

# **Building a JIT compiler for CPython**

**Brandt Bucher (May 17th, 2025)**

# **Building a JIT compiler for CPython**

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**What they \* tell you about**

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# What they **don't** tell you about

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# What they **don't** tell you about building a JIT compiler for CPython

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# Brandt Bucher

- 8 years using Python.
- 6 years contributing to CPython.
- 4 years on Microsoft's CPython Performance Engineering Team.
- 2 years working on CPython's experimental new JIT compiler.

# Brandt Bucher

- 4 years on Microsoft's CPython Performance Engineering Team.



# CPython Performance Engineering Team

# Faster CPython

# Faster CPython

## Results

# Faster CPython

## Results (so far...)

- Python 3.11: 25% faster
- Python 3.12: 4% faster
- Python 3.13: 7% faster
- Python 3.14: 8% faster

# Faster CPython

## Results (so far...)

- In less than 4 years, Python has gotten about 50% faster:
  - 93% of benchmarks have improved.
  - 46% of benchmarks are *over 50%* faster.
  - 20% of benchmarks are *over 100%* faster.

# Faster CPython

## Results (so far...)

- In less than 4 years, Python has gotten about 50% faster:
  - 93% of benchmarks have improved.
  - 46% of benchmarks are *over 50%* faster.
  - 20% of benchmarks are *over 100%* faster... including Pylint!

# Faster CPython

## Results (so far...)

- In less than 4 years, Python has gotten about 50% faster:
  - 93% of benchmarks have improved.
  - 46% of benchmarks are *over 50%* faster.
  - 20% of benchmarks are *over 100%* faster... including Pylint!
  - All without a JIT compiler!

# Faster CPython

## Results (so far...)

- This is what happens when companies fund Python core development!
- 🥹



# Faster CPython

## Background

- This is what happens when companies fund Python core development!
- 🥲

# Background

## Duck Typing

# Background

## Duck Typing

```
simulate_ducks (ducks )
```

# Background

## Duck Typing

```
def simulate_ducks(ducks):
```

# Background

## Duck Typing

```
def simulate_ducks(ducks):  
    for duck in ducks:
```

# Background

## Duck Typing

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()
```

# Background

## Duck Typing

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        print(sound)
```

# Background

## Duck Typing

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
    print(sound)
```



# Background

## Duck Typing

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
    print(sound)
```

```
class Duck:  
    echo = False  
  
    def quack(self):  
        return "Quack!"
```

# Background

## Duck Typing

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
    print(sound)
```

```
class RubberDuck:  
    echo = True  
  
    def quack(self):  
        return "Squeak!"
```

# Background

## Duck Typing

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
    print(sound)
```

```
class RubberDuck:  
    echo = True  
  
    def __init__(self, loud):  
        self.loud = loud  
  
    def quack(self):  
        return "Squeak!"
```

# Background

## Duck Typing

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
    print(sound)
```

```
class RubberDuck:  
    echo = True  
  
    def __init__(self, loud):  
        self.loud = loud  
  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

# Background

## Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
    print(sound)
```

# Background Bytecode

```
duck  
duck  
quack
```

```
sound  
duck  
echo
```

```
sound  
+=  
sound  
print  
sound
```

# Background

## Bytecode

FOR_ITER	L3
STORE_FAST	duck
LOAD_FAST_BORROW	duck
LOAD_ATTR	quack
CALL	0
STORE_FAST	sound
LOAD_FAST_BORROW	duck
LOAD_ATTR	echo
TO_BOOL	-
POP_JUMP_IF_FALSE	L2
LOAD_FAST_BORROW	sound
LOAD_FAST_BORROW	sound
BINARY_OP	+=
STORE_FAST	sound
LOAD_GLOBAL	print
LOAD_FAST_BORROW	sound
CALL	1
POP_TOP	-
JUMP_BACKWARD	L1

# Background

## Bytecode

```
def simulate_ducks(ducks):
    for duck in ducks:
        sound = duck.quack()
        if duck.echo:
            sound += sound
        print(sound)
```

L1:	FOR_ITER	L3
	STORE_FAST	duck
	LOAD_FAST_BORROW	duck
	LOAD_ATTR	quack
	CALL	0
	STORE_FAST	sound
	LOAD_FAST_BORROW	duck
	LOAD_ATTR	echo
	TO_BOOL	-
	POP_JUMP_IF_FALSE	L2
	LOAD_FAST_BORROW	sound
	LOAD_FAST_BORROW	sound
	BINARY_OP	+=
	STORE_FAST	sound
L2:	LOAD_GLOBAL	print
	LOAD_FAST_BORROW	sound
	CALL	1
	POP_TOP	-
	JUMP_BACKWARD	L1
L3:	...	



# Background

## Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
L1: FOR_ITER          L3  
    STORE_FAST        duck  
    LOAD_FAST_BORROW  duck  
    LOAD_ATTR         quack  
    CALL              0  
    STORE_FAST        sound  
    LOAD_FAST_BORROW  duck  
    LOAD_ATTR         echo  
    TO_BOOL           -  
    POP_JUMP_IF_FALSE L2  
    LOAD_FAST_BORROW  sound  
    LOAD_FAST_BORROW  sound  
    BINARY_OP         +=  
    STORE_FAST        sound  
L2: LOAD_GLOBAL       print  
    LOAD_FAST_BORROW  sound  
    CALL              1  
    POP_TOP           -  
    JUMP_BACKWARD     L1  
L3: ...
```

stack

# Background

## Bytecode

```
def simulate_ducks(ducks):
    for duck in ducks:
        sound = duck.quack()
        if duck.echo:
            sound += sound
        print(sound)
```

```
L1: FOR_ITER          L3
    STORE_FAST        duck
    LOAD_FAST_BORROW  duck
    LOAD_ATTR         quack
    CALL              0
    STORE_FAST        sound
    LOAD_FAST_BORROW  duck
    LOAD_ATTR         echo
    TO_BOOL           -
    POP_JUMP_IF_FALSE L2
    LOAD_FAST_BORROW  sound
    LOAD_FAST_BORROW  sound
    BINARY_OP         +=
    STORE_FAST        sound
L2: LOAD_GLOBAL       print
    LOAD_FAST_BORROW  sound
    CALL              1
    POP_TOP           -
    JUMP_BACKWARD     L1
L3: ...
```

stack  
iter(ducks)

# Background

## Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
L1: FOR_ITER  
    STORE_FAST      duck  
    LOAD_FAST_BORROW duck  
    LOAD_ATTR       quack  
    CALL            0  
    STORE_FAST      sound  
    LOAD_FAST_BORROW duck  
    LOAD_ATTR       echo  
    TO_BOOL         -  
    POP_JUMP_IF_FALSE L2  
    LOAD_FAST_BORROW sound  
    LOAD_FAST_BORROW sound  
    BINARY_OP       +=  
    STORE_FAST      sound  
L2: LOAD_GLOBAL     print  
    LOAD_FAST_BORROW sound  
    CALL            1  
    POP_TOP         -  
    JUMP_BACKWARD   L1
```

```
stack  
next(iter(ducks))  
    iter(ducks)
```

# Background

## Bytecode

def simulate_ducks(ducks):	L1: FOR_ITER		
for duck in ducks:	STORE_FAST	duck	ducks
sound = duck.quack()	LOAD_FAST_BORROW	duck	
if duck.echo:	LOAD_ATTR	quack	
sound += sound	CALL	0	
print(sound)	STORE_FAST	sound	
	LOAD_FAST_BORROW	duck	
	LOAD_ATTR	echo	
	TO_BOOL	-	
	POP_JUMP_IF_FALSE	L2	<u>stack</u>
	LOAD_FAST_BORROW	sound	iter(ducks)
	LOAD_FAST_BORROW	sound	
	BINARY_OP	+=	
	STORE_FAST	sound	
	L2: LOAD_GLOBAL	print	
	LOAD_FAST_BORROW	sound	
	CALL	1	
	POP_TOP	-	
	JUMP_BACKWARD	L1	

# Background

## Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
L1: FOR_ITER  
    STORE_FAST  
    LOAD_FAST_BORROW duck  
    LOAD_ATTR quack  
    CALL 0  
    STORE_FAST sound  
    LOAD_FAST_BORROW duck  
    LOAD_ATTR echo  
    TO_BOOL -  
    POP_JUMP_IF_FALSE L2  
    LOAD_FAST_BORROW sound  
    LOAD_FAST_BORROW sound  
    BINARY_OP +=  
    STORE_FAST sound  
L2: LOAD_GLOBAL print  
    LOAD_FAST_BORROW sound  
    CALL 1  
    POP_TOP -  
    JUMP_BACKWARD L1
```

```
for duck in ducks:  
  
    stack  
    iter(ducks)
```

# Background

## Bytecode

def simulate_ducks(ducks):	L1: FOR_ITER		
for duck in ducks:	STORE_FAST		
sound = duck.quack()	LOAD_FAST_BORROW		
if duck.echo:	LOAD_ATTR	quack	
sound += sound	CALL	0	
print(sound)	STORE_FAST	sound	
	LOAD_FAST_BORROW	duck	
	LOAD_ATTR	echo	
	TO_BOOL	-	<u>stack</u>
	POP_JUMP_IF_FALSE	L2	duck
	LOAD_FAST_BORROW	sound	
	LOAD_FAST_BORROW	sound	
	BINARY_OP	+=	
	STORE_FAST	sound	
	L2: LOAD_GLOBAL	print	
	LOAD_FAST_BORROW	sound	
	CALL	1	
	POP_TOP	-	
	JUMP_BACKWARD	L1	iter(ducks)

