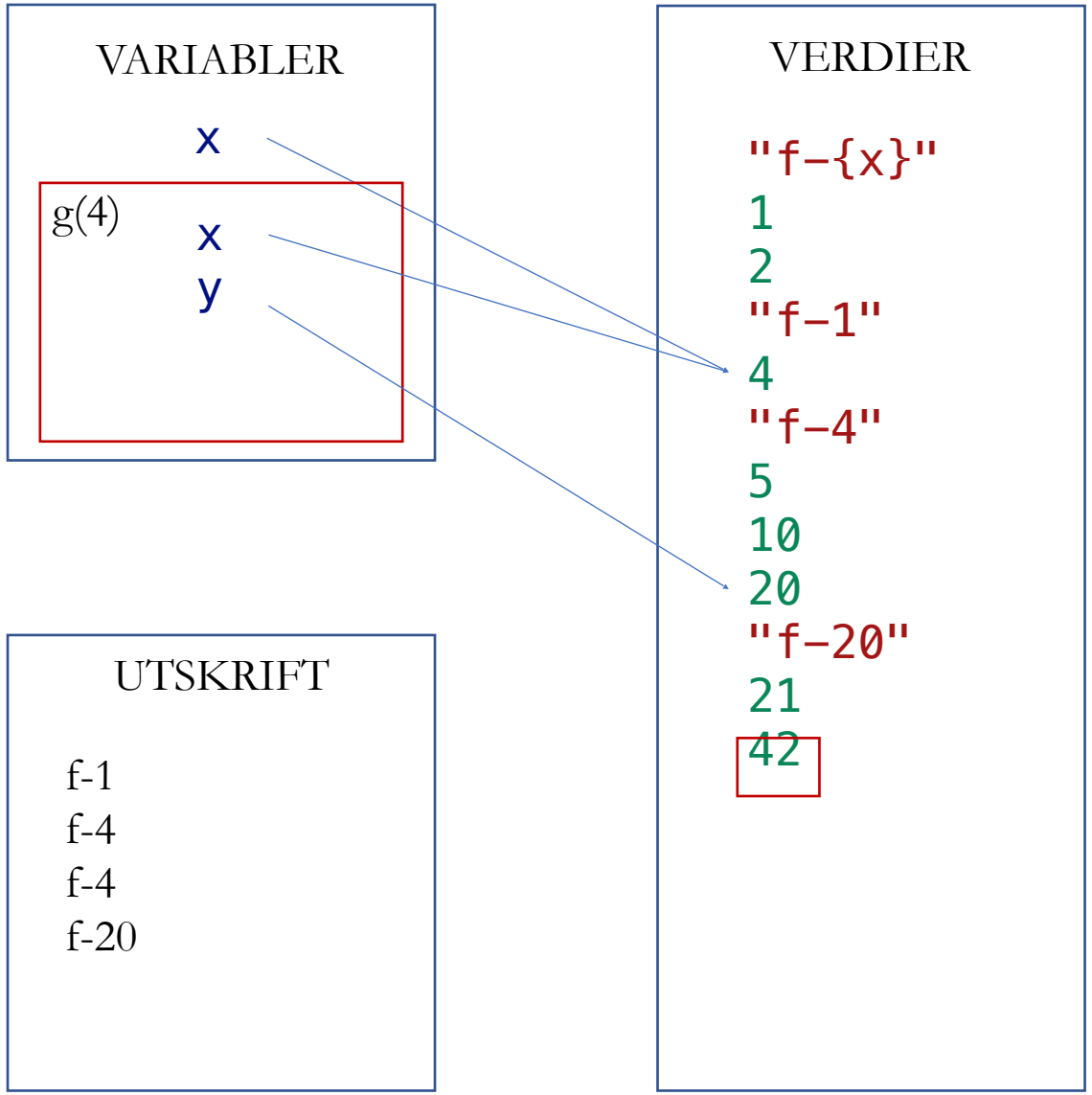

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x = g(x)
print(x)
```

VARIABLER

x

UTSKRIFT

f-1
f-4
f-4
f-20

VERDIER

"f-{x}"
1
2
"f-1"
4
"f-4"
5
10
20
"f-20"
21
42

# KODESPORING

```
def f(x):
    print(f"f-{x}")
    x += 1
    return 2*x

def g(x):
    y = f(x)
    y += f(x)
    return f(y)

x = 1
x = f(x)
x = g(x)
print(x)
```

VARIABLER

x

VERDIER

```
"f-{x}"
1
2
"f-1"
4
"f-4"
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"f-20"
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42
```

UTSKRIFT

f-1
f-4
f-4
f-20

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VARIABLER

x

VERDIER

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"f-1"
4
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10
20
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42

UTSKRIFT

f-1
f-4
f-4
f-20
42

# KODESPORING

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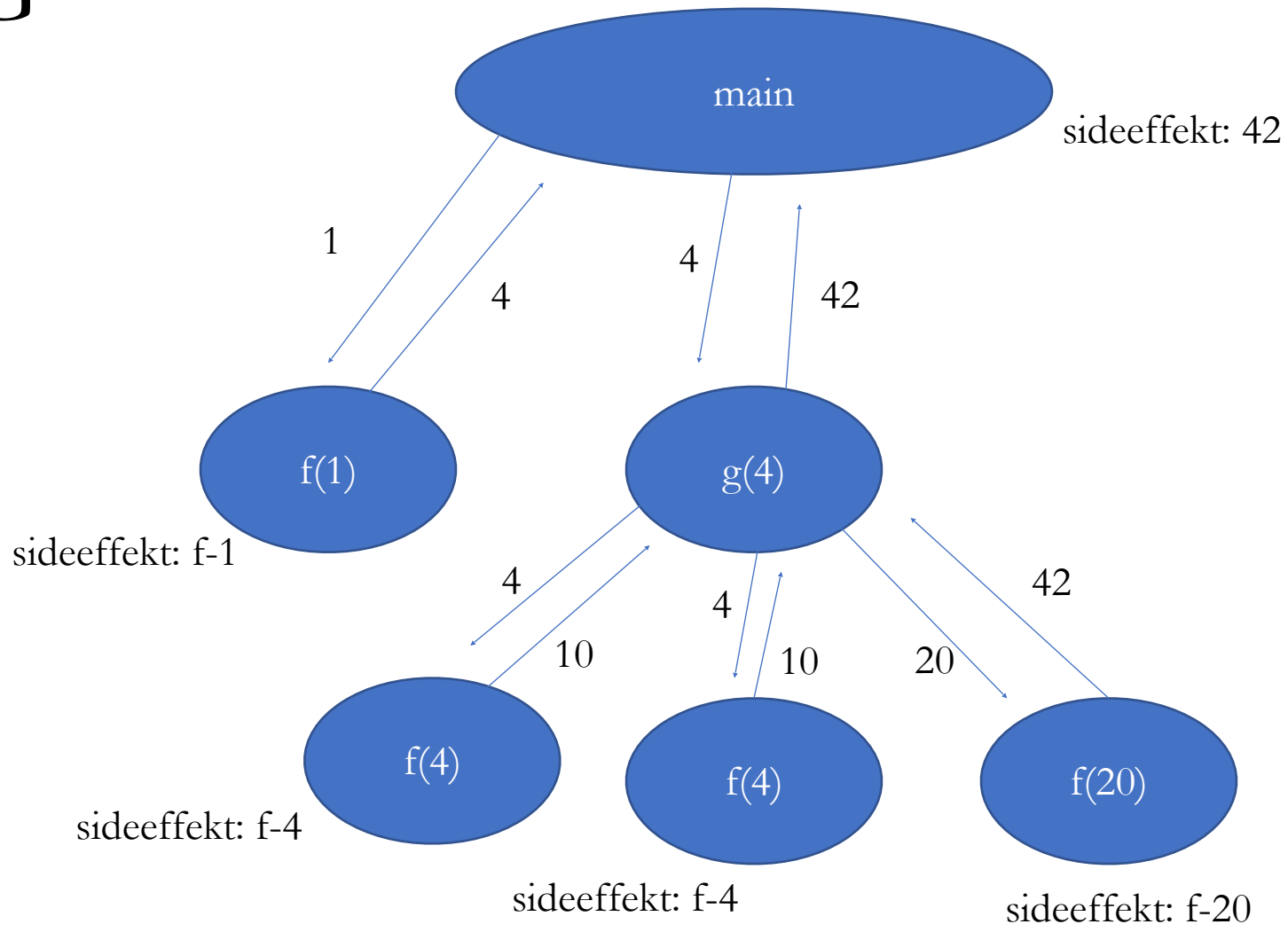


# SAMLINGER

- Strenger, range, tupler og lister

```
s = "abc"
r = range(3, 12, 2)
t = (1, 2, "abc")
a = [9, 8, "abc"]
```

Indeksering

```
s[0]
r[1]
t[1]
a[2]
```

Beskjæring

```
s[:2]
r[1:3]
t[::-1]
a[:2]
```

Løkker

```
for thing in ... :
    ...
```

s/r/t/a

Medlemskap

```
"a" in s
5 in r
"abc" in t
8 in a
```

Funksjoner

```
min  max
len
.count
.index
```

# SAMLINGER

- Strenger, ~~range~~, tupler og lister

```
s = "abc"
r = range(3, 12, 2)
t = (1, 2, "abc")
a = [9, 8, "abc"]
```

Repetisjon

```
s * 0
t * 2
a * 3
```

Konkatenasjon

```
s + "def"
t + (True, 0.0)
a + ["a", -3]
```

# Hvordan opprette tupler

```
# Tom tuple
t = ()
t = tuple()

# Tuple med ett element
t = (42,)


# Tuple med flere elementer
t = (42, 95, "abc",)
t = (42, 95)

# Konvertere andre samlinger til tuple
t = tuple("abc")
t = tuple([1, 2, 3])
t = tuple(range(5))
```

# Hvordan opprette lister

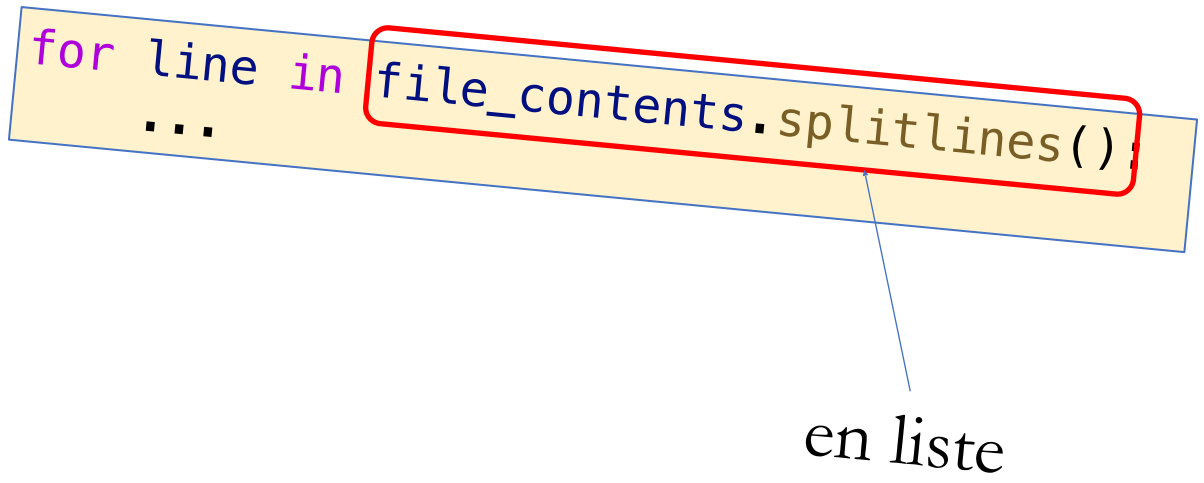
```
# Tom liste
a = []
a = list()

# Liste med ett element
a = [42,]
a = [42]

# Liste med flere elementer
a = [42, 95, "abc",]
a = [42, 95]

# Konvertere andre samlinger til liste
a = list("abc")
a = list((1, 2, 3))
a = list(range(5))
```

```
# Splitting av en streng
a = "1 2 5 9 4".split(" ")
a = "1\n5 9\n4\n".splitlines()
```



# PROBLEMLØSNING

- Top-down design: løse "de store linjene" først
- Bottom-up: kjenne igjen små deler som kan løses separat

- Forstå problemet – forstå eksemplene
- Still spørsmål
- Samarbeid

- Øvelse, øvelse, øvelse

# Advent of Code

- https://adventofcode.com/2022/day/1

# LICENSE TO LAUNCH

https://open.kattis.com/problems/licensetolaunch

- Input
  - Første linje: et tall *n*
  - Andre linje: en streng med *n* tall adskilt med mellomrom (i.e. en liste med *n* tall)
- Output
  - Posisjonen til (det første) tallet med lavest verdi

# ODD GNOME

https://open.kattis.com/problems/oddgnome

- Input
  - Første linje: et tall *n*, antall testcaser
  - I hver testcase: en liste med tall

- Output
  - For hver testcase: posisjonen til første tall som ikke er akkurat én mer enn forrige

# BUBBLE TEA

https://open.kattis.com/problems/bubbletea

- Input
  - En liste med priser for boble-te
  - En liste med priser for toppinger
  - For hver boble-te, en liste med hvilke toppinger som kan passe
  - Et tall, hvor stort budsjettet er

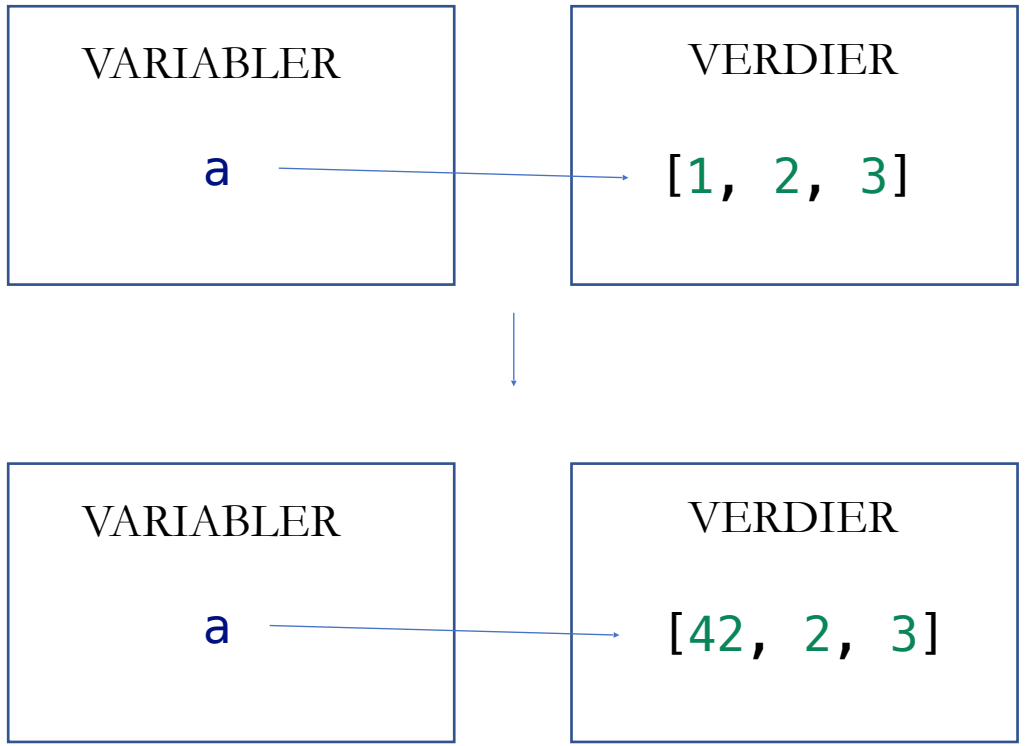
- Output
  - Et tall, hvor mange boble-te man har råd til å kjøpe (-1, siden vi drikker en selv)

# LISTER vs. TUPLER

- En liste kan *muteres*
- En tupel kan *ikke* muteres

# MUTASJON