# Background

## Bytecode

```
def simulate_ducks(ducks):
    for duck in ducks:
        sound = duck.quack()
        if duck.echo:
            sound += sound
        print(sound)
```

```
L1:  FOR_ITER
      STORE_FAST
      LOAD_FAST BORROW
      LOAD_ATTR
      CALL                                0
      STORE_FAST                          sound
      LOAD_FAST BORROW                    duck
      LOAD_ATTR                            echo
      TO_BOOL                              -
      POP_JUMP_IF_FALSE L2
      LOAD_FAST BORROW                    sound
      LOAD_FAST BORROW                    sound
      BINARY_OP                            +=
      STORE_FAST                          sound
L2:  LOAD_GLOBAL                          print
      LOAD_FAST BORROW                    sound
      CALL                                1
      POP_TOP                              -
      JUMP BACKWARD                       L1
```

```
for duck in ducks:
```

```

    stack
    duck.quack
    iter(ducks)

```

# Background

## Bytecode

def simulate_ducks(ducks):	L1: FOR_ITER		
for duck in ducks:	STORE_FAST		for duck in ducks:
sound = duck.quack()	LOAD_FAST_BORROW		
if duck.echo:	LOAD_ATTR		
sound += sound	CALL		
print(sound)	STORE_FAST	sound	
	LOAD_FAST_BORROW	duck	
	LOAD_ATTR	echo	
	TO_BOOL	-	<u>stack</u>
	POP_JUMP_IF_FALSE	L2	duck.quack( )
	LOAD_FAST_BORROW	sound	iter(ducks)
	LOAD_FAST_BORROW	sound	
	BINARY_OP	+=	
	STORE_FAST	sound	
	L2: LOAD_GLOBAL	print	
	LOAD_FAST_BORROW	sound	
	CALL	1	
	POP_TOP	-	
	JUMP_BACKWARD	L1	



# Background

## Bytecode

```
def simulate_ducks(ducks):
    for duck in ducks:
        sound = duck.quack()
        if duck.echo:
            sound += sound
        print(sound)
```

```
L1: FOR_ITER
    STORE_FAST
    LOAD_FAST_BORROW
    LOAD_ATTR
    CALL
    STORE_FAST
    LOAD_FAST_BORROW duck
    LOAD_ATTR        echo
    TO_BOOL          -
    POP_JUMP_IF_FALSE L2
    LOAD_FAST_BORROW sound
    LOAD_FAST_BORROW sound
    BINARY_OP        +=
    STORE_FAST       sound
L2: LOAD_GLOBAL     print
    LOAD_FAST_BORROW sound
    CALL            1
    POP_TOP        -
    JUMP_BACKWARD   L1
```

```
for duck in ducks:
    sound = duck.quack()

    stack
    iter(ducks)
```

# Background

## Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
L1: FOR_ITER  
    STORE_FAST  
    LOAD_FAST_BORROW  
    LOAD_ATTR  
    CALL  
    STORE_FAST  
    LOAD_FAST_BORROW  
    LOAD_ATTR      echo  
    TO_BOOL        -  
    POP_JUMP_IF_FALSE L2  
    LOAD_FAST_BORROW sound  
    LOAD_FAST_BORROW sound  
    BINARY_OP      +=  
    STORE_FAST     sound  
L2: LOAD_GLOBAL    print  
    LOAD_FAST_BORROW sound  
    CALL           1  
    POP_TOP        -  
    JUMP_BACKWARD  L1
```

```
for duck in ducks:  
    sound = duck.quack()  
  
    stack  
    duck  
    iter(ducks)
```

# Background

## Bytecode

def simulate_ducks(ducks):	L1: FOR_ITER		
for duck in ducks:	STORE_FAST		
sound = duck.quack()	LOAD_FAST_BORROW		
if duck.echo:	LOAD_ATTR		
sound += sound	CALL		
print(sound)	STORE_FAST		
	LOAD_FAST_BORROW		
	LOAD_ATTR		
	TO_BOOL	-	<u>stack</u>
	POP_JUMP_IF_FALSE	L2	duck.echo
	LOAD_FAST_BORROW	sound	iter(ducks)
	LOAD_FAST_BORROW	sound	
	BINARY_OP	+=	
	STORE_FAST	sound	
	L2: LOAD_GLOBAL	print	
	LOAD_FAST_BORROW	sound	
	CALL	1	
	POP_TOP	-	
	JUMP_BACKWARD	L1	

# Background

## Bytecode

```
def simulate_ducks(ducks):
    for duck in ducks:
        sound = duck.quack()
        if duck.echo:
            sound += sound
        print(sound)
```

```
L1:  FOR_ITER
      STORE_FAST
      LOAD_FAST BORROW
      LOAD_ATTR
      CALL
      STORE_FAST
      LOAD_FAST BORROW
      LOAD_ATTR
      TO_BOOL
      POP_JUMP_IF_FALSE L2
      LOAD_FAST BORROW    sound
      LOAD_FAST BORROW    sound
      BINARY_OP            +=
      STORE_FAST           sound
L2:  LOAD_GLOBAL          print
      LOAD_FAST BORROW    sound
      CALL                 1
      POP_TOP              -
      JUMP BACKWARD       L1
```

```
for duck in ducks:
    sound = duck.quack()
```

```

    stack
    bool(duck.echo)
    iter(ducks)

```

# Background

## Bytecode

```
def simulate_ducks(ducks):
    for duck in ducks:
        sound = duck.quack()
        if duck.echo:
            sound += sound
        print(sound)
```

```
L1:  FOR_ITER
      STORE_FAST
      LOAD_FAST_BORROW
      LOAD_ATTR
      CALL
      STORE_FAST
      LOAD_FAST_BORROW
      LOAD_ATTR
      TO_BOOL
      POP_JUMP_IF_FALSE
      LOAD_FAST_BORROW      sound
      LOAD_FAST_BORROW      sound
      BINARY_OP              +=
      STORE_FAST             sound
      LOAD_GLOBAL             print
      LOAD_FAST_BORROW        sound
      CALL                    1
      POP_TOP                 -
      JUMP_BACKWARD           L1
```

```
for duck in ducks:
    sound = duck.quack()
    duck.echo
```

```
stack  
iter(ducks)
```

# Background

## Bytecode

```
def simulate_ducks(ducks):
    for duck in ducks:
        sound = duck.quack()
        if duck.echo:
            sound += sound
        print(sound)
```

```
L1:  FOR_ITER
      STORE_FAST
      LOAD_FAST_BORROW
      LOAD_ATTR
      CALL
      STORE_FAST
      LOAD_FAST_BORROW
      LOAD_ATTR
      TO_BOOL
      POP_JUMP_IF_FALSE
      LOAD_FAST_BORROW      sound
      LOAD_FAST_BORROW      sound
      BINARY_OP              +=
      STORE_FAST             sound
      LOAD_GLOBAL             print
      LOAD_FAST_BORROW        sound
      CALL                    1
      POP_TOP                 -
      JUMP_BACKWARD           L1
```

```
for duck in ducks:
    sound = duck.quack()
    if duck.echo:
```

```
stack  
iter(ducks)
```

# Background

## Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
L1: FOR_ITER  
    STORE_FAST  
    LOAD_FAST_BORROW  
    LOAD_ATTR  
    CALL  
    STORE_FAST  
    LOAD_FAST_BORROW  
    LOAD_ATTR  
    TO_BOOL  
    POP_JUMP_IF_FALSE  
    LOAD_FAST_BORROW  
    LOAD_FAST_BORROW sound  
    BINARY_OP +=  
    STORE_FAST sound  
    LOAD_GLOBAL print  
    LOAD_FAST_BORROW sound  
    CALL 1  
    POP_TOP -  
    JUMP_BACKWARD L1
```

```
for duck in ducks:  
    sound = duck.quack()  
    if duck.echo:  
  
        stack  
        sound  
        iter(ducks)
```

# Background

## Bytecode

```
def simulate_ducks(ducks):
    for duck in ducks:
        sound = duck.quack()
        if duck.echo:
            sound += sound
        print(sound)
```

```
L1: FOR_ITER
    STORE_FAST
    LOAD_FAST_BORROW
    LOAD_ATTR
    CALL
    STORE_FAST
    LOAD_FAST_BORROW
    LOAD_ATTR
    TO_BOOL
    POP_JUMP_IF_FALSE
    LOAD_FAST_BORROW
    LOAD_FAST_BORROW    sound
    BINARY_OP          +=
    STORE_FAST          sound
    LOAD_GLOBAL         print
    LOAD_FAST_BORROW    sound
    CALL                1
    POP_TOP             -
    JUMP_BACKWARD       L1
```

```
for duck in ducks:
    sound = duck.quack()
    if duck.echo:

        stack
        sound
        iter(ducks)
```



# Background

## Bytecode

```
def simulate_ducks(ducks):
    for duck in ducks:
        sound = duck.quack()
        if duck.echo:
            sound += sound
        print(sound)
```

```
L1: FOR_ITER
    STORE_FAST
    LOAD_FAST_BORROW
    LOAD_ATTR
    CALL
    STORE_FAST
    LOAD_FAST_BORROW
    LOAD_ATTR
    TO_BOOL
    POP_JUMP_IF_FALSE
    LOAD_FAST_BORROW
    LOAD_FAST_BORROW
    BINARY_OP      +=
    STORE_FAST      sound
    LOAD_GLOBAL     print
    LOAD_FAST_BORROW sound
    CALL            1
    POP_TOP         -
    JUMP_BACKWARD   L1
```

```
for duck in ducks:
    sound = duck.quack()
    if duck.echo:

        stack
        sound
        sound
    iter(ducks)
```

# Background

## Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
L1: FOR_ITER  
    STORE_FAST  
    LOAD_FAST_BORROW  
    LOAD_ATTR  
    CALL  
    STORE_FAST  
    LOAD_FAST_BORROW  
    LOAD_ATTR  
    TO_BOOL  
    POP_JUMP_IF_FALSE  
    LOAD_FAST_BORROW  
    LOAD_FAST_BORROW  
    BINARY_OP  
    STORE_FAST          sound  
    LOAD_GLOBAL          print  
    LOAD_FAST_BORROW     sound  
    CALL                 1  
    POP_TOP              -  
    JUMP_BACKWARD        L1
```

```
for duck in ducks:  
    sound = duck.quack()  
    if duck.echo:  
  
        stack  
        sound + sound  
        iter(ducks)
```

# Background

## Bytecode

```
def simulate_ducks(ducks):
    for duck in ducks:
        sound = duck.quack()
        if duck.echo:
            sound += sound
        print(sound)
```

```
L1: FOR_ITER
    STORE_FAST
    LOAD_FAST_BORROW
    LOAD_ATTR
    CALL
    STORE_FAST
    LOAD_FAST_BORROW
    LOAD_ATTR
    TO_BOOL
    POP_JUMP_IF_FALSE
    LOAD_FAST_BORROW
    LOAD_FAST_BORROW
    BINARY_OP
    STORE_FAST
    LOAD_GLOBAL          print
    LOAD_FAST_BORROW     sound
    CALL                 1
    POP_TOP              -
    JUMP_BACKWARD        L1
```

```
for duck in ducks:
    sound = duck.quack()
    if duck.echo:
        sound += sound

    stack
    iter(ducks)
```

# Background

## Bytecode

```
def simulate_ducks(ducks):
    for duck in ducks:
        sound = duck.quack()
        if duck.echo:
            sound += sound
        print(sound)
```

```
L1: FOR_ITER
    STORE_FAST
    LOAD_FAST_BORROW
    LOAD_ATTR
    CALL
    STORE_FAST
    LOAD_FAST_BORROW
    LOAD_ATTR
    TO_BOOL
    POP_JUMP_IF_FALSE
    LOAD_FAST_BORROW
    LOAD_FAST_BORROW
    BINARY_OP
    STORE_FAST
    LOAD_GLOBAL
    LOAD_FAST_BORROW    sound
    CALL                1
    POP_TOP             -
    JUMP_BACKWARD       L1
```

```
for duck in ducks:
    sound = duck.quack()
    if duck.echo:
        sound += sound

    stack
    print
    iter(ducks)
```

# Background

## Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
L1: FOR_ITER  
    STORE_FAST  
    LOAD_FAST_BORROW  
    LOAD_ATTR  
    CALL  
    STORE_FAST  
    LOAD_FAST_BORROW  
    LOAD_ATTR  
    TO_BOOL  
    POP_JUMP_IF_FALSE  
    LOAD_FAST_BORROW  
    LOAD_FAST_BORROW  
    BINARY_OP  
    STORE_FAST  
    LOAD_GLOBAL  
    LOAD_FAST_BORROW  
    CALL 1  
    POP_TOP  
    JUMP_BACKWARD L1
```

```
for duck in ducks:  
    sound = duck.quack()  
    if duck.echo:  
        sound += sound  
  
    stack  
    sound  
    print  
    iter(ducks)
```

# Background

## Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
L1: FOR_ITER  
    STORE_FAST  
    LOAD_FAST_BORROW  
    LOAD_ATTR  
    CALL  
    STORE_FAST  
    LOAD_FAST_BORROW  
    LOAD_ATTR  
    TO_BOOL  
    POP_JUMP_IF_FALSE  
    LOAD_FAST_BORROW  
    LOAD_FAST_BORROW  
    BINARY_OP  
    STORE_FAST  
    LOAD_GLOBAL  
    LOAD_FAST_BORROW  
    CALL  
    POP_TOP  
    JUMP_BACKWARD    L1
```

```
for duck in ducks:  
    sound = duck.quack()  
    if duck.echo:  
        sound += sound  
  
    stack  
    print(sound)  
    iter(ducks)
```

# Background

## Bytecode

```
def simulate_ducks(ducks):
    for duck in ducks:
        sound = duck.quack()
        if duck.echo:
            sound += sound
        print(sound)
```

```
L1: FOR_ITER
    STORE_FAST
    LOAD_FAST_BORROW
    LOAD_ATTR
    CALL
    STORE_FAST
    LOAD_FAST_BORROW
    LOAD_ATTR
    TO_BOOL
    POP_JUMP_IF_FALSE
    LOAD_FAST_BORROW
    LOAD_FAST_BORROW
    BINARY_OP
    STORE_FAST
    LOAD_GLOBAL
    LOAD_FAST_BORROW
    CALL
    POP_TOP
    JUMP_BACKWARD      L1
```

```
for duck in ducks:
    sound = duck.quack()
    if duck.echo:
        sound += sound
    print(sound)

    stack
    iter(ducks)
```

# Background

## Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
FOR_ITER  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR  
CALL  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR  
TO_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP  
STORE_FAST  
LOAD_GLOBAL  
LOAD_FAST_BORROW  
CALL  
POP_TOP  
JUMP_BACKWARD
```

```
for duck in ducks:  
    sound = duck.quack()  
    if duck.echo:  
        sound += sound  
    print(sound)
```

stack  
iter(ducks)



# Background

## Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
FOR_ITER  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR  
CALL  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR  
TO_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP  
STORE_FAST  
LOAD_GLOBAL  
LOAD_FAST_BORROW  
CALL  
POP_TOP  
JUMP_BACKWARD
```

```
for duck in ducks:  
    sound = duck.quack()  
    if duck.echo:  
        sound += sound  
    print(sound)
```

stack  
iter(ducks)

# Background

## Specialized Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
FOR_ITER  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR  
CALL  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR  
TO_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP  
STORE_FAST  
LOAD_GLOBAL  
LOAD_FAST_BORROW  
CALL  
POP_TOP  
JUMP_BACKWARD
```

# Background

## Specialized Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
FOR_ITER  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR  
CALL  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR  
TO_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP  
STORE_FAST  
LOAD_GLOBAL  
LOAD_FAST_BORROW  
CALL  
POP_TOP  
JUMP_BACKWARD
```

# Background

## Specialized Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
FOR_ITER_LIST  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR  
CALL  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR  
TO_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP  
STORE_FAST  
LOAD_GLOBAL  
LOAD_FAST_BORROW  
CALL  
POP_TOP  
JUMP_BACKWARD
```

# Background

## Specialized Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
FOR_ITER_LIST  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_METHOD_WITH_VALUES  
CALL  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR  
TO_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP  
STORE_FAST  
LOAD_GLOBAL  
LOAD_FAST_BORROW  
CALL  
POP_TOP  
JUMP_BACKWARD
```

# Background

## Specialized Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
FOR_ITER_LIST  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_METHOD_WITH_VALUES  
CALL_PY_EXACT_ARGS  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR  
TO_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP  
STORE_FAST  
LOAD_GLOBAL  
LOAD_FAST_BORROW  
CALL  
POP_TOP  
JUMP_BACKWARD
```

# Background

## Specialized Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
FOR_ITER_LIST  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_METHOD_WITH_VALUES  
CALL_PY_EXACT_ARGS  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES  
TO_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP  
STORE_FAST  
LOAD_GLOBAL  
LOAD_FAST_BORROW  
CALL  
POP_TOP  
JUMP_BACKWARD
```

# Background

## Specialized Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
    print(sound)
```

```
FOR_ITER_LIST  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_METHOD_WITH_VALUES  
CALL_PY_EXACT_ARGS  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES  
TO_BOOL_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP  
STORE_FAST  
LOAD_GLOBAL  
LOAD_FAST_BORROW  
CALL  
POP_TOP  
JUMP_BACKWARD
```



# Background

## Specialized Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
    print(sound)
```

```
FOR_ITER_LIST  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_METHOD_WITH_VALUES  
CALL_PY_EXACT_ARGS  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES  
TO_BOOL_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP_INPLACE_ADD_UNICODE  
STORE_FAST  
LOAD_GLOBAL  
LOAD_FAST_BORROW  
CALL  
POP_TOP  
JUMP_BACKWARD
```

# Background

## Specialized Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
FOR_ITER_LIST  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_METHOD_WITH_VALUES  
CALL_PY_EXACT_ARGS  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES  
TO_BOOL_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP_INPLACE_ADD_UNICODE  
STORE_FAST  
LOAD_GLOBAL_BUILTIN  
LOAD_FAST_BORROW  
CALL  
POP_TOP  
JUMP_BACKWARD
```