```
a = [1, 2, 3]
a[0] = 42
```



# MUTASJON

```
t = (1, 2, 3)
t[0] = 42
```

TypeError: 'tuple' object does not support item assignment

# STRENG

VARIABLER

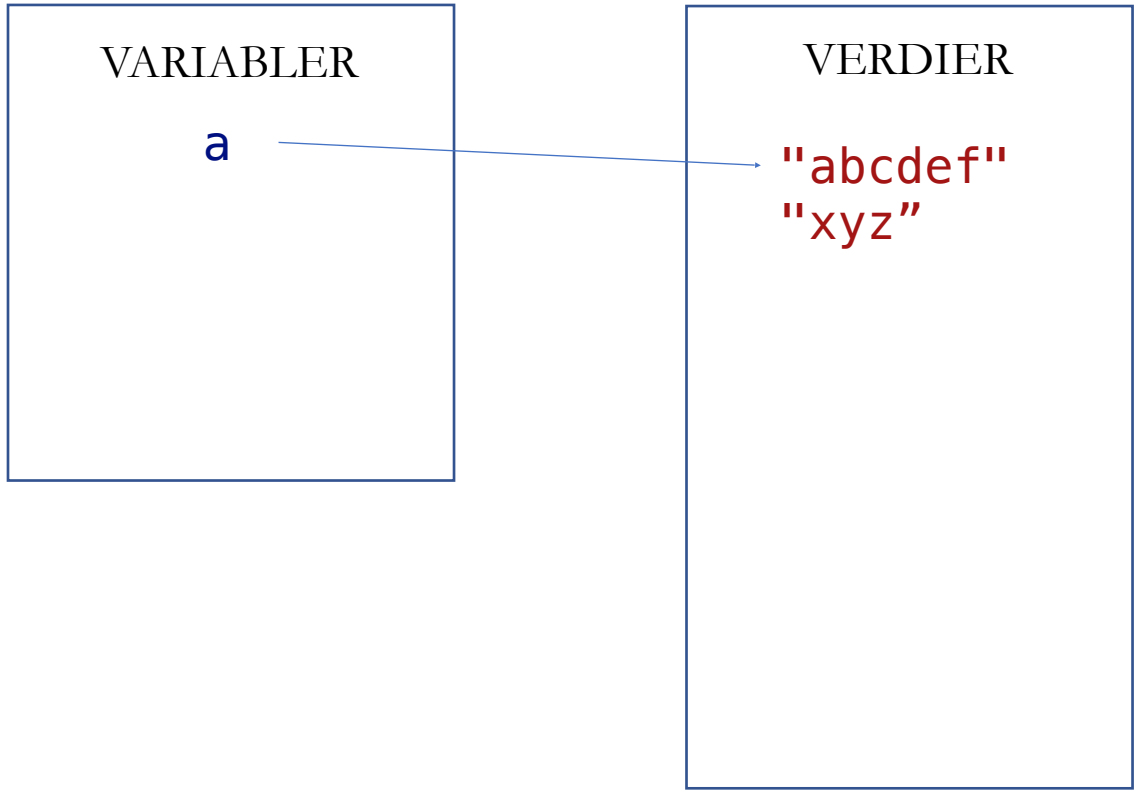
VERDIER

"abcdef"
"xyz”

```
a = "abcdef"
b = "xyz"
a += b
```

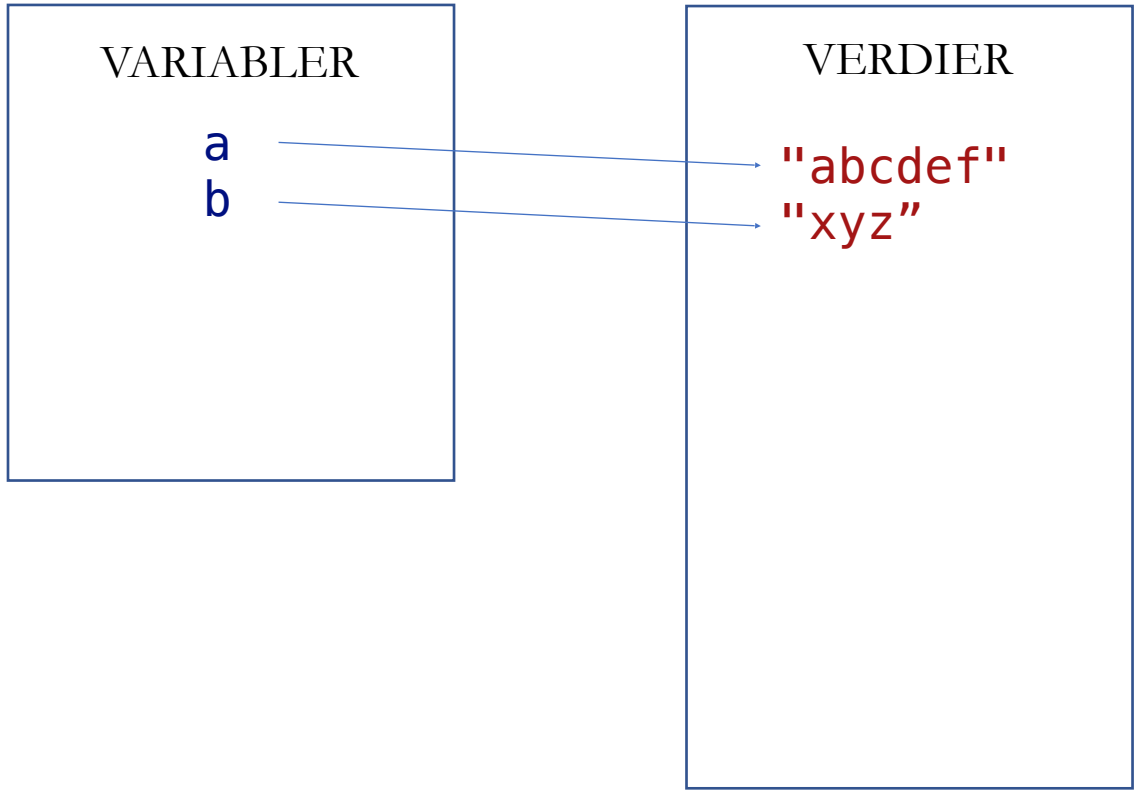
# STRENG

```
a = "abcdef"
b = "xyz"
a += b
```



# STRENG

```
a = "abcdef"
b = "xyz"
a += b
```



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a = "abcdef"
b = "xyz"
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```
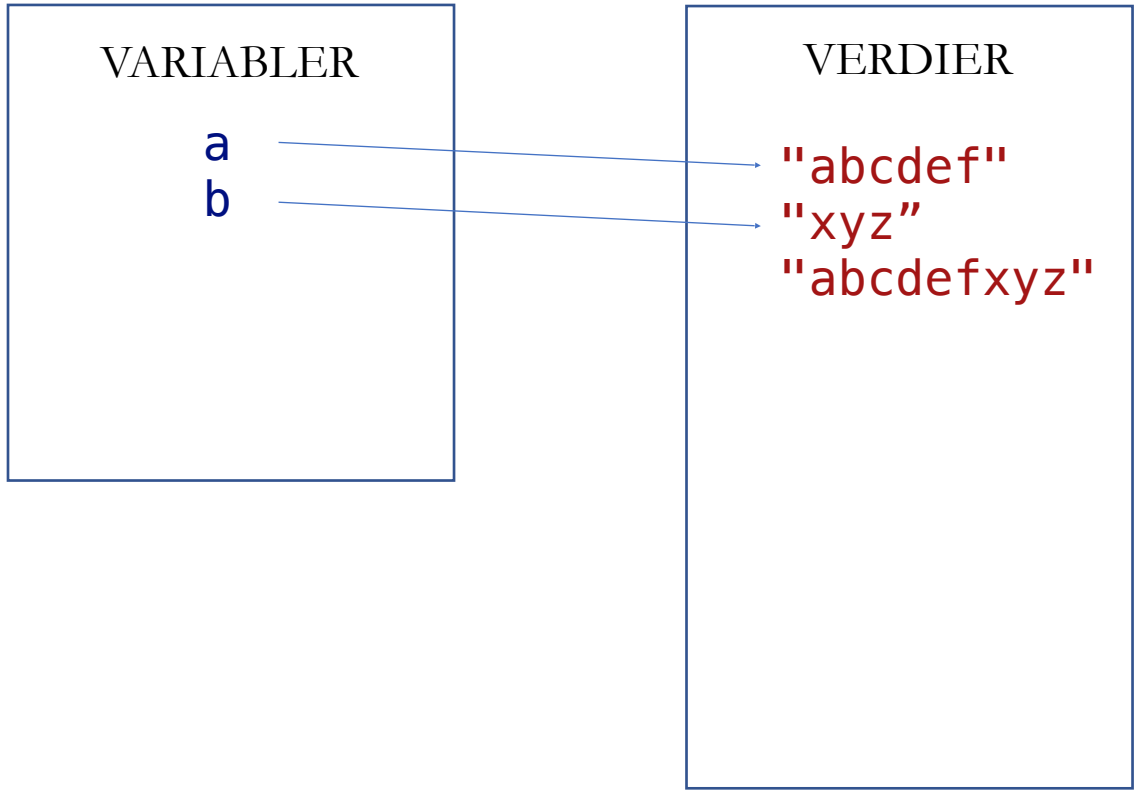
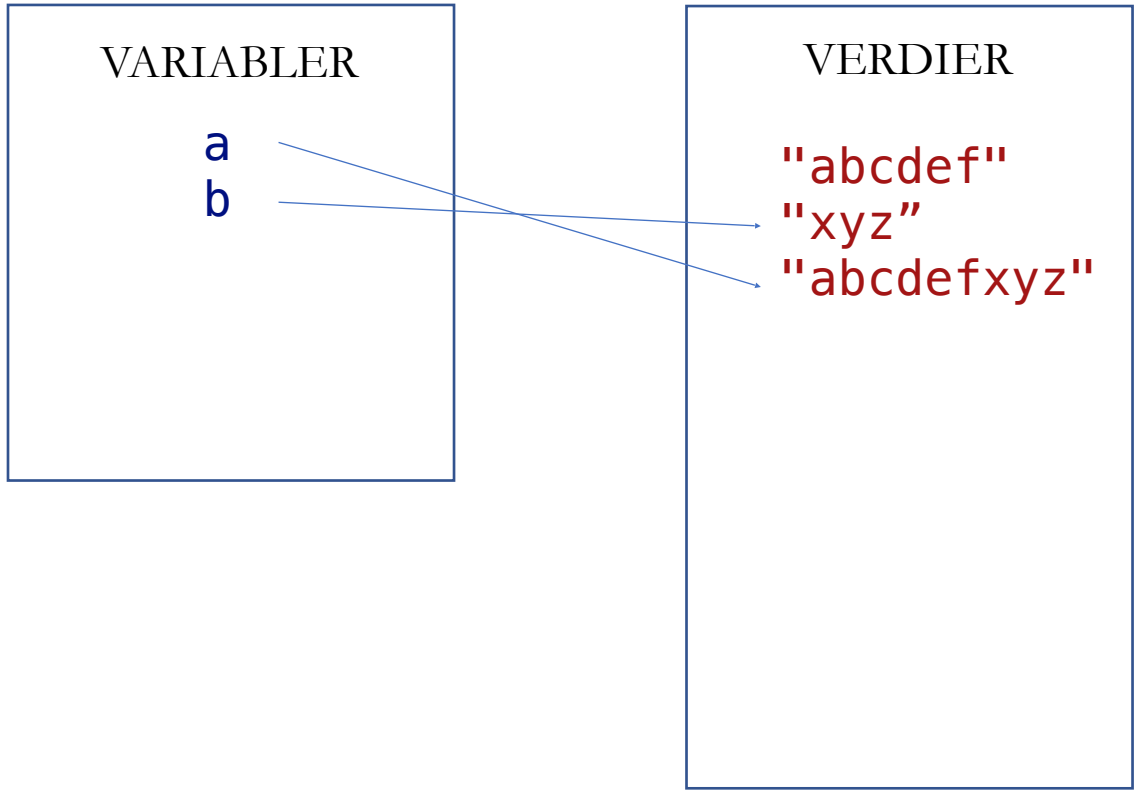



# STRENG

```
a = "abcdef"
b = "xyz"
a += b
```



# TUPLE

VARIABLER

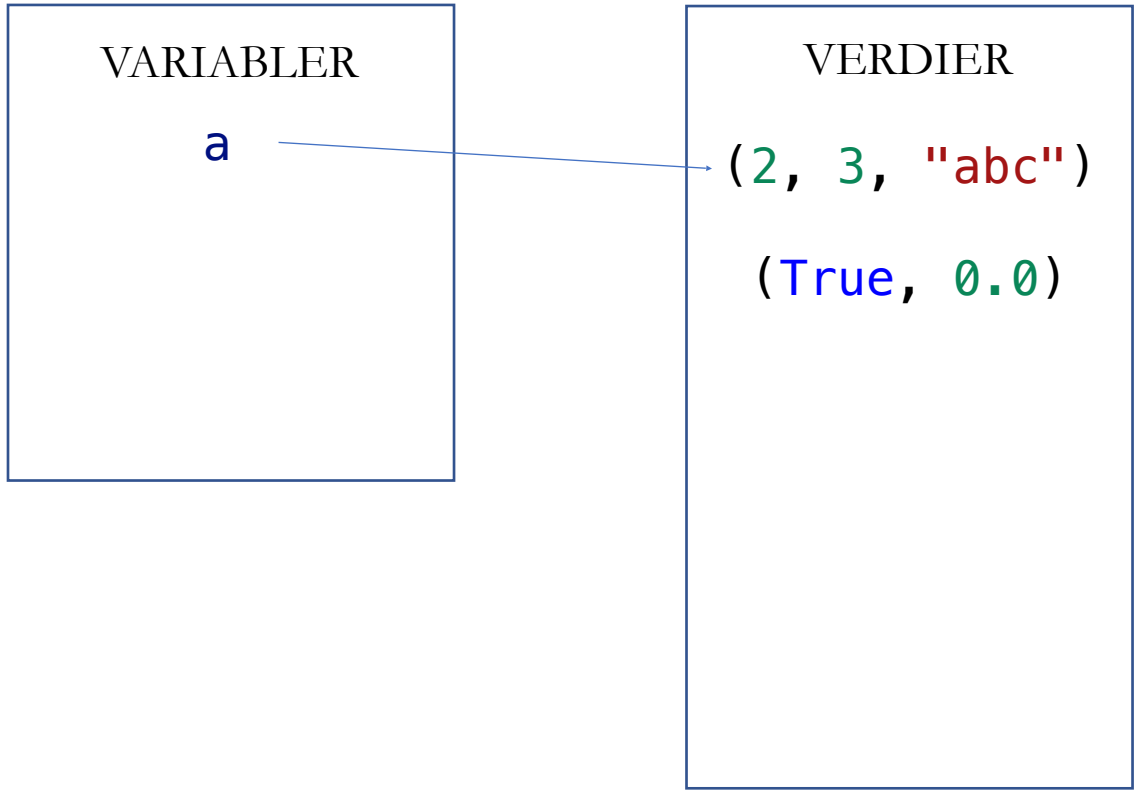
VERDIER

```
(2, 3, "abc")