# Background

## Specialized Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
FOR_ITER_LIST  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_METHOD_WITH_VALUES  
CALL_PY_EXACT_ARGS  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES  
TO_BOOL_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP_INPLACE_ADD_UNICODE  
STORE_FAST  
LOAD_GLOBAL_BUILTIN  
LOAD_FAST_BORROW  
CALL_BUILTIN_FAST_WITH_KEYWORDS  
POP_TOP  
JUMP_BACKWARD
```

# Background

## Specialized Bytecode

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
FOR_ITER_LIST  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_METHOD_WITH_VALUES  
CALL_PY_EXACT_ARGS  
STORE_FAST  
LOAD_FAST_BORROW  
LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES  
TO_BOOL_BOOL  
POP_JUMP_IF_FALSE  
LOAD_FAST_BORROW  
LOAD_FAST_BORROW  
BINARY_OP_INPLACE_ADD_UNICODE  
STORE_FAST  
LOAD_GLOBAL_BUILTIN  
LOAD_FAST_BORROW  
CALL_BUILTIN_FAST_WITH_KEYWORDS  
POP_TOP  
JUMP_BACKWARD
```

# Background

## Micro-Ops

FOR\_ITER\_LIST  
STORE\_FAST  
LOAD\_FAST\_BORROW  
LOAD\_ATTR\_METHOD\_WITH\_VALUES  
CALL\_PY\_EXACT\_ARGS  
STORE\_FAST  
LOAD\_FAST\_BORROW  
LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES  
TO\_BOOL\_BOOL  
POP\_JUMP\_IF\_FALSE  
LOAD\_GLOBAL\_BUILTIN  
LOAD\_FAST\_BORROW  
CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
POP\_TOP  
JUMP\_BACKWARD

# Background

## Micro-Ops

\_CHECK\_VALIDITY  
\_SET\_IP  
\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO

STORE\_FAST  
LOAD\_FAST\_BORROW  
LOAD\_ATTR\_METHOD\_WITH\_VALUES  
CALL\_PY\_EXACT\_ARGS  
STORE\_FAST  
LOAD\_FAST\_BORROW  
LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES  
TO\_BOOL\_BOOL  
POP\_JUMP\_IF\_FALSE  
LOAD\_GLOBAL\_BUILTIN  
LOAD\_FAST\_BORROW  
CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
POP\_TOP  
JUMP\_BACKWARD

# Background

## Micro-Ops

\_CHECK\_VALIDITY  
\_SET\_IP  
\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST

LOAD\_FAST\_BORROW  
LOAD\_ATTR\_METHOD\_WITH\_VALUES  
CALL\_PY\_EXACT\_ARGS  
STORE\_FAST  
LOAD\_FAST\_BORROW  
LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES  
TO\_BOOL\_BOOL  
POP\_JUMP\_IF\_FALSE  
LOAD\_GLOBAL\_BUILTIN  
LOAD\_FAST\_BORROW  
CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
POP\_TOP  
JUMP\_BACKWARD

# Background

## Micro-Ops

\_CHECK\_VALIDITY  
\_SET\_IP  
\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW

LOAD\_ATTR\_METHOD\_WITH\_VALUES  
CALL\_PY\_EXACT\_ARGS  
STORE\_FAST  
LOAD\_FAST\_BORROW  
LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES  
TO\_BOOL\_BOOL  
POP\_JUMP\_IF\_FALSE  
LOAD\_GLOBAL\_BUILTIN  
LOAD\_FAST\_BORROW  
CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
POP\_TOP  
JUMP\_BACKWARD



# Background

## Micro-Ops

```
_CHECK_VALIDITY
_SET_IP
_ITER_CHECK_LIST
_GUARD_NOT_EXHAUSTED_LIST
_ITER_NEXT_LIST_TIER_TWO
_CHECK_VALIDITY
_SET_IP
_STORE_FAST
_CHECK_VALIDITY
_SET_IP
_LOAD_FAST_BORROW
_CHECK_VALIDITY
_SET_IP
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
```

```
CALL_PY_EXACT_ARGS
_STORE_FAST
_LOAD_FAST_BORROW
_LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES
_TO_BOOL_BOOL
_POP_JUMP_IF_FALSE
_LOAD_GLOBAL_BUILTIN
_LOAD_FAST_BORROW
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_POP_TOP
_JUMP_BACKWARD
```

# Background

## Micro-Ops

\_CHECK\_VALIDITY  
\_SET\_IP  
\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CHECK\_PEP\_523  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE  
\_CHECK\_RECURSION\_REMAINING  
\_INIT\_CALL\_PY\_EXACT\_ARGS

\_SAVE\_RETURN\_OFFSET  
\_PUSH\_FRAME  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RESUME\_CHECK  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_CONST\_MORTAL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RETURN\_VALUE

STORE\_FAST  
LOAD\_FAST\_BORROW  
LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES  
TO\_BOOL\_BOOL  
POP\_JUMP\_IF\_FALSE  
LOAD\_GLOBAL\_BUILTIN  
LOAD\_FAST\_BORROW  
CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
POP\_TOP  
JUMP\_BACKWARD

# Background

## Micro-Ops

\_CHECK\_VALIDITY  
\_SET\_IP  
\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CHECK\_PEP\_523  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE  
\_CHECK\_RECURSION\_REMAINING  
\_INIT\_CALL\_PY\_EXACT\_ARGS

\_SAVE\_RETURN\_OFFSET  
\_PUSH\_FRAME  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RESUME\_CHECK  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_CONST\_MORTAL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RETURN\_VALUE  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST

LOAD\_FAST\_BORROW  
LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES  
TO\_BOOL\_BOOL  
POP\_JUMP\_IF\_FALSE  
LOAD\_GLOBAL\_BUILTIN  
LOAD\_FAST\_BORROW  
CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
POP\_TOP  
JUMP\_BACKWARD

# Background

## Micro-Ops

\_CHECK\_VALIDITY  
\_SET\_IP  
\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CHECK\_PEP\_523  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE  
\_CHECK\_RECURSION\_REMAINING  
\_INIT\_CALL\_PY\_EXACT\_ARGS

\_SAVE\_RETURN\_OFFSET  
\_PUSH\_FRAME  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RESUME\_CHECK  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_CONST\_MORTAL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RETURN\_VALUE  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW

LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES  
TO\_BOOL\_BOOL  
POP\_JUMP\_IF\_FALSE  
LOAD\_GLOBAL\_BUILTIN  
LOAD\_FAST\_BORROW  
CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
POP\_TOP  
JUMP\_BACKWARD

# Background

## Micro-Ops

\_CHECK\_VALIDITY  
\_SET\_IP  
\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CHECK\_PEP\_523  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE  
\_CHECK\_RECURSION\_REMAINING  
\_INIT\_CALL\_PY\_EXACT\_ARGS

\_SAVE\_RETURN\_OFFSET  
\_PUSH\_FRAME  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RESUME\_CHECK  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_CONST\_MORTAL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RETURN\_VALUE  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES

TO\_BOOL\_BOOL  
POP\_JUMP\_IF\_FALSE  
LOAD\_GLOBAL\_BUILTIN  
LOAD\_FAST\_BORROW  
CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
POP\_TOP  
JUMP\_BACKWARD

# Background Micro-Ops

```

_CHECK_VALIDITY
_SET_IP
_ITER_CHECK_LIST
_GUARD_NOT_EXHAUSTED_LIST
_ITER_NEXT_LIST_TIER_TWO
_CHECK_VALIDITY
_SET_IP
_STORE_FAST
_CHECK_VALIDITY
_SET_IP
_LOAD_FAST_BORROW
_CHECK_VALIDITY
_SET_IP
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_CHECK_VALIDITY
_SET_IP
_CHECK_PEP_523
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE
_CHECK_RECURSION_REMAINING
INIT CALL PY EXACT ARGS

```

```

_SAVE_RETURN_OFFSET
_PUSH_FRAME
_CHECK_VALIDITY
_SET_IP
_RESUME_CHECK
_CHECK_VALIDITY
_SET_IP
_LOAD_CONST_MORTAL
_CHECK_VALIDITY
_SET_IP
_RETURN_VALUE
_CHECK_VALIDITY
_SET_IP
_STORE_FAST
_CHECK_VALIDITY
_SET_IP
_LOAD_FAST_BORROW
_CHECK_VALIDITY
_SET_IP
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES
_CHECK_VALIDITY
_SET_IP

```

```

_TO_BOOL_BOOL

POP_JUMP_IF_FALSE
LOAD_GLOBAL_BUILTIN
LOAD_FAST_BORROW
CALL_BUILTIN_FAST_WITH_KEYWORDS
POP_TOP
JUMP_BACKWARD

```

# Background

## Micro-Ops

```

_CHECK_VALIDITY
_SET_IP
_ITER_CHECK_LIST
_GUARD_NOT_EXHAUSTED_LIST
_ITER_NEXT_LIST_TIER_TWO
_CHECK_VALIDITY
_SET_IP
_STORE_FAST
_CHECK_VALIDITY
_SET_IP
_LOAD_FAST_BORROW
_CHECK_VALIDITY
_SET_IP
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_CHECK_VALIDITY
_SET_IP
_CHECK_PEP_523
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE
_CHECK_RECURSION_REMAINING
_INIT_CALL_PY_EXACT_ARGS

```

```

_SAVE_RETURN_OFFSET
_PUSH_FRAME
_CHECK_VALIDITY
_SET_IP
_RESUME_CHECK
_CHECK_VALIDITY
_SET_IP
_LOAD_CONST_MORTAL
_CHECK_VALIDITY
_SET_IP
_RETURN_VALUE
_CHECK_VALIDITY
_SET_IP
_STORE_FAST
_CHECK_VALIDITY
_SET_IP
_LOAD_FAST_BORROW
_CHECK_VALIDITY
_SET_IP
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES
_CHECK_VALIDITY
_SET_IP

```

```
_TO_BOOL_BOOL
_CHECK_VALIDITY
_SET_IP
_GUARD_IS_FALSE_POP
```

```
LOAD_GLOBAL_BUILTIN
LOAD_FAST_BORROW
CALL_BUILTIN_FAST_WITH_KEYWORDS
POP_TOP
JUMP_BACKWARD
```

# Background

## Micro-Ops

```

_CHECK_VALIDITY
_SET_IP
_ITER_CHECK_LIST
_GUARD_NOT_EXHAUSTED_LIST
_ITER_NEXT_LIST_TIER_TWO
_CHECK_VALIDITY
_SET_IP
_STORE_FAST
_CHECK_VALIDITY
_SET_IP
_LOAD_FAST_BORROW
_CHECK_VALIDITY
_SET_IP
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_CHECK_VALIDITY
_SET_IP
_CHECK_PEP_523
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE
_CHECK_RECURSION_REMAINING
INIT CALL PY EXACT ARGS

```

```

_SAVE_RETURN_OFFSET
_PUSH_FRAME
_CHECK_VALIDITY
_SET_IP
_RESUME_CHECK
_CHECK_VALIDITY
_SET_IP
_LOAD_CONST_MORTAL
_CHECK_VALIDITY
_SET_IP
_RETURN_VALUE
_CHECK_VALIDITY
_SET_IP
_STORE_FAST
_CHECK_VALIDITY
_SET_IP
_LOAD_FAST_BORROW
_CHECK_VALIDITY
_SET_IP
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES
_CHECK_VALIDITY
_SET_IP

```

```
_TO_BOOL_BOOL
_CHECK_VALIDITY
_SET_IP
_GUARD_IS_FALSE_POP
_CHECK_VALIDITY
_SET_IP
_GUARD_GLOBALS_VERSION
_LOAD_GLOBAL_BUILTINS
PUSH NULL CONDITIONAL
```

```
LOAD_FAST_BORROW
CALL_BUILTIN_FAST_WITH_KEYWORDS
POP_TOP
JUMP_BACKWARD
```



# Background

## Micro-Ops

\_CHECK\_VALIDITY  
\_SET\_IP  
\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CHECK\_PEP\_523  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE  
\_CHECK\_RECURSION\_REMAINING  
\_INIT\_CALL\_PY\_EXACT\_ARGS

\_SAVE\_RETURN\_OFFSET  
\_PUSH\_FRAME  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RESUME\_CHECK  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_CONST\_MORTAL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RETURN\_VALUE  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES  
\_CHECK\_VALIDITY  
\_SET\_IP

\_TO\_BOOL\_BOOL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_IS\_FALSE\_POP  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_GLOBALS\_VERSION  
\_LOAD\_GLOBAL\_BUILTINS  
\_PUSH\_NULL\_CONDITIONAL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
  
CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
POP\_TOP  
JUMP\_BACKWARD

# Background

## Micro-Ops

\_CHECK\_VALIDITY  
\_SET\_IP  
\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CHECK\_PEP\_523  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE  
\_CHECK\_RECURSION\_REMAINING  
\_INIT\_CALL\_PY\_EXACT\_ARGS

\_SAVE\_RETURN\_OFFSET  
\_PUSH\_FRAME  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RESUME\_CHECK  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_CONST\_MORTAL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RETURN\_VALUE  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES  
\_CHECK\_VALIDITY  
\_SET\_IP

\_TO\_BOOL\_BOOL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_IS\_FALSE\_POP  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_GLOBALS\_VERSION  
\_LOAD\_GLOBAL\_BUILTINS  
\_PUSH\_NULL\_CONDITIONAL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
  
POP\_TOP  
JUMP\_BACKWARD

# Background

## Micro-Ops

```

_CHECK_VALIDITY
_SET_IP
_ITER_CHECK_LIST
_GUARD_NOT_EXHAUSTED_LIST
_ITER_NEXT_LIST_TIER_TWO
_CHECK_VALIDITY
_SET_IP
_STORE_FAST
_CHECK_VALIDITY
_SET_IP
_LOAD_FAST_BORROW
_CHECK_VALIDITY
_SET_IP
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_CHECK_VALIDITY
_SET_IP
_CHECK_PEP_523
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE
_CHECK_RECURSION_REMAINING
INIT CALL PY EXACT ARGS

```

```

_SAVE_RETURN_OFFSET
_PUSH_FRAME
_CHECK_VALIDITY
_SET_IP
_RESUME_CHECK
_CHECK_VALIDITY
_SET_IP
_LOAD_CONST_MORTAL
_CHECK_VALIDITY
_SET_IP
_RETURN_VALUE
_CHECK_VALIDITY
_SET_IP
_STORE_FAST
_CHECK_VALIDITY
_SET_IP
_LOAD_FAST_BORROW
_CHECK_VALIDITY
_SET_IP
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES
_CHECK_VALIDITY
_SET_IP

```

```

_TO_BOOL_BOOL
_CHECK_VALIDITY
_SET_IP
_GUARD_IS_FALSE_POP
_CHECK_VALIDITY
_SET_IP
_GUARD_GLOBALS_VERSION
_LOAD_GLOBAL_BUILTINS
_PUSH_NULL_CONDITIONAL
_CHECK_VALIDITY
_SET_IP
_LOAD_FAST_BORROW
_CHECK_VALIDITY
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP

JUMP_BACKWARD

```

# Background

## Micro-Ops

\_CHECK\_VALIDITY  
\_SET\_IP  
\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CHECK\_PEP\_523  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE  
\_CHECK\_RECURSION\_REMAINING  
\_INIT\_CALL\_PY\_EXACT\_ARGS

\_SAVE\_RETURN\_OFFSET  
\_PUSH\_FRAME  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RESUME\_CHECK  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_CONST\_MORTAL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RETURN\_VALUE  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES  
\_CHECK\_VALIDITY  
\_SET\_IP

\_TO\_BOOL\_BOOL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_IS\_FALSE\_POP  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_GLOBALS\_VERSION  
\_LOAD\_GLOBAL\_BUILTINS  
\_PUSH\_NULL\_CONDITIONAL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Optimized Micro-Ops

\_CHECK\_VALIDITY  
\_SET\_IP  
\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CHECK\_PEP\_523  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE  
\_CHECK\_RECURSION\_REMAINING  
\_INIT\_CALL\_PY\_EXACT\_ARGS

\_SAVE\_RETURN\_OFFSET  
\_PUSH\_FRAME  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RESUME\_CHECK  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_CONST\_MORTAL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_RETURN\_VALUE  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES  
\_CHECK\_VALIDITY  
\_SET\_IP

\_TO\_BOOL\_BOOL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_IS\_FALSE\_POP  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_GUARD\_GLOBALS\_VERSION  
\_LOAD\_GLOBAL\_BUILTINS  
\_PUSH\_NULL\_CONDITIONAL  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_LOAD\_FAST\_BORROW  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Optimized Micro-Ops

`_CHECK_VALIDITY`  
`_SET_IP`  
`_ITER_CHECK_LIST`  
`_GUARD_NOT_EXHAUSTED_LIST`  
`_ITER_NEXT_LIST_TIER_TWO`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_STORE_FAST`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_LOAD_FAST_BORROW`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_GUARD_TYPE_VERSION`  
`_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT`  
`_GUARD_KEYS_VERSION`  
`_LOAD_ATTR_METHOD_WITH_VALUES`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_CHECK_PEP_523`  
`_CHECK_FUNCTION_VERSION`  
`_CHECK_FUNCTION_EXACT_ARGS`  
`_CHECK_STACK_SPACE`  
`_CHECK_RECURSION_REMAINING`  
`_INIT_CALL_PY_EXACT_ARGS`

`_SAVE_RETURN_OFFSET`  
`_PUSH_FRAME`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_RESUME_CHECK`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_LOAD_CONST_MORTAL`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_RETURN_VALUE`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_STORE_FAST`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_LOAD_FAST_BORROW`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_GUARD_TYPE_VERSION`  
`_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT`  
`_GUARD_KEYS_VERSION`  
`_LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES`  
`_CHECK_VALIDITY`  
`_SET_IP`