(True, 0.0)
```

```
a = (2, 3, "abc")
b = (True, 0.0)
a += b
```

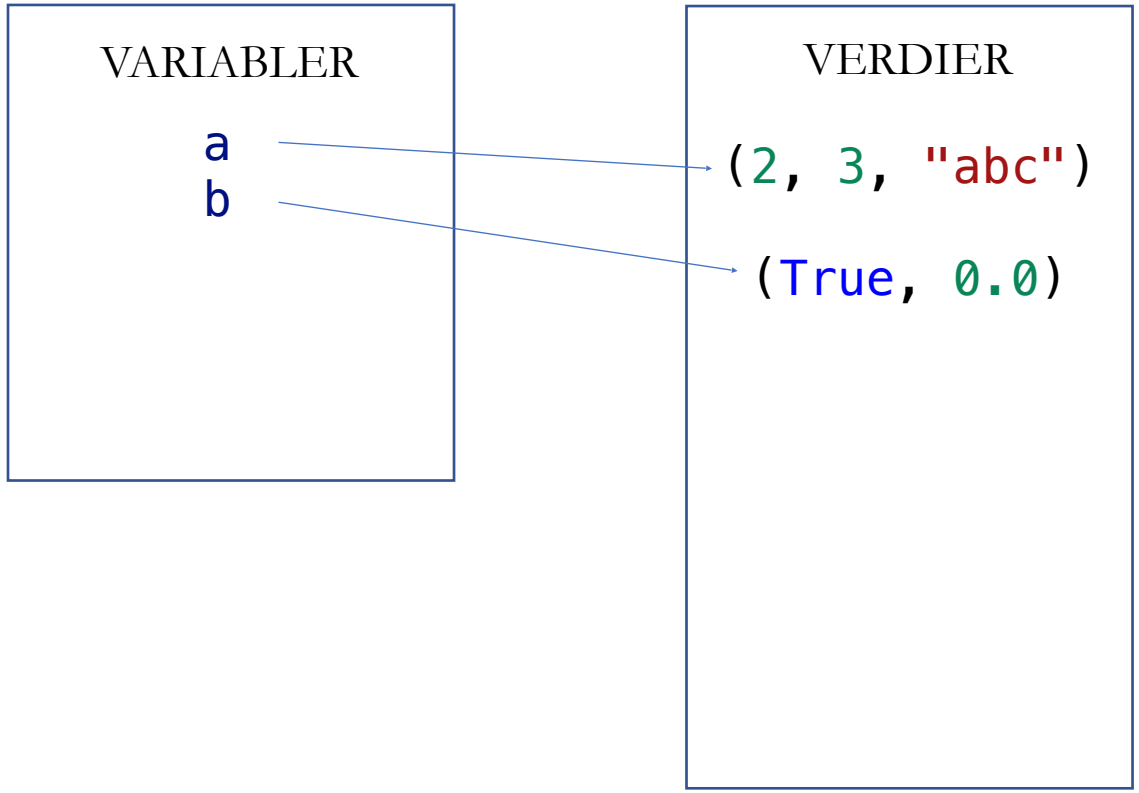
# TUPLE

```
a = (2, 3, "abc")
b = (True, 0.0)
a += b
```



# TUPLE

```
a = (2, 3, "abc")
b = (True, 0.0)
a += b
```



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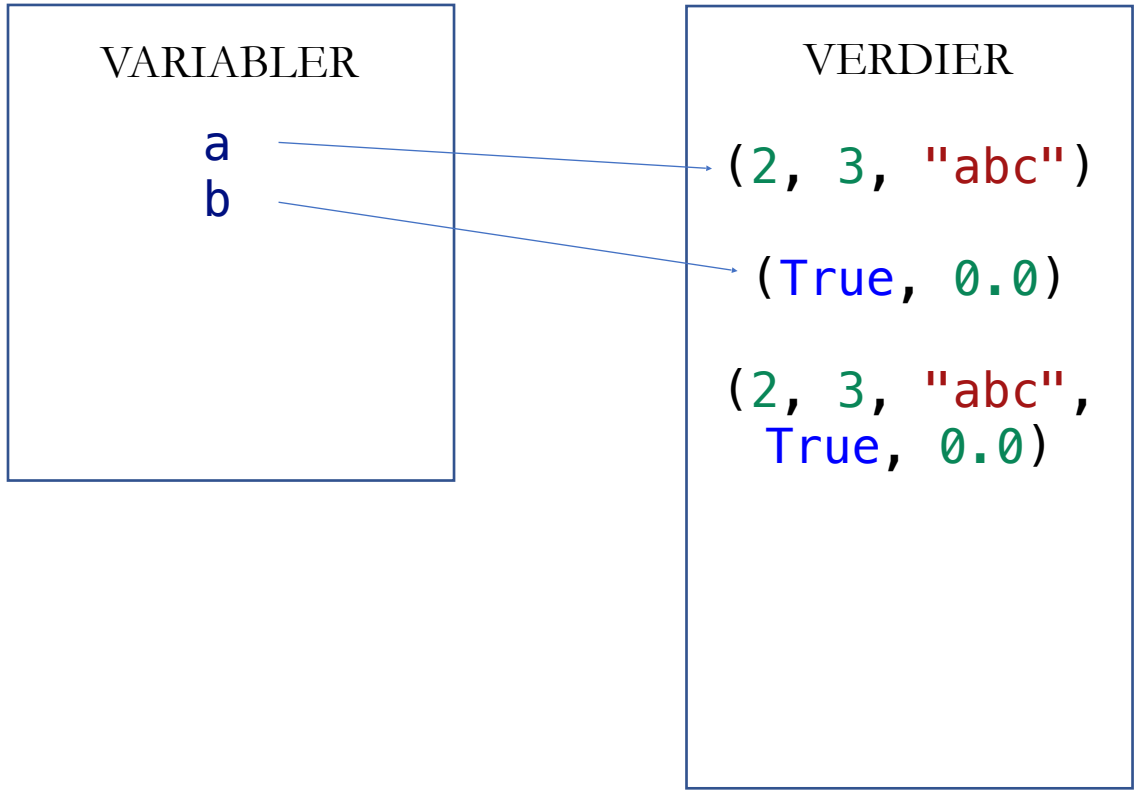
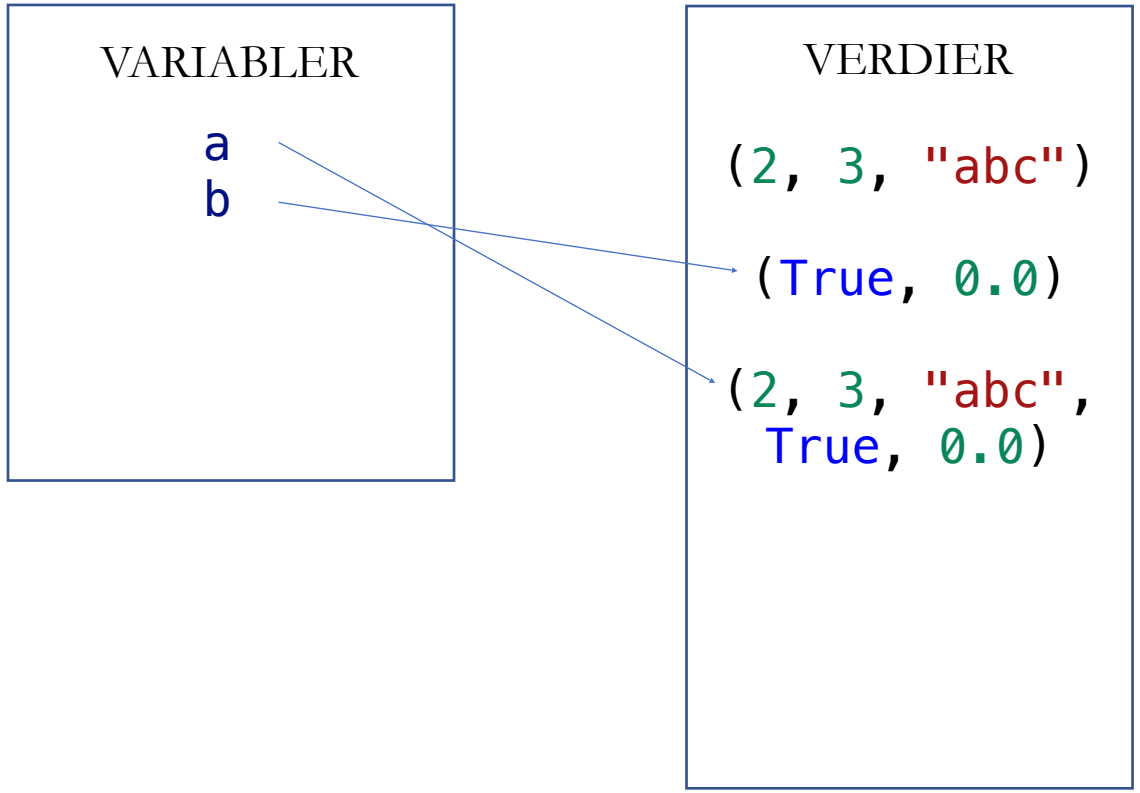
a = (2, 3, "abc")
b = (True, 0.0)
a += b
```



# TUPLE

```
a = (2, 3, "abc")
b = (True, 0.0)
a += b
```



# LISTE

```
a = [2, 3, "abc"]
b = [True, 0.0]
a += b
```

VARIABLER

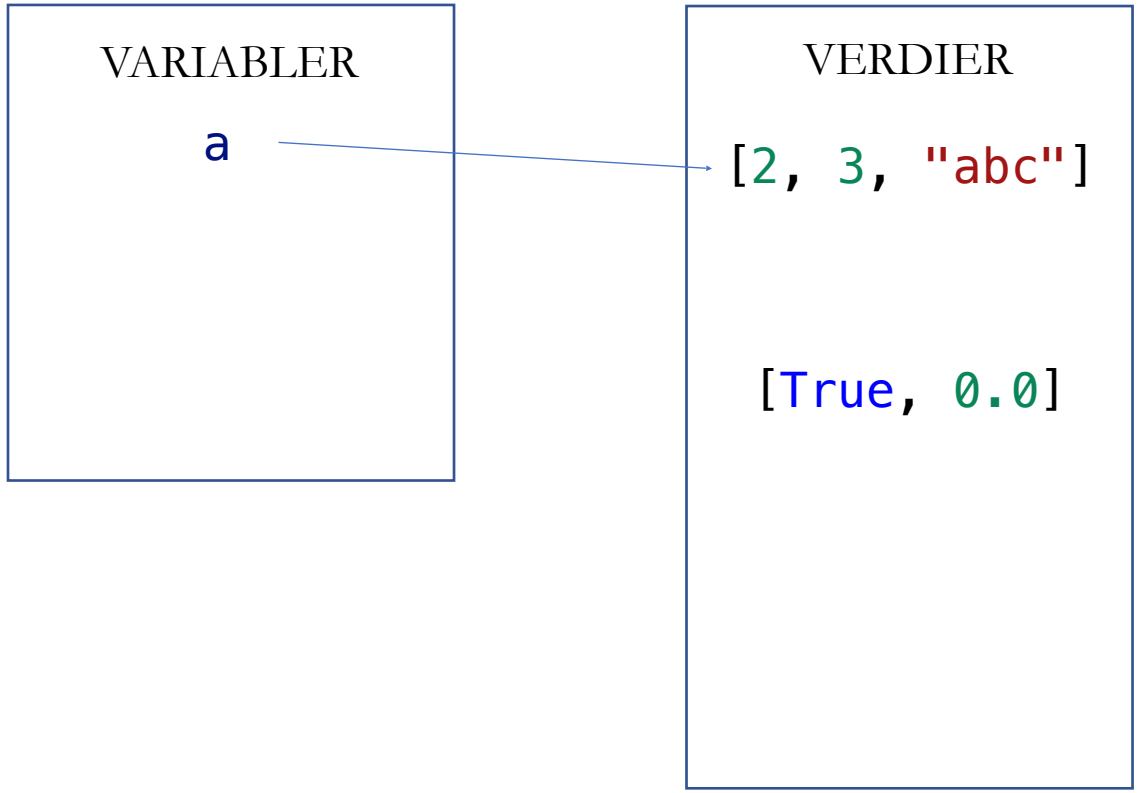
VERDIER

```
[2, 3, "abc"]

[True, 0.0]
```

# LISTE

```
a = [2, 3, "abc"]
b = [True, 0.0]
a += b
```



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a += b
```

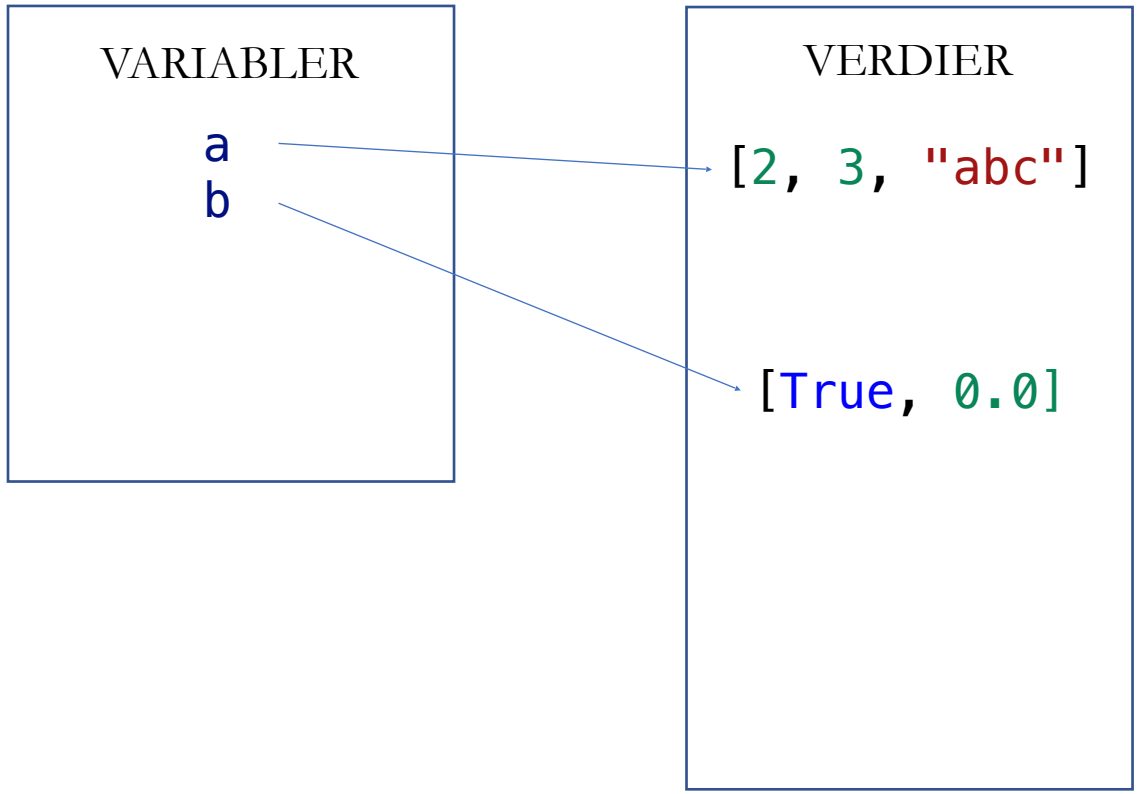

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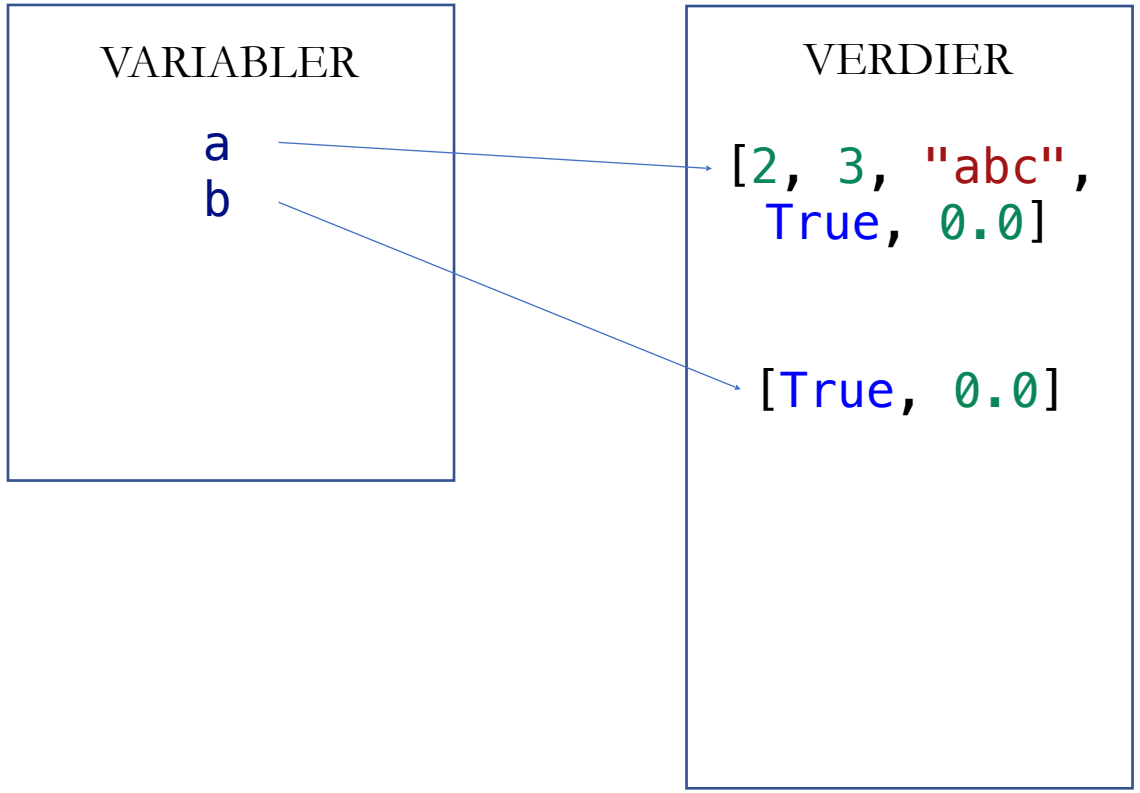

# MUTATIVE OPERASJONER PÅ LISTER

- Operasjoner som *muterer*