`_TO_BOOL_BOOL`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_GUARD_IS_FALSE_POP`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_GUARD_GLOBALS_VERSION`  
`_LOAD_GLOBAL_BUILTINS`  
`_PUSH_NULL_CONDITIONAL`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_LOAD_FAST_BORROW`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_CALL_BUILTIN_FAST_WITH_KEYWORDS`  
`_CHECK_PERIODIC`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_POP_TOP`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_CHECK_PERIODIC`  
`_JUMP_TO_TOP`

# Background

## Optimized Micro-Ops

`_CHECK_VALIDITY`  
`_SET_IP`  
`_ITER_CHECK_LIST`  
`_GUARD_NOT_EXHAUSTED_LIST`  
`_ITER_NEXT_LIST_TIER_TWO`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_STORE_FAST_1`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_LOAD_FAST_BORROW_1`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_GUARD_TYPE_VERSION`  
`_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT`  
`_GUARD_KEYS_VERSION`  
`_LOAD_ATTR_METHOD_WITH_VALUES`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_CHECK_PEP_523`  
`_CHECK_FUNCTION_VERSION`  
`_CHECK_FUNCTION_EXACT_ARGS`  
`_CHECK_STACK_SPACE_OPERAND`  
`_CHECK_RECURSION_REMAINING`  
`_INIT_CALL_PY_EXACT_ARGS_0`

`_SAVE_RETURN_OFFSET`  
`_PUSH_FRAME`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_RESUME_CHECK`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_LOAD_CONST_INLINE`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_RETURN_VALUE`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_STORE_FAST_2`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_LOAD_FAST_BORROW_1`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_GUARD_TYPE_VERSION`  
`_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT`  
`_GUARD_KEYS_VERSION`  
`_LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES`  
`_CHECK_VALIDITY`  
`_SET_IP`

`_TO_BOOL_BOOL`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_GUARD_IS_FALSE_POP`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_CHECK_FUNCTION`  
`_LOAD_CONST_INLINE`  
`_PUSH_NULL`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_LOAD_FAST_BORROW_2`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_CALL_BUILTIN_FAST_WITH_KEYWORDS`  
`_CHECK_PERIODIC`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_POP_TOP`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_CHECK_PERIODIC`  
`_JUMP_TO_TOP`

# Background

## Optimized Micro-Ops

`_CHECK_VALIDITY`  
`_SET_IP`  
`_ITER_CHECK_LIST`  
`_GUARD_NOT_EXHAUSTED_LIST`  
`_ITER_NEXT_LIST_TIER_TWO`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_STORE_FAST_1`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_LOAD_FAST_BORROW_1`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_GUARD_TYPE_VERSION`  
`_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT`  
`_GUARD_KEYS_VERSION`  
`_LOAD_ATTR_METHOD_WITH_VALUES`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_CHECK_PEP_523`  
`_CHECK_FUNCTION_VERSION`  
`_CHECK_FUNCTION_EXACT_ARGS`  
`_CHECK_STACK_SPACE_OPERAND`  
`_CHECK_RECURSION_REMAINING`  
`_INIT_CALL_PY_EXACT_ARGS_0`

`_SAVE_RETURN_OFFSET`  
`_PUSH_FRAME`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_RESUME_CHECK`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_LOAD_CONST_INLINE`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_RETURN_VALUE`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_STORE_FAST_2`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_LOAD_FAST_BORROW_1`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_GUARD_TYPE_VERSION`  
`_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT`  
`_GUARD_KEYS_VERSION`  
`_LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES`  
`_CHECK_VALIDITY`  
`_SET_IP`

`_TO_BOOL_BOOL`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_GUARD_IS_FALSE_POP`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_CHECK_FUNCTION`  
`_LOAD_CONST_INLINE`  
`_PUSH_NULL`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_LOAD_FAST_BORROW_2`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_CALL_BUILTIN_FAST_WITH_KEYWORDS`  
`_CHECK_PERIODIC`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_POP_TOP`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_CHECK_PERIODIC`  
`_JUMP_TO_TOP`



# Background

## Optimized Micro-Ops

\_CHECK\_VALIDITY  
\_SET\_IP  
\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST\_1  
\_CHECK\_VALIDITY

\_LOAD\_FAST\_BORROW\_1

\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES

\_SET\_IP

\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_INIT\_CALL\_PY\_EXACT\_ARGS\_0

\_SAVE\_RETURN\_OFFSET  
\_PUSH\_FRAME

\_RESUME\_CHECK

\_LOAD\_CONST\_INLINE

\_SET\_IP  
\_RETURN\_VALUE  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY

\_LOAD\_FAST\_BORROW\_1

\_SET\_IP

\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_NONDESCRIPTOR\_WITH\_VALUES  
\_CHECK\_VALIDITY

\_TO\_BOOL\_BOOL

\_GUARD\_IS\_FALSE\_POP

\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL

\_LOAD\_FAST\_BORROW\_2

\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP

\_SET\_IP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Optimized Micro-Ops

`_CHECK_VALIDITY`  
`_SET_IP`  
`_ITER_CHECK_LIST`  
`_GUARD_NOT_EXHAUSTED_LIST`  
`_ITER_NEXT_LIST_TIER_TWO`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_STORE_FAST_1`  
`_CHECK_VALIDITY`

`_LOAD_FAST_BORROW_1`

`_GUARD_TYPE_VERSION`  
`_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT`  
`_GUARD_KEYS_VERSION`  
`_LOAD_ATTR_METHOD_WITH_VALUES`

`_SET_IP`

`_CHECK_FUNCTION_VERSION`  
`_CHECK_FUNCTION_EXACT_ARGS`  
`_CHECK_STACK_SPACE_OPERAND`  
`_CHECK_RECURSION_REMAINING`  
`_INIT_CALL_PY_EXACT_ARGS_0`

`_SAVE_RETURN_OFFSET`  
`_PUSH_FRAME`

`_RESUME_CHECK`

`_LOAD_CONST_INLINE`

`_SET_IP`  
`_RETURN_VALUE`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_STORE_FAST_2`  
`_CHECK_VALIDITY`

`_LOAD_FAST_BORROW_1`

`_SET_IP`

`_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT`  
`_GUARD_KEYS_VERSION`  
`_LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES`  
`_CHECK_VALIDITY`

`_TO_BOOL_BOOL`

`_GUARD_IS_FALSE_POP`

`_CHECK_FUNCTION`  
`_LOAD_CONST_INLINE`  
`_PUSH_NULL`

`_LOAD_FAST_BORROW_2`

`_SET_IP`  
`_CALL_BUILTIN_FAST_WITH_KEYWORDS`  
`_CHECK_PERIODIC`  
`_CHECK_VALIDITY`  
`_SET_IP`  
`_POP_TOP`

`_SET_IP`  
`_CHECK_PERIODIC`  
`_JUMP_TO_TOP`

# Background

## Optimized Micro-Ops

\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO

\_SET\_IP  
\_STORE\_FAST\_1  
\_CHECK\_VALIDITY

\_LOAD\_FAST\_BORROW\_1

\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES

\_SET\_IP

\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING

\_LOAD\_CONST\_INLINE

\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY

\_LOAD\_FAST\_BORROW\_1

\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION

\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL

\_LOAD\_FAST\_BORROW\_2

\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP

\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

\_ITER\_CHECK\_LIST  
\_GUARD\_NOT\_EXHAUSTED\_LIST  
\_ITER\_NEXT\_LIST\_TIER\_TWO

\_SET\_IP  
\_STORE\_FAST\_1  
\_CHECK\_VALIDITY

\_LOAD\_FAST\_BORROW\_1

\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES

\_SET\_IP

\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING

\_LOAD\_CONST\_INLINE

\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY

\_LOAD\_FAST\_BORROW\_1

\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION

\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL

\_LOAD\_FAST\_BORROW\_2

\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP

\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

```
_ITER_CHECK_LIST
_GUARD_NOT_EXHAUSTED_LIST
_ITER_NEXT_LIST_TIER_TWO
_SET_IP
_STORE_FAST_1
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Background

## Machine Code

```

                                _ITER_CHECK_LIST
_GUARD_NOT_EXHAUSTED_LIST
_ITER_NEXT_LIST_TIER_TWO
_SET_IP
_STORE_FAST_1
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Background Machine Code

```
a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00
```

```

_GUARD_NOT_EXHAUSTED_LIST
_ITER_NEXT_LIST_TIER_TWO
_SET_IP
_STORE_FAST_1
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP

```

# Background

# Machine Code

```
                                a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 _GUARD_NOT_EXHAUSTED_LIST

_ITER_NEXT_LIST_TIER_TWO
_SET_IP
_STORE_FAST_1
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```



# Background

## Machine Code

```
a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00
```

```

_ITER_NEXT_LIST_TIER_TWO
_SET_IP
_STORE_FAST_1
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP

```

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 \_ITER\_NEXT\_LIST\_TIER\_TWO

\_SET\_IP  
\_STORE\_FAST\_1  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

# Machine Code

	a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
	00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
	41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
	00
_SET_IP	
_STORE_FAST_1	
_CHECK_VALIDITY	
_LOAD_FAST_BORROW_1	
_GUARD_TYPE_VERSION	
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT	
_GUARD_KEYS_VERSION	
_LOAD_ATTR_METHOD_WITH_VALUES	
_SET_IP	
_CHECK_FUNCTION_VERSION	
_CHECK_FUNCTION_EXACT_ARGS	
_CHECK_STACK_SPACE_OPERAND	
_CHECK_RECURSION_REMAINING	
_LOAD_CONST_INLINE	
_SET_IP	
_STORE_FAST_2	
_CHECK_VALIDITY	
_LOAD_FAST_BORROW_1	
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT	
_GUARD_KEYS_VERSION	
_CHECK_FUNCTION	
_LOAD_CONST_INLINE	
_PUSH_NULL	
_LOAD_FAST_BORROW_2	
_SET_IP	
_CALL_BUILTIN_FAST_WITH_KEYWORDS	
_CHECK_PERIODIC	
_CHECK_VALIDITY	
_SET_IP	
_POP_TOP	
_CHECK_PERIODIC	
_JUMP_TO_TOP	

# Background

## Machine Code

```

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
00 _SET_IP

```

```

_STORE_FAST_1
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP

```

# Background Machine Code

```
a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00
```

```

_STORE_FAST_1
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP

```

# Background

# Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 \_STORE\_FAST\_1

\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

	a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
	00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
	41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
	00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
	95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00

```
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 \_CHECK\_VALIDITY

\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP



# Background Machine Code

a8	82	5f	f8	08	f9	7f	92	08	05	40	f9	09	00	00	90	29	01	40	f9	1f	01	09	eb	40	00	00	54	00	00	00	14	00	00	00	14	1f	20	03	d5	00	a8	82	5f	f8	08	f9	7f	92	09	0d	40	f9	c9
00	00	b4	0a	09	40	f9	29	09	40	f9	5f	01	09	eb	62	00	00	54	00	00	00	14	00	00	00	14	09	00	80	92	09	09	00	f9	00	00	00	14	1f	20	03	d5	00	a8	82	5f	f8	08	f9	7f	92	0a	25
41	a9	29	0d	40	f9	4b	05	00	91	0b	09	00	f9	28	79	6a	f8	09	01	40	b9	a9	00	f8	37	29	05	00	11	09	01	00	b9	a8	86	00	f8	00	00	00	14	08	01	40	b2	a8	86	00	f8	00	00	00	14
00	08	00	00	90	08	01	40	f9	88	1e	00	f9	00	00	00	14	00	a8	8e	5f	f8	80	2e	40	f9	88	2e	00	f9	95	22	00	f9	a0	00	00	37	08	00	40	b9	08	05	00	71	08	00	00	b9	60	00	00	54
95	22	40	f9	00	00	00	14	fd	7b	bf	a9	fd	03	00	91	00	00	00	94	fd	7b	c1	a8	95	22	40	f9	00	00	00	14	1f	20	03	d5	00	08	00	00	90	08	01	40	f9	08	89	40	39	48	00	00	37	00

```

_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP

```

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 \_LOAD\_FAST\_BORROW\_1

\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00

\_GUARD\_TYPE\_VERSION  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

# Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 \_GUARD\_TYPE\_VERSION

\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00

\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 \_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT

\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00

\_GUARD\_KEYS\_VERSION  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

# Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00  
\_GUARD\_KEYS\_VERSION

\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP



# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00

\_LOAD\_ATTR\_METHOD\_WITH\_VALUES  
\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00  
\_LOAD\_ATTR\_METHOD\_WITH\_VALUES

\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00

\_SET\_IP  
\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
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00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 \_SET\_IP

\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00

\_CHECK\_FUNCTION\_VERSION  
\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

```
a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 _CHECK_FUNCTION_VERSION
```

```
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00

\_CHECK\_FUNCTION\_EXACT\_ARGS  
\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

```
a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 _CHECK_FUNCTION_EXACT_ARGS
```

```
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```



# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00

\_CHECK\_STACK\_SPACE\_OPERAND  
\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

```
a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00
_CHECK_STACK_SPACE_OPERAND
```

```
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00

\_CHECK\_RECURSION\_REMAINING  
\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 \_CHECK\_RECURSION\_REMAINING

\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00

\_LOAD\_CONST\_INLINE  
\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

```
a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 _LOAD_CONST_INLINE
```

```
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00

\_SET\_IP  
\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

```
a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 _SET_IP
```

```
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```



# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00

\_STORE\_FAST\_2  
\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 \_STORE\_FAST\_2

\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00

\_CHECK\_VALIDITY  
\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00

\_LOAD\_FAST\_BORROW\_1  
\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 \_LOAD\_FAST\_BORROW\_1

\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00

\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT  
\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

```
a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00
```

\_\_GUARD\_DORV\_VALUES\_INST\_ATTR\_FROM\_DICT

```
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00

\_GUARD\_KEYS\_VERSION  
\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP



# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 \_GUARD\_KEYS\_VERSION

\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00  
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00

\_CHECK\_FUNCTION  
\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00  
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 \_CHECK\_FUNCTION

\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00  
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00  
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00

\_LOAD\_CONST\_INLINE  
\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

```
a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 _LOAD_CONST_INLINE
```

```
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00  
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00  
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8  
00 00 00 14 1f 20 03 d5 00

\_PUSH\_NULL  
\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

```
a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8
00 00 00 14 1f 20 03 d5 00 _PUSH_NULL
```

```
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00  
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00  
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8  
00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00

\_LOAD\_FAST\_BORROW\_2  
\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP



# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00  
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00  
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8  
00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 \_LOAD\_FAST\_BORROW\_2

\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00  
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00  
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8  
00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00

\_SET\_IP  
\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00  
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00  
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8  
00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 \_SET\_IP

\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00  
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00  
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8  
00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 08 00 00 90 08 01 40 f9 88 1e 00  
f9 00 00 00 14 00

\_CALL\_BUILTIN\_FAST\_WITH\_KEYWORDS  
\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