```
a = [1, 2, 3]

a[i] = 42
a += [4, 5]
a *= 2
```

- Operasjoner som oppretter ny verdi

```
a = [1, 2, 3]

a = a[:i] + [42] + a[i+1:]
a = a + [4, 5]
a = a * 2
```

# DESTRUKTIVE FUNKSJONER

- En destruktiv funksjon har en sideeffekt: den muterer en ekstern verdi
- En ikke-destruktiv funksjon muterer ingen eksterne verdier

- Destruktive funksjoner trenger ikke returverdi
- Ikke-destruktive funksjoner benytter returverdi

# FUNKSJONER PÅ LISTER

| Hva? | Destruktiv funksjon | Ikke-destruktivt alternativ |
|---|---|---|
| Legge til en ny verdi på slutten av listen | `a.append(42)` | `a = a + [42]` |
| Utvid listen med flere nye elementer på en gang | `a.extend([3, 4])` | `a = a + [3, 4]` |
| Putte inn en verdi på gitt posisjon | `a.insert(3, "foo")` | `a = a[:3] + ["foo"] + a[3:]` |
| Fjerne første forekomst av gitt verdi | `a.remove(2)` | `i = a.index(2)`<br>`a = a[:i] + a[i + 1:]` |
| Fjerne element på en gitt posisjon | `a.pop(5)` | `a = a[:5] + a[5 + 1:]` |
| Fjerne alle elementer | `a.clear()` | `a = []` |
| Reverser | `a.reverse()` | `a = a[::-1]` |
| Sorter | `a.sort()` | `a = sorted(a)` |

# FUNKSJONER PÅ LISTER

| Hva? | Destruktiv funksjon | Ikke-destruktivt alternativ |
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| Reverser | `a.reverse()` | `a = a[::-1]` |
| Sorter | `a.sort()` | `a = sorted(a)` |

```
def foo(a):
    ........

x = [1,2,3]
foo(x)
```

```
def foo(a):
    a = .......
    return a

x = [1,2,3]
y = foo(x)
```

# ALIAS

+ mutasjon

```python
a = [2, 3, 4]

# Oppretter et alias
b = a

# Mutasjon av listen
a[0] = 99
b[1] = 42
print(a)
print(b)
```

VARIABLER

UTSKRIFT

VERDIER

[2, 3, 4]

# ALIAS

+ mutasjon

```
a = [2, 3, 4]

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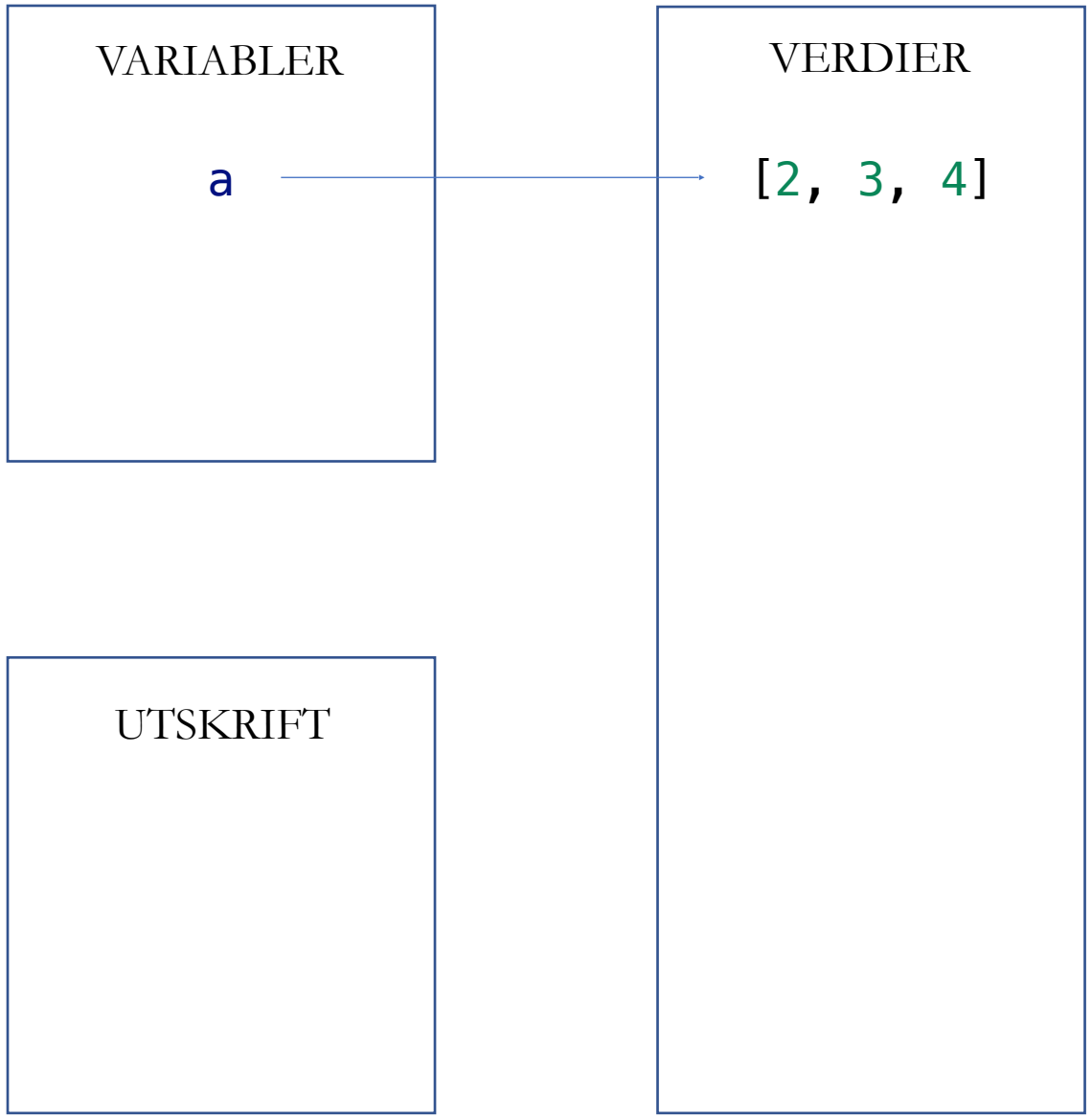

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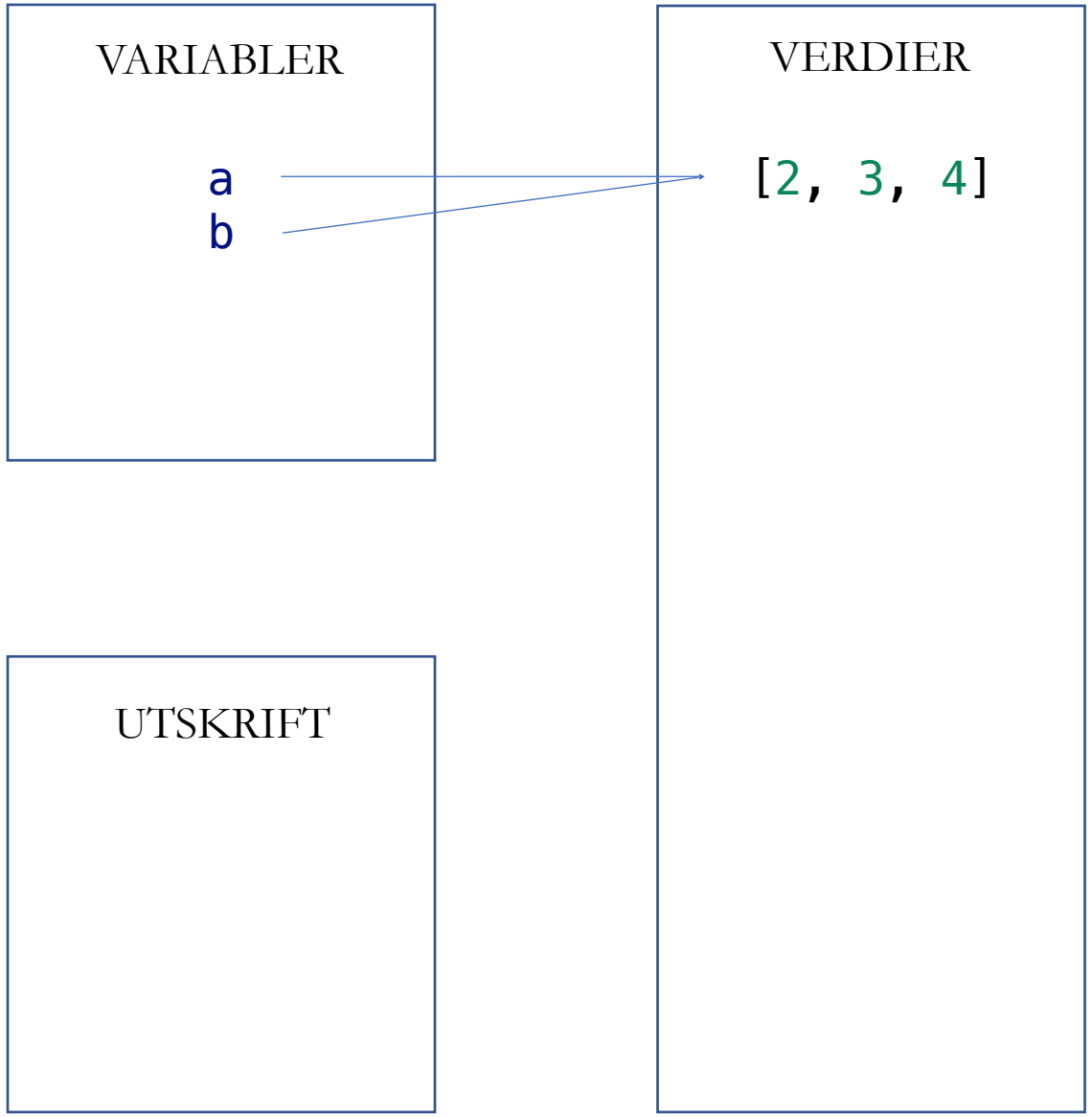

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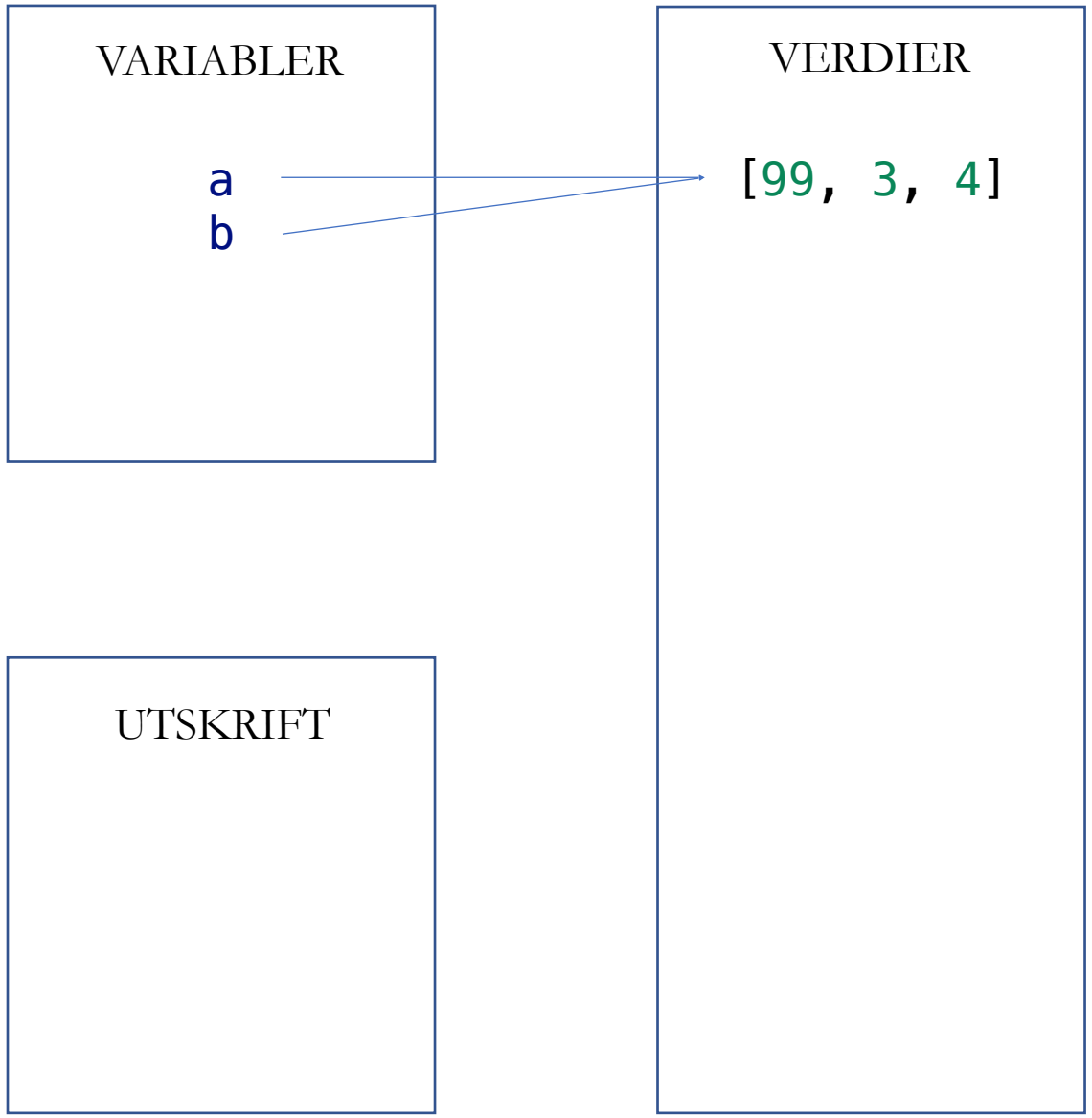

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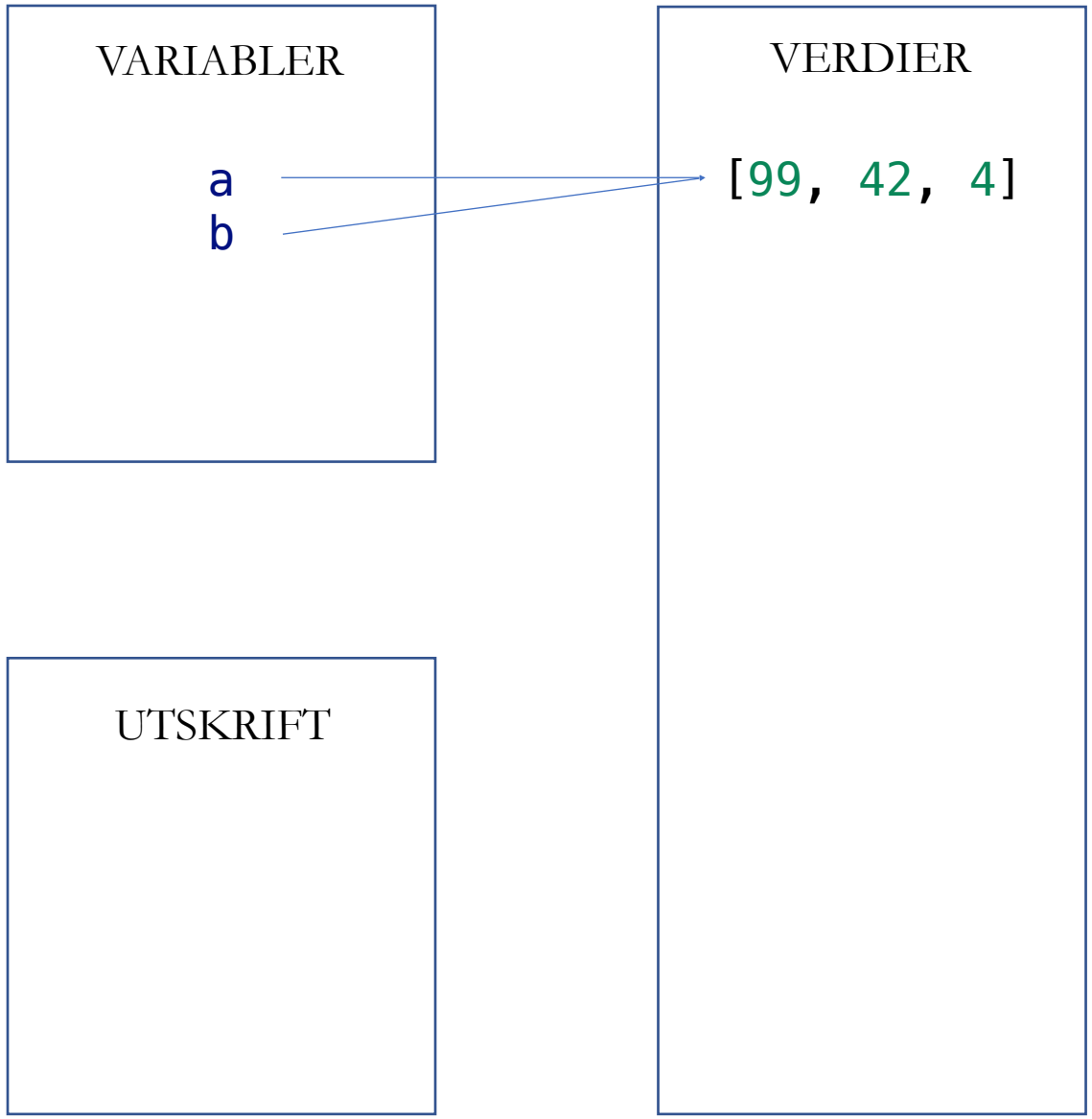

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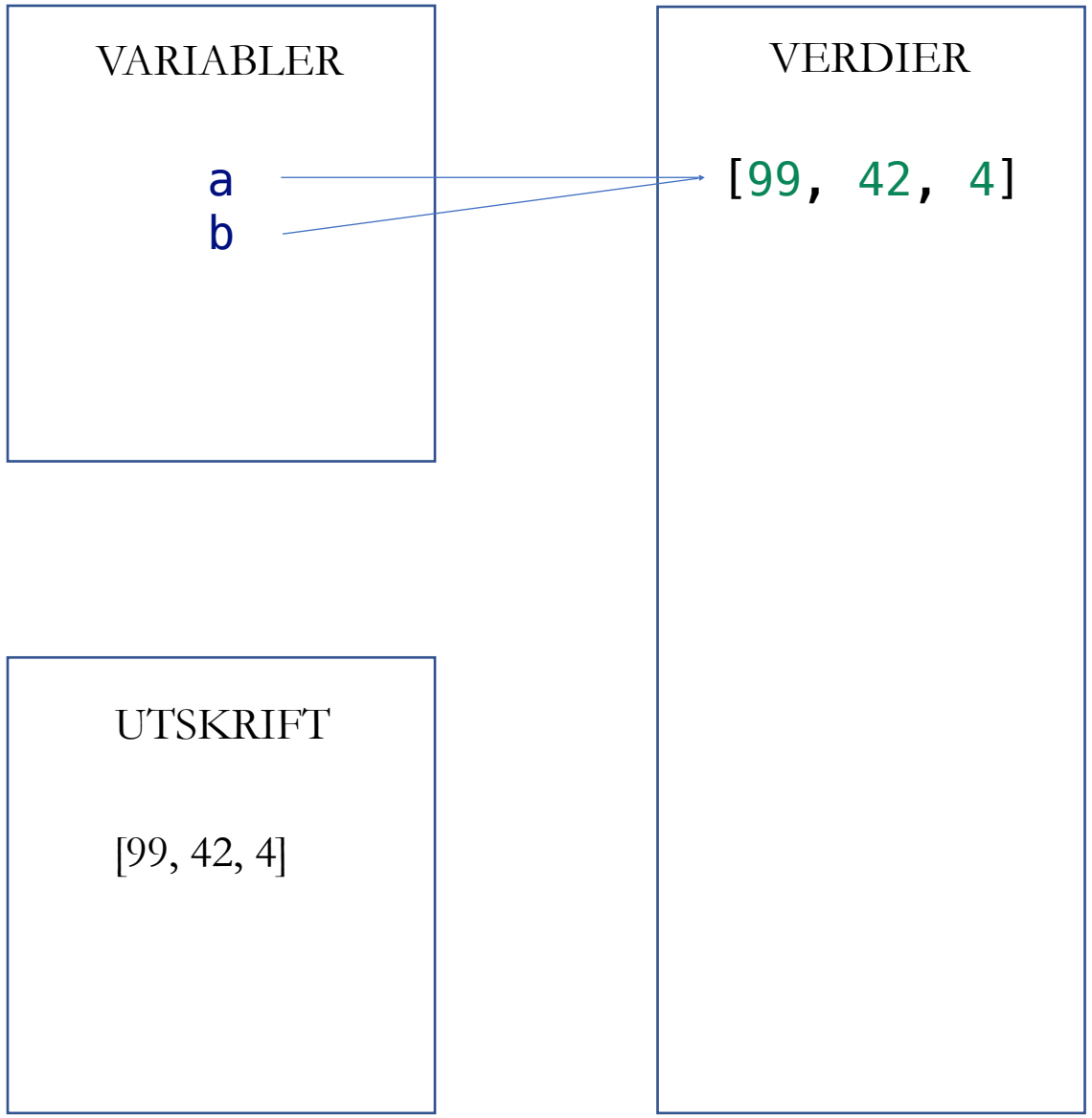

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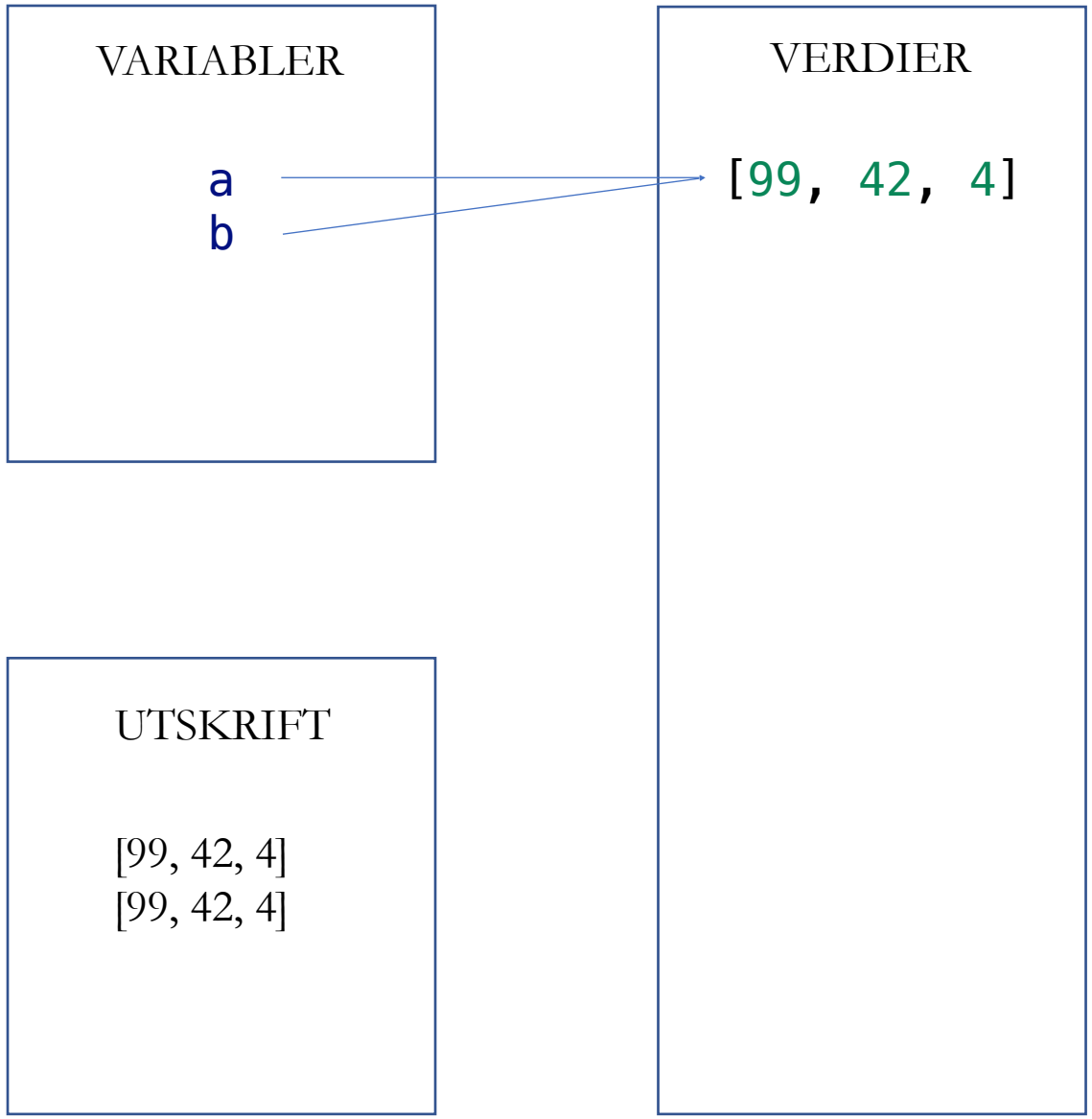

# ALIAS

+ ikke-destruktive endringer

```
a = [2, 3, 4]

# Oppretter et alias
b = a

# Ikke-destruktiv endring
a = [99] + a[1:]
b = b[:1] + [42] + b[2:]
print(a)
print(b)
```

VARIABLER

UTSKRIFT

VERDIER

```
[2, 3, 4]
```

# ALIAS

+ ikke-destruktive endringer

```
a = [2, 3, 4]

# Oppretter et alias
b = a

# Ikke-destruktiv endring
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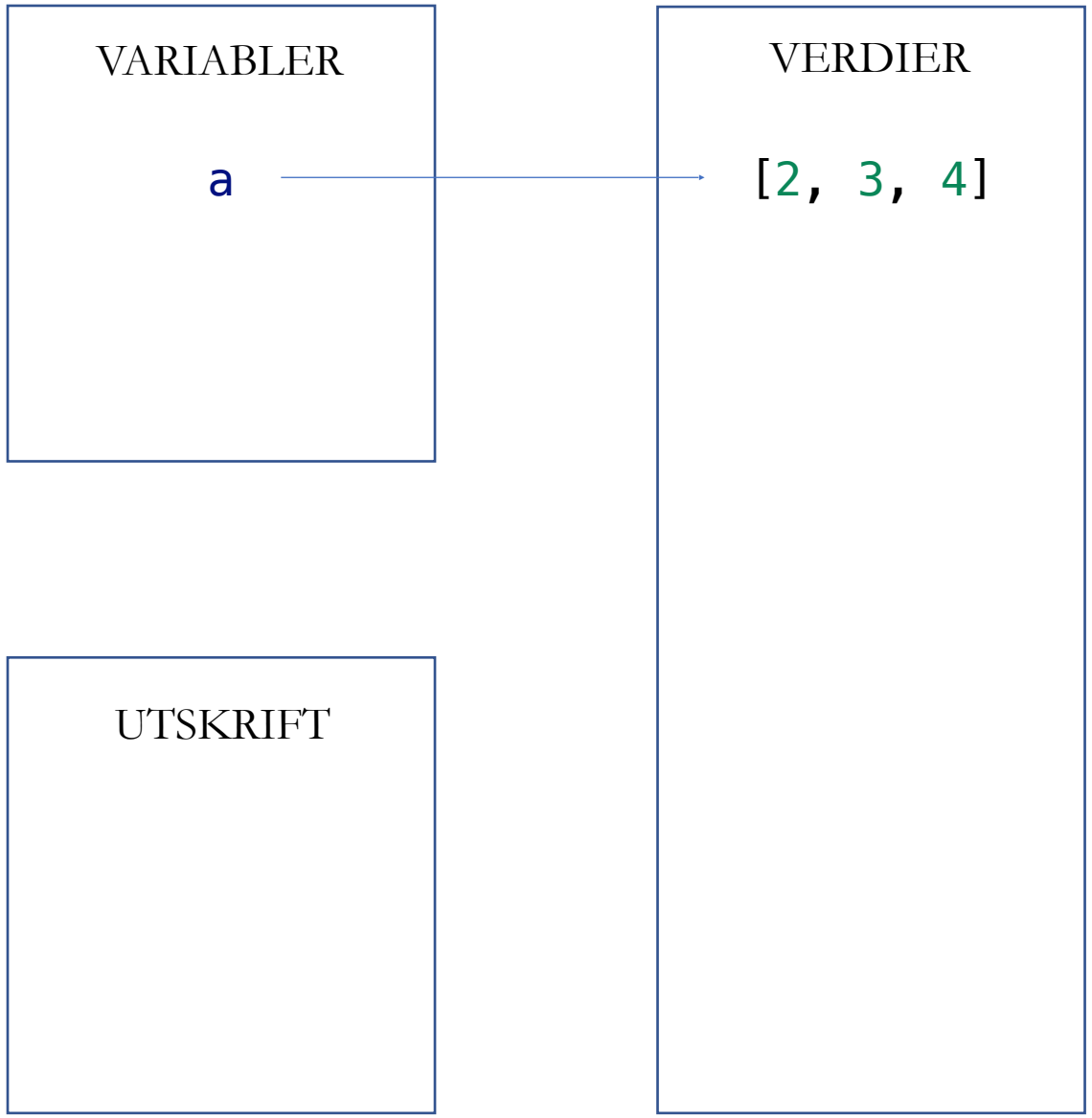

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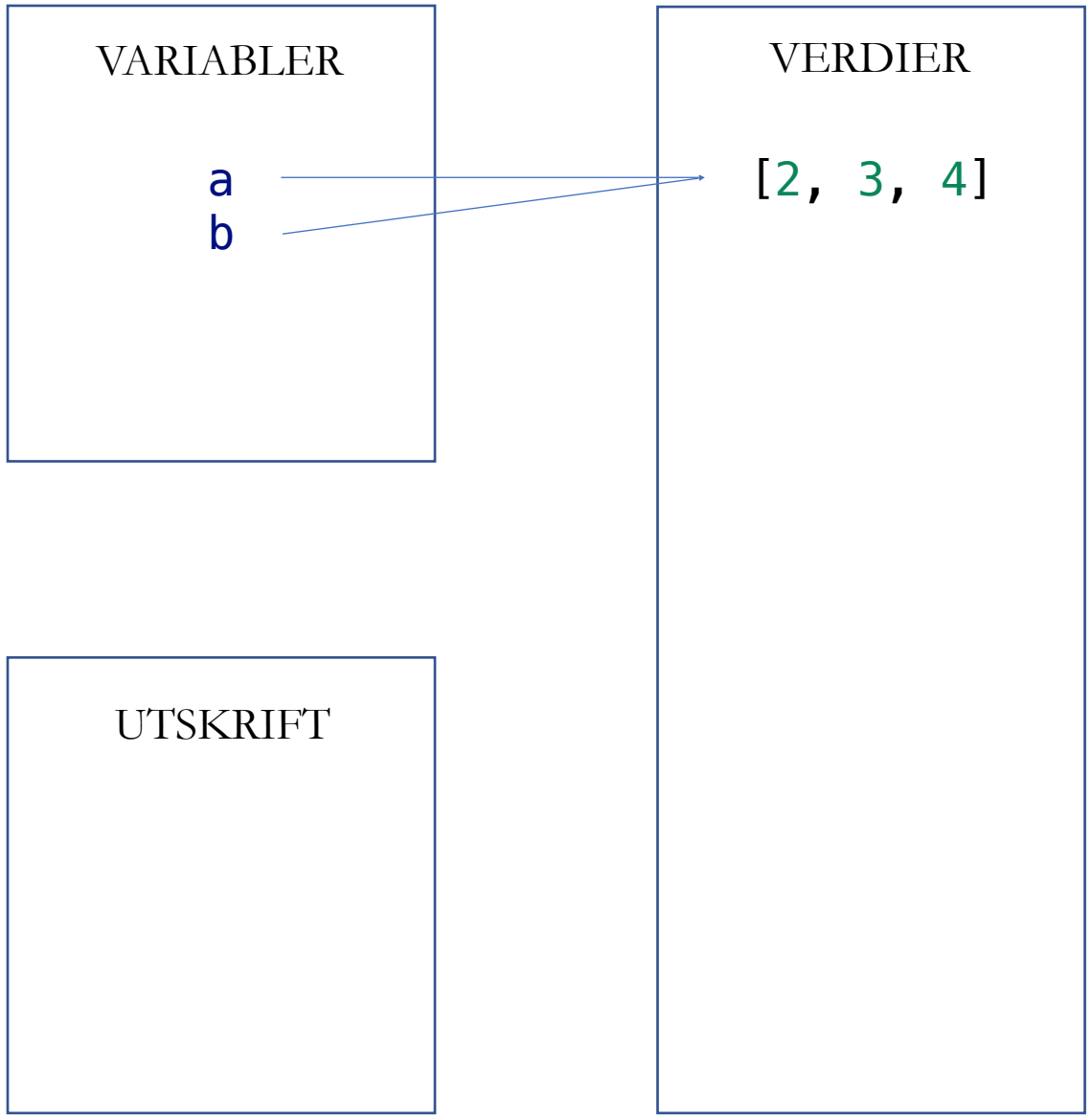
```



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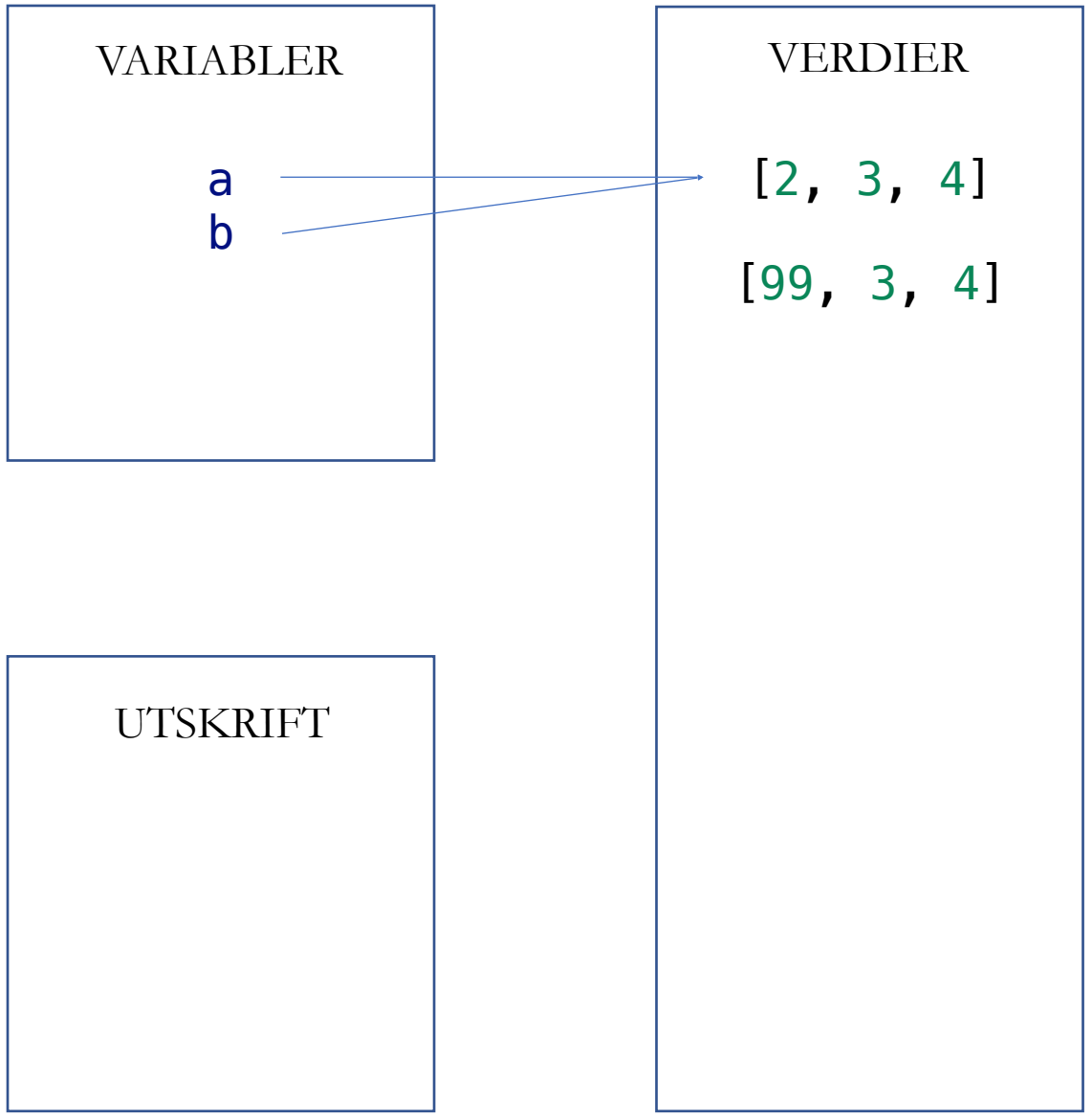

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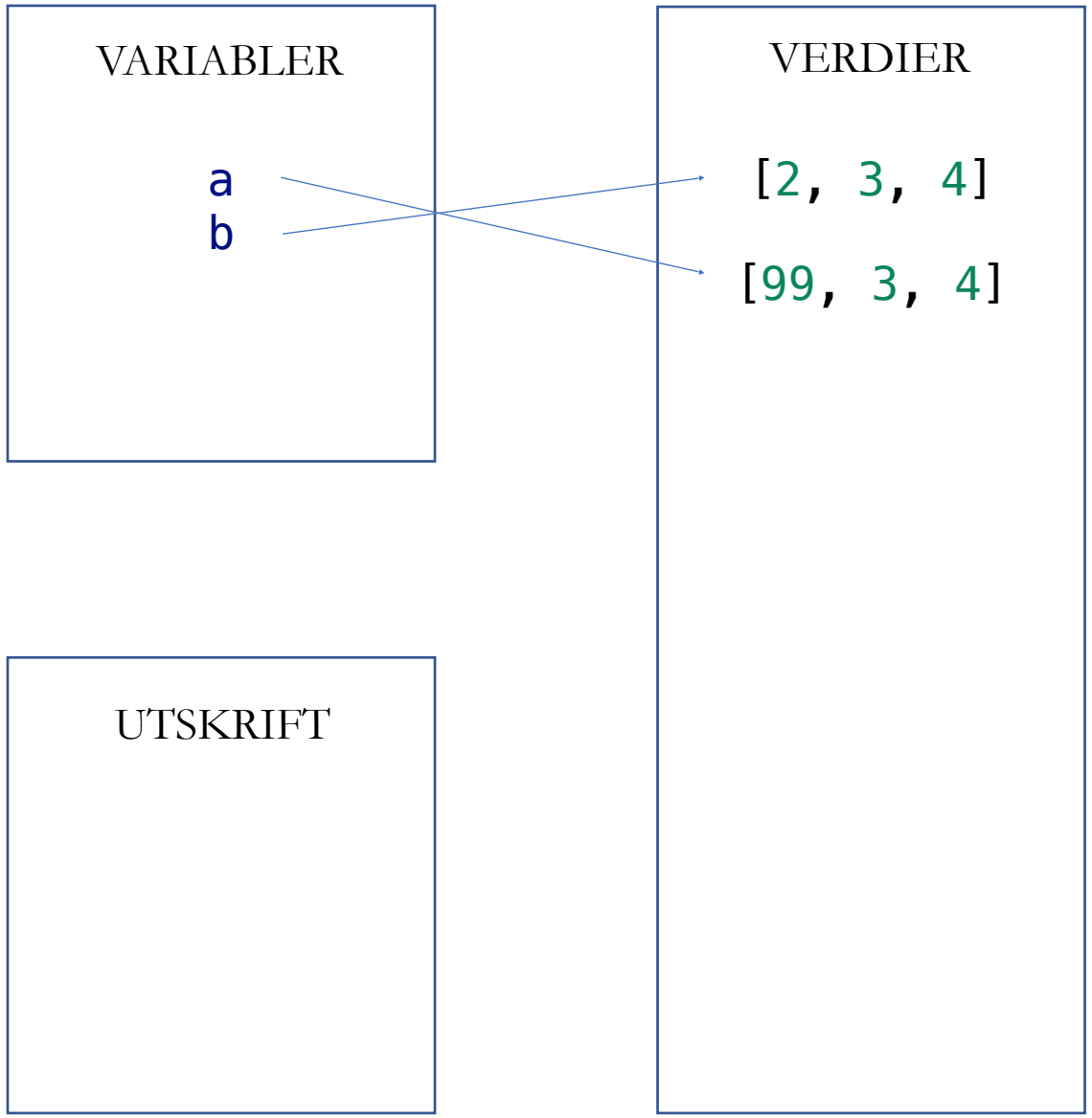

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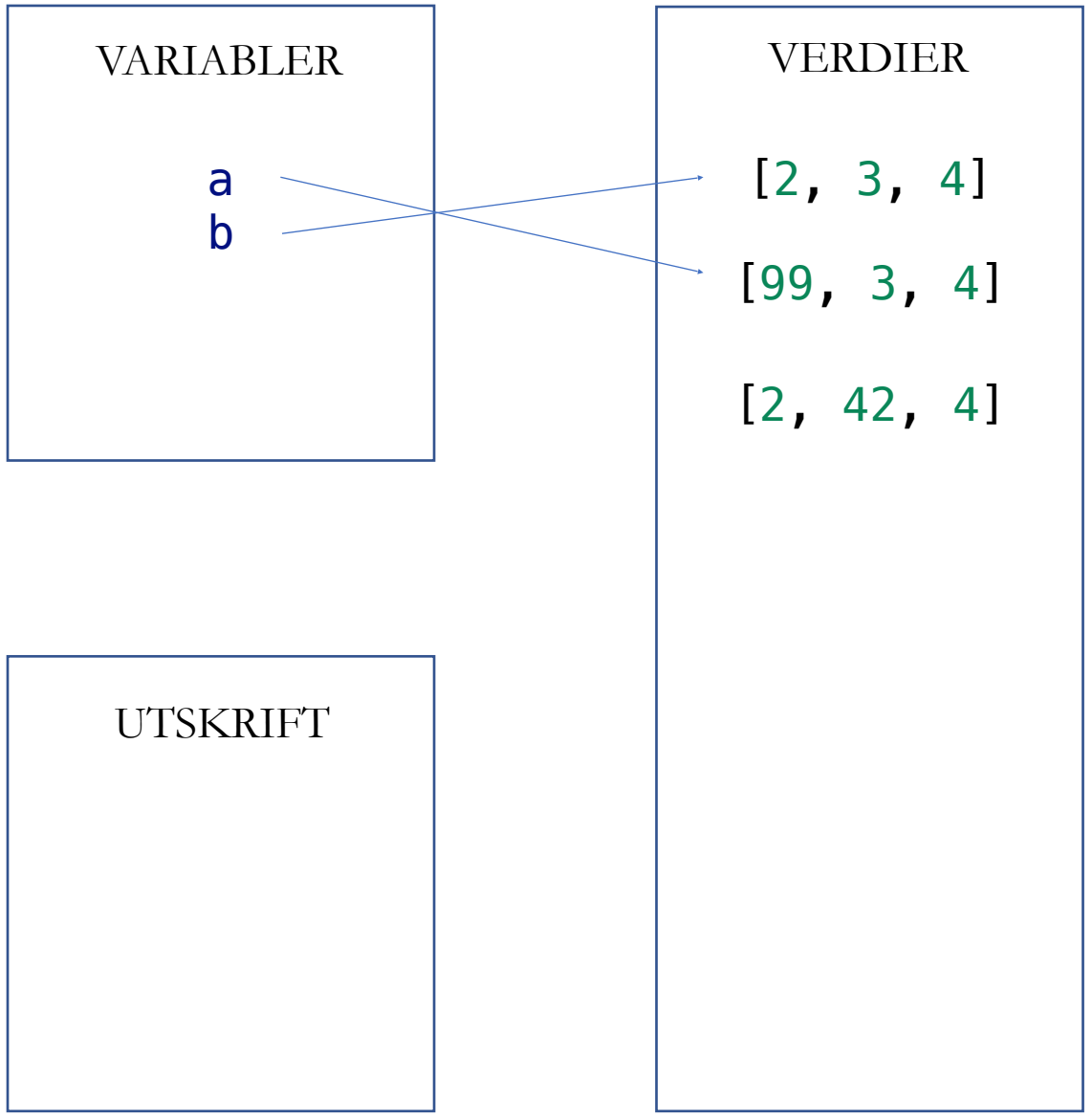

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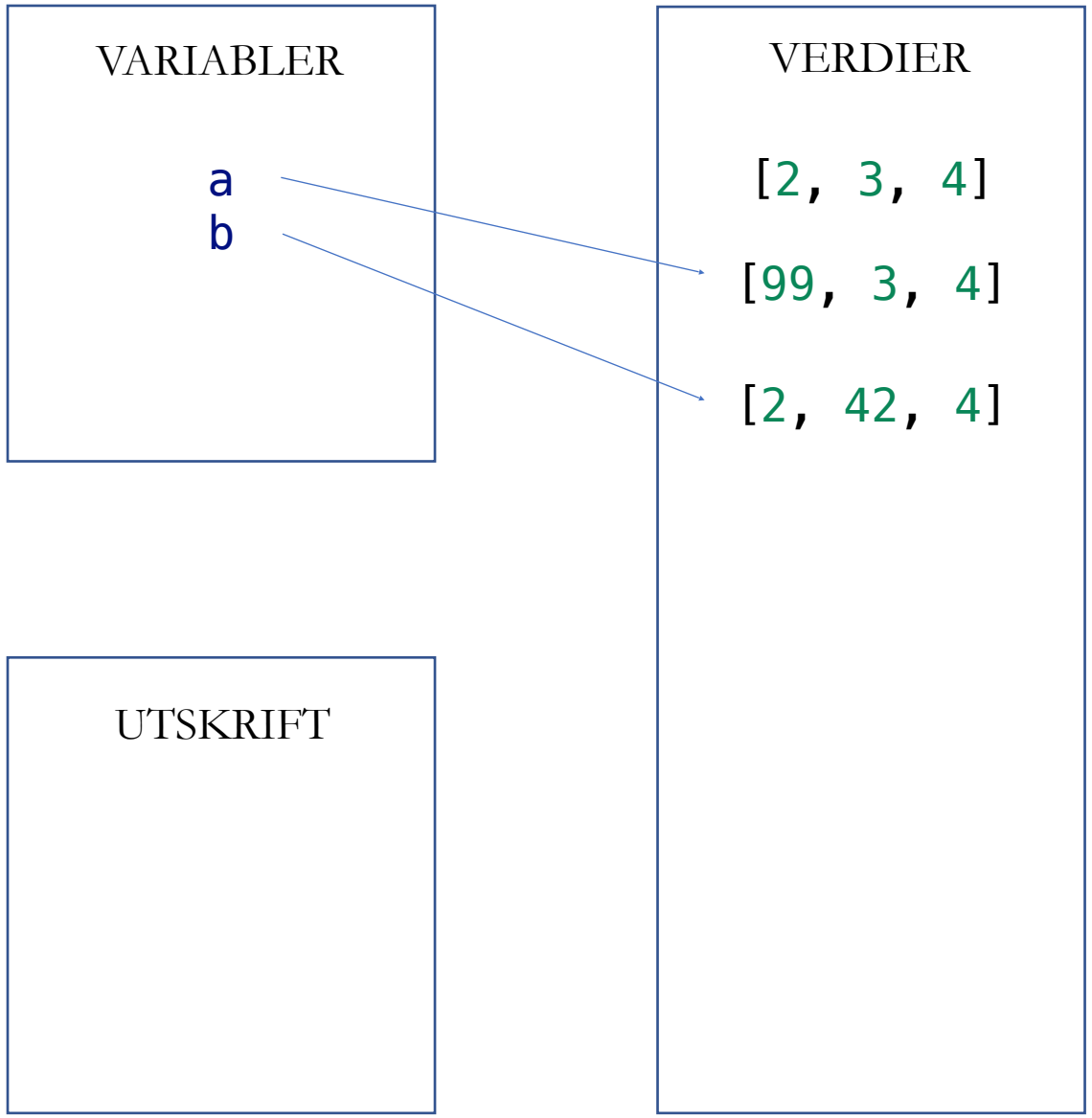

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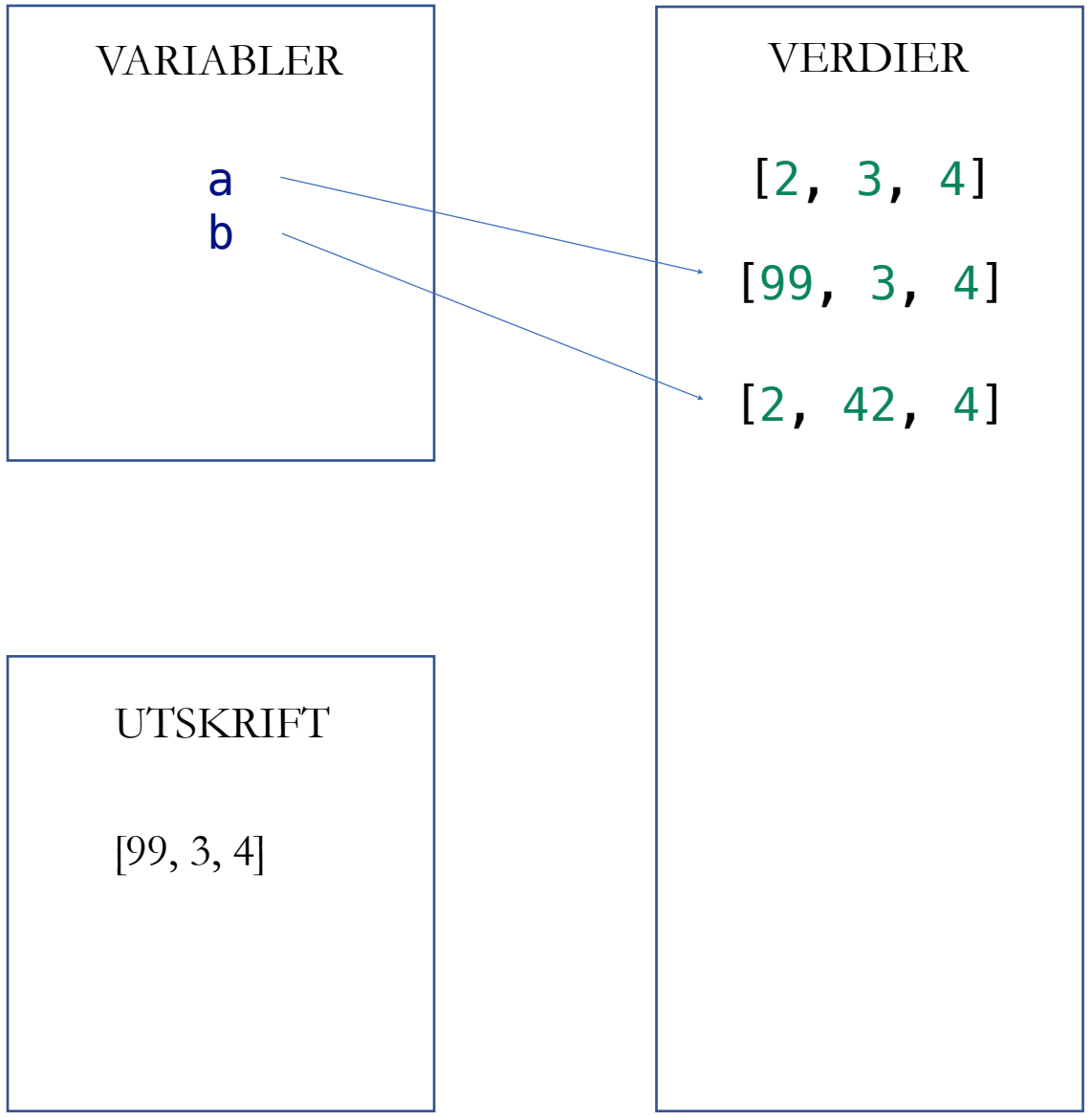

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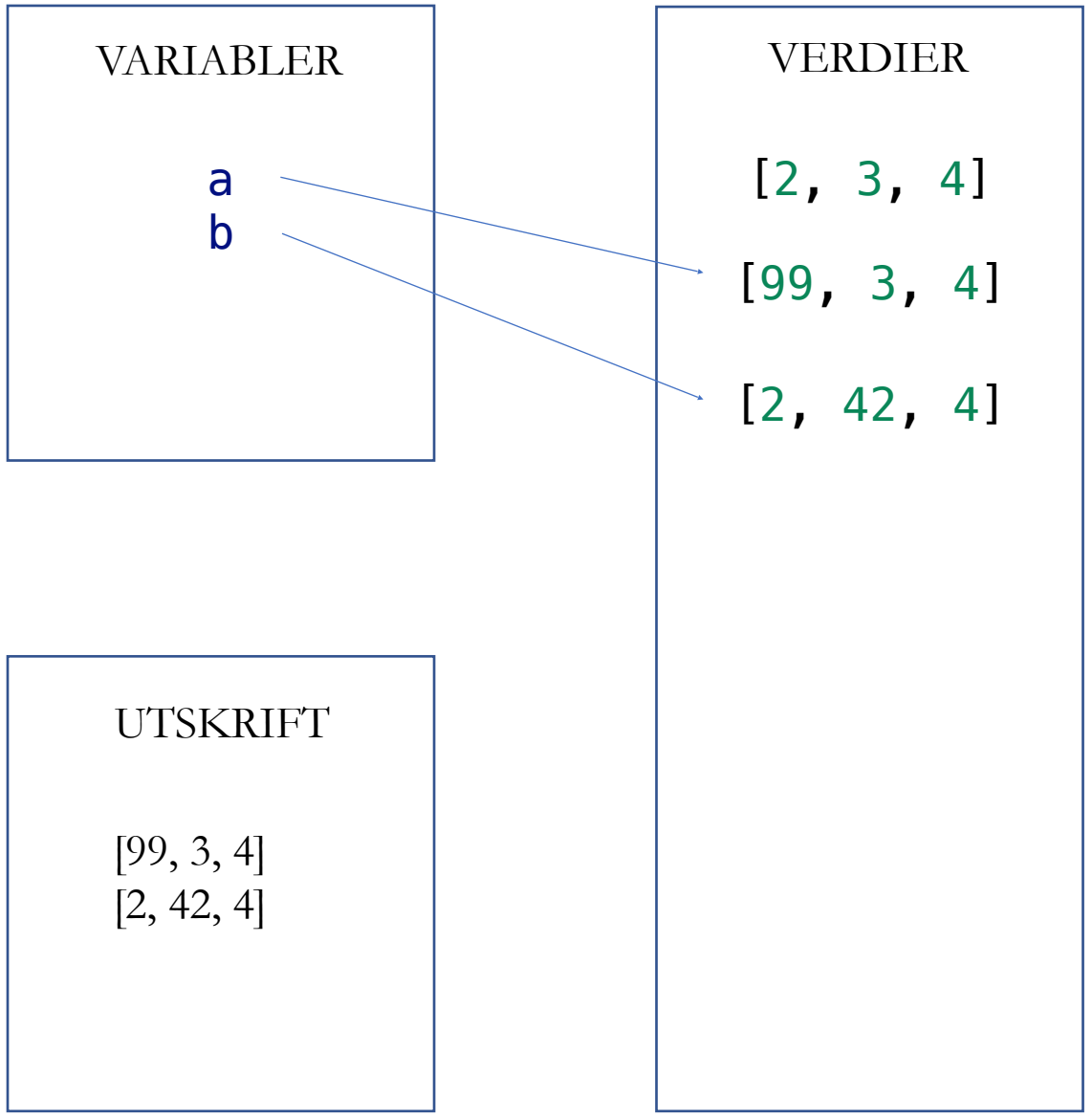

# ALIAS

+ destruktiv funksjon

```
def foo(bar):
    bar[2] = 42

a = ["p", "q", "r", "s"]
foo(a)
print(a)
```

VARIABLER

UTSKRIFT

VERDIER

["p", "q", "r", "s"]

# ALIAS

+ destruktiv funksjon

```
def foo(bar):
    bar[2] = 42

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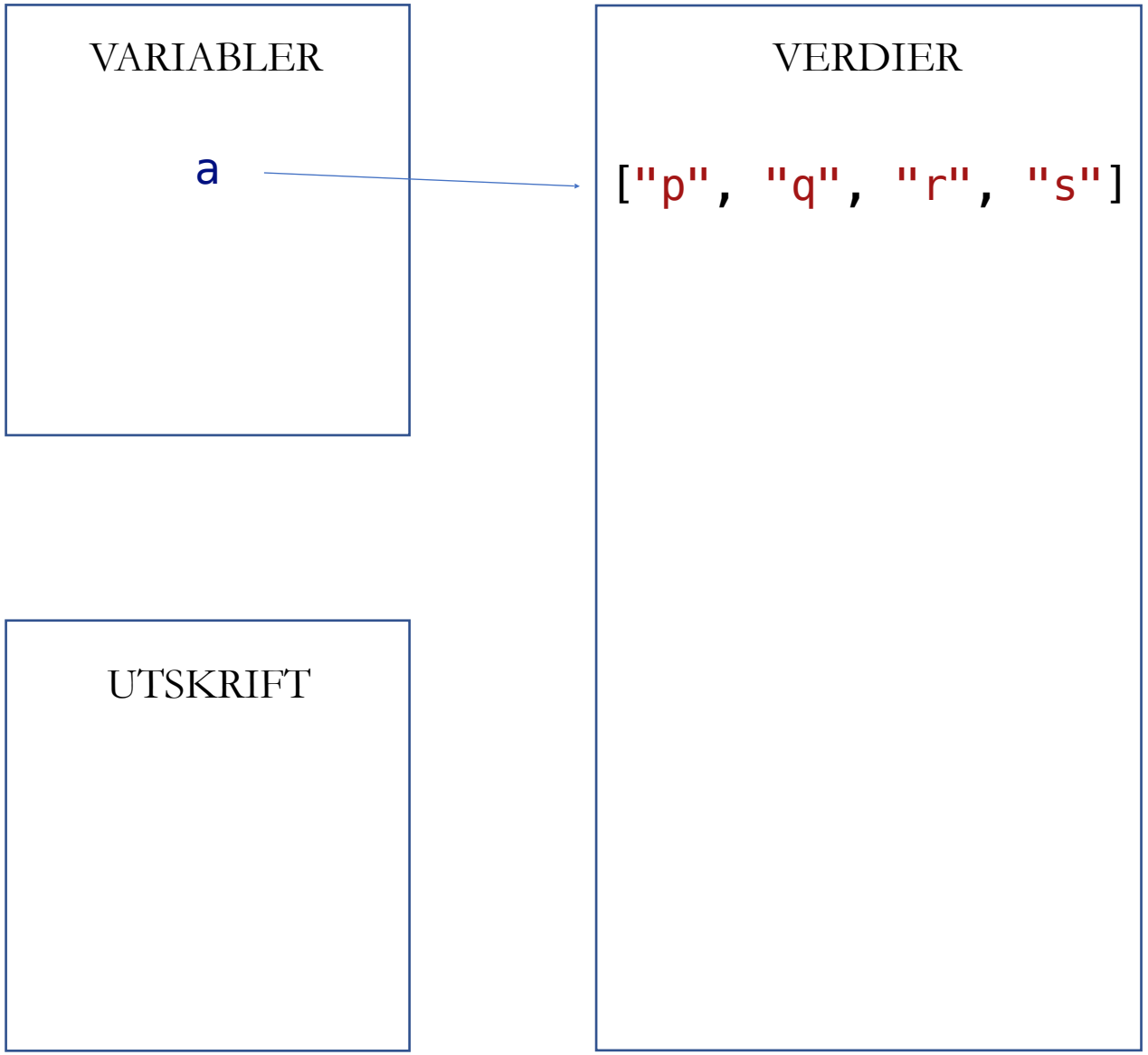

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+ destruktiv funksjon

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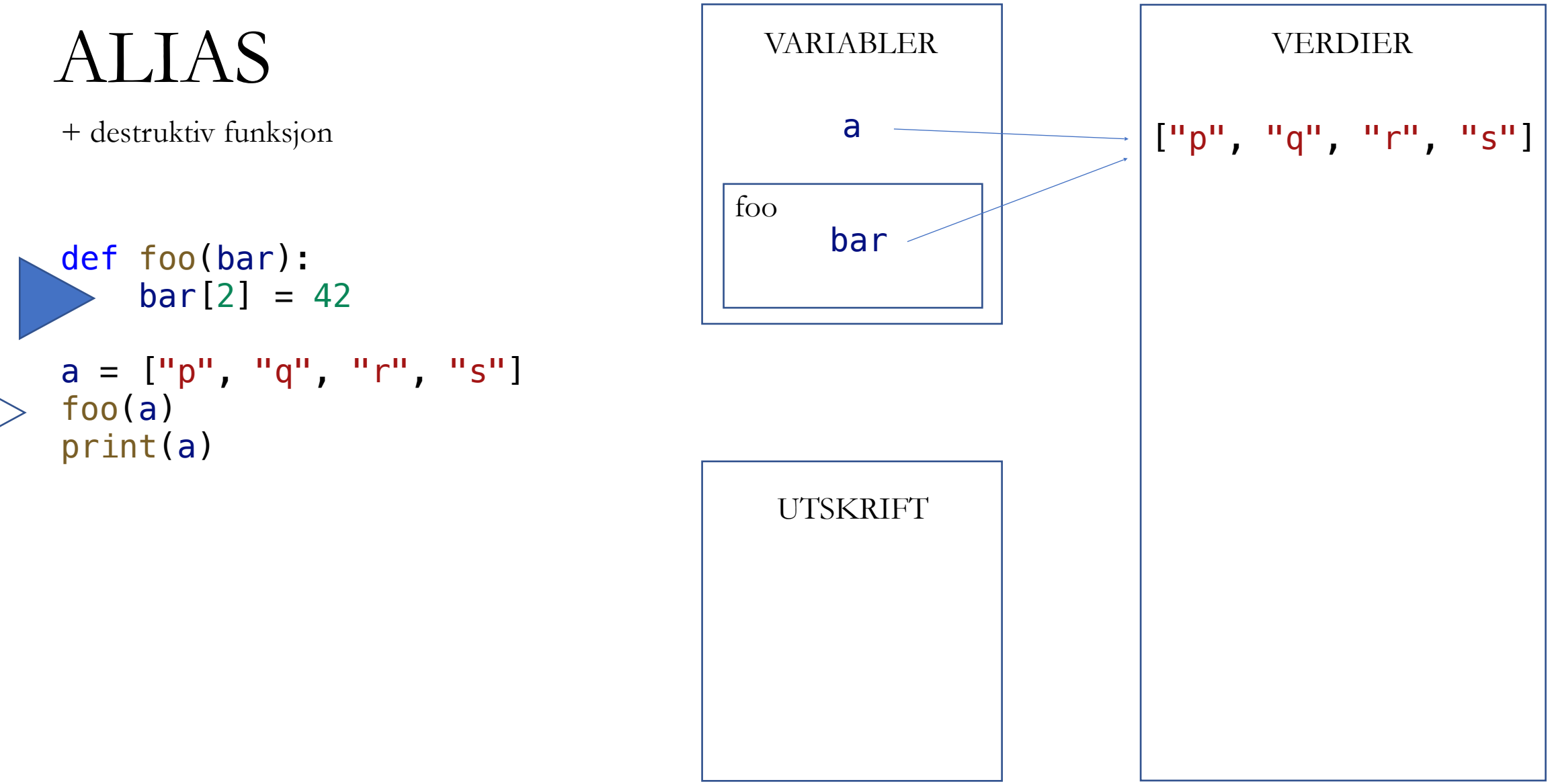

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a = ["p", "q", "r", "s"]
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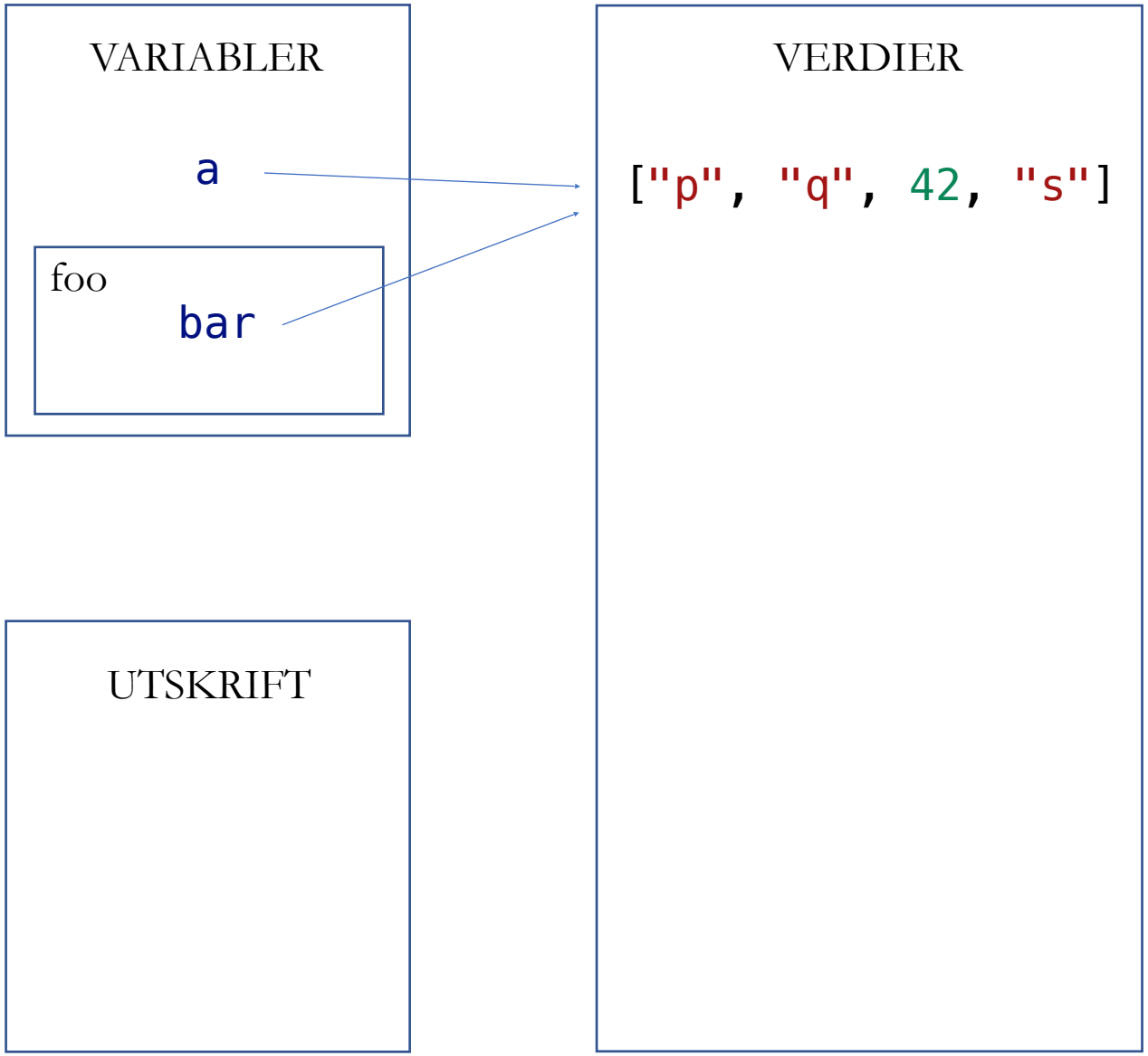

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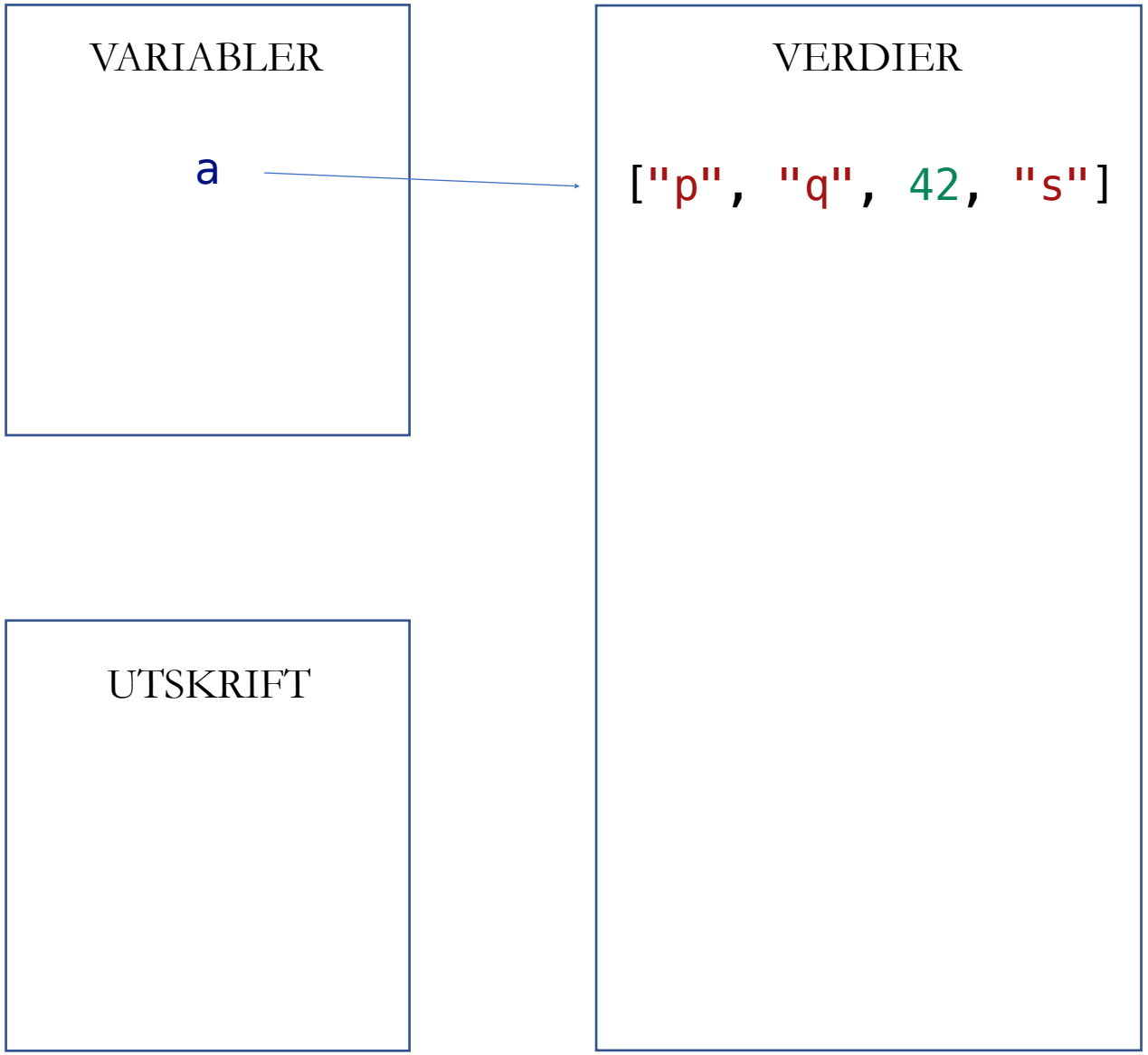

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+ destruktiv funksjon

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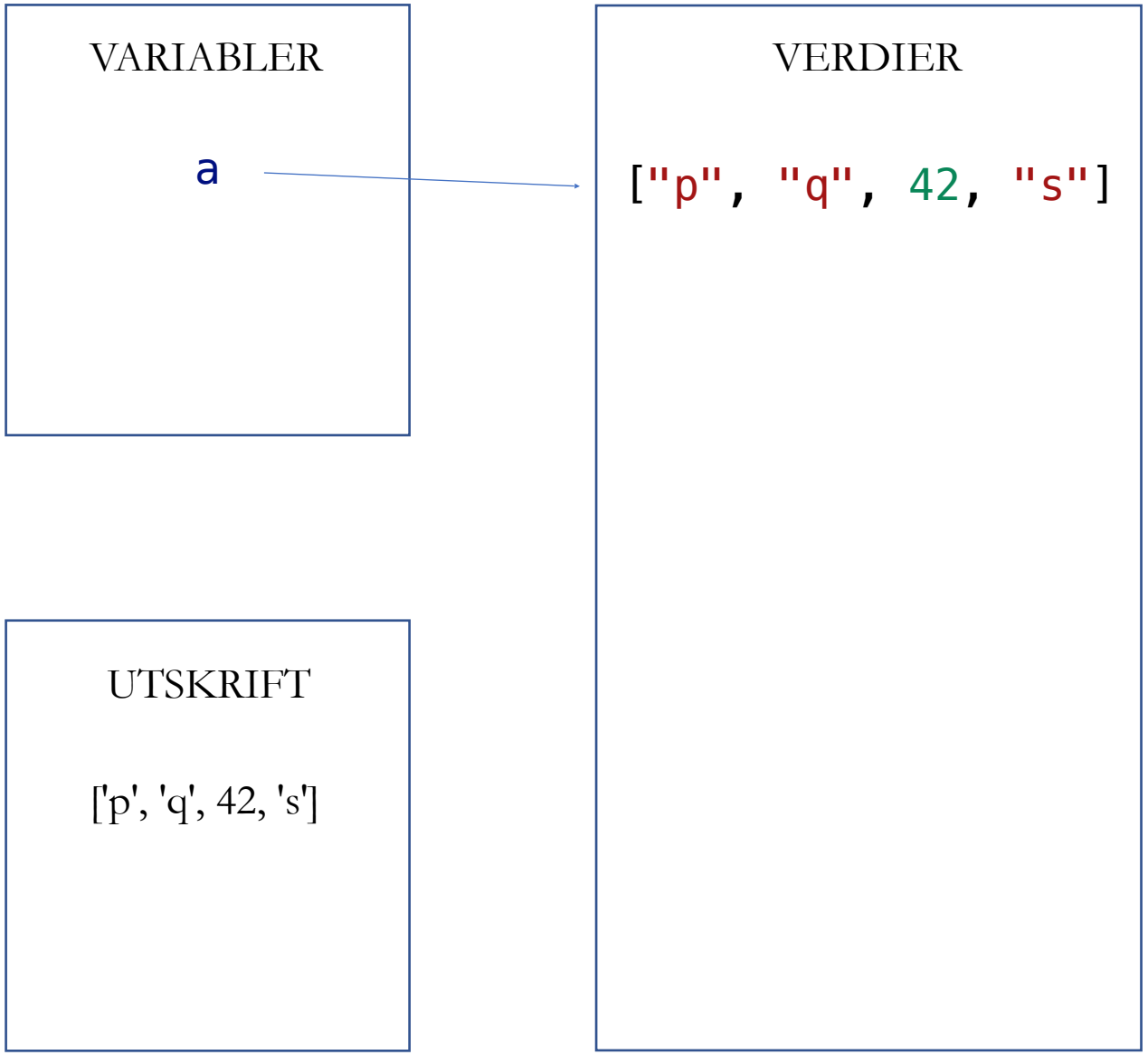
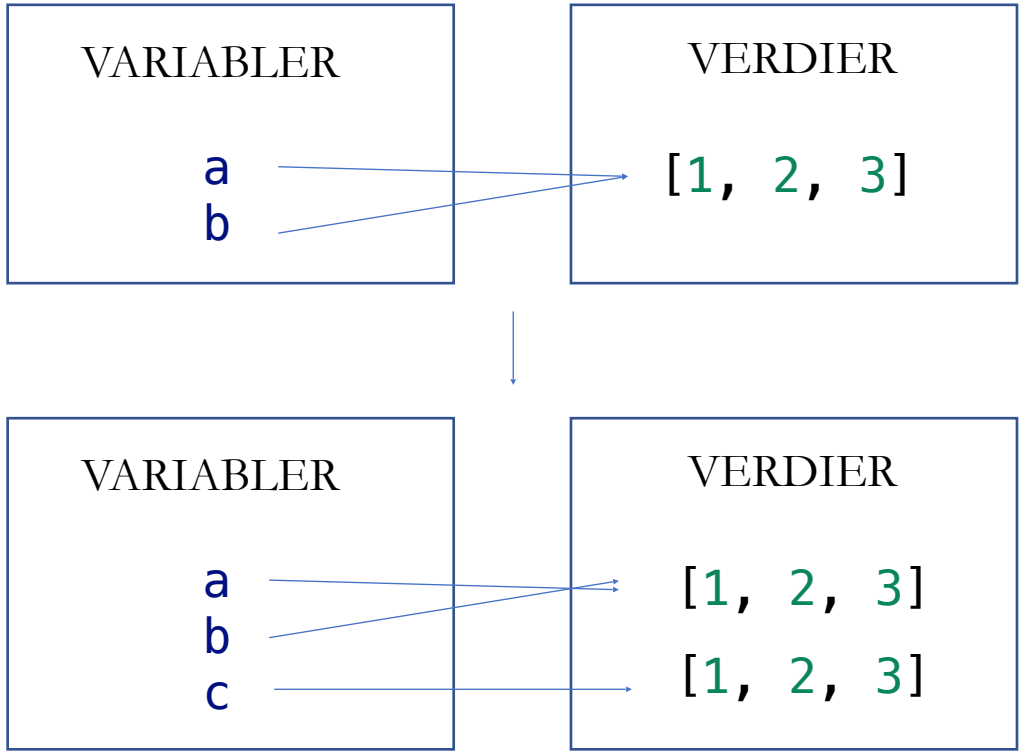
print(a)
```



# KOPIERING

- Vi kan bryte et alias ved å lage en kopi

```
a = [1, 2, 3]
b = a
c = a.copy()
```




- Destruktive operasjoner på kopien påvirker ikke originalen
- Bruker mer tid og minne