# Background

## Machine Code

```
a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8
00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 08 00 00 90 08 01 40 f9 88 1e 00
f9 00 00 00 14 00 _CALL_BUILTIN_FAST_WITH_KEYWORDS
```

```
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Background

## Machine Code

\_CHECK\_PERIODIC  
\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00  
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00  
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8  
00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 08 00 00 90 08 01 40 f9 88 1e 00  
f9 00 00 00 14 00 ff c3 01 d1 fd 7b 06 a9 fd 83 01 91 08 00 00 90 08 01 40 f9 0a 3d 00 12 fb 03 2a 2a b7 da 7b f8 29 00 80 92 3a 21 28 cb b3 7a 7a f8 7c fa 7f 92  
e9 00 80 92 ff 06 00 f1 29 11 9f 9a 58 05 8a 1a 8a 07 40 f9 0b 00 00 90 6b 01 40 f9 5f 01 0b eb c1 02 00 54 8a 0b 40 f9 4b 11 40 b9 7f 09 02 71 41 02 00 54 a8 2e  
28 cb 95 22 00 f9 4a 05 40 f9 ea 03 00 f9 ea 23 00 91 00 01 09 8b 42 21 00 91 e1 03 18 aa 00 00 00 94 95 22 00 f9 40 01 00 b4 f9 03 00 aa 88 0b 40 f9 08 41 40 39  
28 06 28 37 80 0f 40 f9 30 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 18 05 00 91 b9 22 00 d1 3c 00  
80 52 05 00 00 14 18 07 00 d1 39 23 00 d1 1f 07 00 f1 49 01 00 54 20 03 40 f9 3c 03 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54 00 00 00 94  
f4 ff ff 17 28 00 80 52 a8 da 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 a8 7a 3a f8 f3 00 00 37 68 02  
40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b 40 00 00 14 00 00 80 d2 e8 03 40 f9 e1 03 19 aa e2 03 18 aa 03 00 80 d2  
00 01 3f d6 e0 03 00 f9 9c 22 40 f9 20 23 00 d1 e1 23 00 91 00 00 00 94 9c 22 00 f9 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 19 05 00 91 b5 22  
00 d1 38 00 80 52 05 00 00 14 39 07 00 d1 b5 22 00 d1 3f 07 00 f1 49 01 00 54 a0 02 40 f9 b8 02 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54  
00 00 00 94 f4 ff ff 17 28 00 80 52 88 db 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 88 7b 3a f8 f3 00  
00 37 68 02 40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b e9 03 40 f9 09 01 00 b4 28 0d 40 79 08 01 40 92 08 01 09 aa  
a8 86 00 f8 fd 7b 46 a9 ff c3 01 91 00 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 00

# Background

## Machine Code

	a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
	00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
	41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
	00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
	95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
	00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
	00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
	82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
	00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
	90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
	e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
	00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a
	40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14
	00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8
	00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9
	a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20
	03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09
	05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00
	00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00
	54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8
	00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 08 00 00 90 08 01 40 f9 88 1e 00
	f9 00 00 00 14 00 ff c3 01 d1 fd 7b 06 a9 fd 83 01 91 08 00 00 90 08 01 40 f9 0a 3d 00 12 fb 03 2a 2a b7 da 7b f8 29 00 80 92 3a 21 28 cb b3 7a 7a f8 7c fa 7f 92
	e9 00 80 92 ff 06 00 f1 29 11 9f 9a 58 05 8a 1a 8a 07 40 f9 0b 00 00 90 6b 01 40 f9 5f 01 0b eb c1 02 00 54 8a 0b 40 f9 4b 11 40 b9 7f 09 02 71 41 02 00 54 a8 2e
	28 cb 95 22 00 f9 4a 05 40 f9 ea 03 00 f9 ea 23 00 91 00 01 09 8b 42 21 00 91 e1 03 18 aa 00 00 00 94 95 22 00 f9 40 01 00 b4 f9 03 00 aa 88 0b 40 f9 08 41 40 39
	28 06 28 37 80 0f 40 f9 30 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 18 05 00 91 b9 22 00 d1 3c 00
	80 52 05 00 00 14 18 07 00 d1 39 23 00 d1 1f 07 00 f1 49 01 00 54 20 03 40 f9 3c 03 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54 00 00 00 94
	f4 ff ff 17 28 00 80 52 a8 da 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 a8 7a 3a f8 f3 00 00 37 68 02
	40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b 40 00 00 14 00 00 80 d2 e8 03 40 f9 e1 03 19 aa e2 03 18 aa 03 00 80 d2
	00 01 3f d6 e0 03 00 f9 9c 22 40 f9 20 23 00 d1 e1 23 00 91 00 00 00 94 9c 22 00 f9 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 19 05 00 91 b5 22
	00 d1 38 00 80 52 05 00 00 14 39 07 00 d1 b5 22 00 d1 3f 07 00 f1 49 01 00 54 a0 02 40 f9 b8 02 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54
	00 00 00 94 f4 ff ff 17 28 00 80 52 88 db 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 88 7b 3a f8 f3 00
	00 37 68 02 40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b e9 03 40 f9 09 01 00 b4 28 0d 40 79 08 01 40 92 08 01 09 aa
_CHECK_VALIDITY	
_SET_IP	
_POP_TOP	
_CHECK_PERIODIC	a8 86 00 f8 fd 7b 46 a9 ff c3 01 91 00 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 00 _CHECK_PERIODIC
_JUMP_TO_TOP	

# Background

## Machine Code

\_CHECK\_VALIDITY  
\_SET\_IP  
\_POP\_TOP  
\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00  
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00  
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8  
00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 08 00 00 90 08 01 40 f9 88 1e 00  
f9 00 00 00 14 00 ff c3 01 d1 fd 7b 06 a9 fd 83 01 91 08 00 00 90 08 01 40 f9 0a 3d 00 12 fb 03 2a 2a b7 da 7b f8 29 00 80 92 3a 21 28 cb b3 7a 7a f8 7c fa 7f 92  
e9 00 80 92 ff 06 00 f1 29 11 9f 9a 58 05 8a 1a 8a 07 40 f9 0b 00 00 90 6b 01 40 f9 5f 01 0b eb c1 02 00 54 8a 0b 40 f9 4b 11 40 b9 7f 09 02 71 41 02 00 54 a8 2e  
28 cb 95 22 00 f9 4a 05 40 f9 ea 03 00 f9 ea 23 00 91 00 01 09 8b 42 21 00 91 e1 03 18 aa 00 00 00 94 95 22 00 f9 40 01 00 b4 f9 03 00 aa 88 0b 40 f9 08 41 40 39  
28 06 28 37 80 0f 40 f9 30 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 18 05 00 91 b9 22 00 d1 3c 00  
80 52 05 00 00 14 18 07 00 d1 39 23 00 d1 1f 07 00 f1 49 01 00 54 20 03 40 f9 3c 03 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54 00 00 00 94  
f4 ff ff 17 28 00 80 52 a8 da 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 a8 7a 3a f8 f3 00 00 37 68 02  
40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b 40 00 00 14 00 00 80 d2 e8 03 40 f9 e1 03 19 aa e2 03 18 aa 03 00 80 d2  
00 01 3f d6 e0 03 00 f9 9c 22 40 f9 20 23 00 d1 e1 23 00 91 00 00 00 94 9c 22 00 f9 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 19 05 00 91 b5 22  
00 d1 38 00 80 52 05 00 00 14 39 07 00 d1 b5 22 00 d1 3f 07 00 f1 49 01 00 54 a0 02 40 f9 b8 02 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54  
00 00 00 94 f4 ff ff 17 28 00 80 52 88 db 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 88 7b 3a f8 f3 00  
00 37 68 02 40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b e9 03 40 f9 09 01 00 b4 28 0d 40 79 08 01 40 92 08 01 09 aa  
a8 86 00 f8 fd 7b 46 a9 ff c3 01 91 00 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 00 c8 0e 40 f9 1f 1d 40 f2 40 01 00 54 fd 7b bf a9 fd 03 00 91 95 22 00 f9 e0  
03 16 aa 00 00 00 94 95 22 40 f9 fd 7b c1 a8 40 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00



# Background

## Machine Code

	a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
	00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
	41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
	00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
	95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
	00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
	00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
	82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
	00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
	90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
	e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
	00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a
	40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14
	00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8
	00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9
	a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20
	03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09
	05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00
	00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00
	54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8
	00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 08 00 00 90 08 01 40 f9 88 1e 00
	f9 00 00 00 14 00 ff c3 01 d1 fd 7b 06 a9 fd 83 01 91 08 00 00 90 08 01 40 f9 0a 3d 00 12 fb 03 2a 2a b7 da 7b f8 29 00 80 92 3a 21 28 cb b3 7a 7a f8 7c fa 7f 92
	e9 00 80 92 ff 06 00 f1 29 11 9f 9a 58 05 8a 1a 8a 07 40 f9 0b 00 00 90 6b 01 40 f9 5f 01 0b eb c1 02 00 54 8a 0b 40 f9 4b 11 40 b9 7f 09 02 71 41 02 00 54 a8 2e
	28 cb 95 22 00 f9 4a 05 40 f9 ea 03 00 f9 ea 23 00 91 00 01 09 8b 42 21 00 91 e1 03 18 aa 00 00 00 94 95 22 00 f9 40 01 00 b4 f9 03 00 aa 88 0b 40 f9 08 41 40 39
	28 06 28 37 80 0f 40 f9 30 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 18 05 00 91 b9 22 00 d1 3c 00
	80 52 05 00 00 14 18 07 00 d1 39 23 00 d1 1f 07 00 f1 49 01 00 54 20 03 40 f9 3c 03 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54 00 00 00 94
	f4 ff ff 17 28 00 80 52 a8 da 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 a8 7a 3a f8 f3 00 00 37 68 02
	40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b 40 00 00 14 00 00 80 d2 e8 03 40 f9 e1 03 19 aa e2 03 18 aa 03 00 80 d2
	00 01 3f d6 e0 03 00 f9 9c 22 40 f9 20 23 00 d1 e1 23 00 91 00 00 00 94 9c 22 00 f9 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 19 05 00 91 b5 22
	00 d1 38 00 80 52 05 00 00 14 39 07 00 d1 b5 22 00 d1 3f 07 00 f1 49 01 00 54 a0 02 40 f9 b8 02 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54
	00 00 00 94 f4 ff ff 17 28 00 80 52 88 db 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 88 7b 3a f8 f3 00
_SET_IP	00 37 68 02 40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b e9 03 40 f9 09 01 00 b4 28 0d 40 79 08 01 40 92 08 01 09 aa
_POP_TOP	a8 86 00 f8 fd 7b 46 a9 ff c3 01 91 00 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 00 c8 0e 40 f9 1f 1d 40 f2 40 01 00 54 fd 7b bf a9 fd 03 00 91 95 22 00 f9 e0
_CHECK_PERIODIC	03 16 aa 00 00 00 94 95 22 40 f9 fd 7b c1 a8 40 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 _CHECK_VALIDITY
_JUMP_TO_TOP	

# Background

## Machine Code

	a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
	00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
	41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
	00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
	95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
	00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
	00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
	82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
	00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
	90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
	e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
	00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a
	40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14
	00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8
	00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9
	a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20
	03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09
	05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00
	00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00
	54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8
	00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 08 00 00 90 08 01 40 f9 88 1e 00
	f9 00 00 00 14 00 ff c3 01 d1 fd 7b 06 a9 fd 83 01 91 08 00 00 90 08 01 40 f9 0a 3d 00 12 fb 03 2a 2a b7 da 7b f8 29 00 80 92 3a 21 28 cb b3 7a 7a f8 7c fa 7f 92
	e9 00 80 92 ff 06 00 f1 29 11 9f 9a 58 05 8a 1a 8a 07 40 f9 0b 00 00 90 6b 01 40 f9 5f 01 0b eb c1 02 00 54 8a 0b 40 f9 4b 11 40 b9 7f 09 02 71 41 02 00 54 a8 2e
	28 cb 95 22 00 f9 4a 05 40 f9 ea 03 00 f9 ea 23 00 91 00 01 09 8b 42 21 00 91 e1 03 18 aa 00 00 00 94 95 22 00 f9 40 01 00 b4 f9 03 00 aa 88 0b 40 f9 08 41 40 39
	28 06 28 37 80 0f 40 f9 30 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 18 05 00 91 b9 22 00 d1 3c 00
	80 52 05 00 00 14 18 07 00 d1 39 23 00 d1 1f 07 00 f1 49 01 00 54 20 03 40 f9 3c 03 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54 00 00 00 94
	f4 ff ff 17 28 00 80 52 a8 da 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 a8 7a 3a f8 f3 00 00 37 68 02
	40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b 40 00 00 14 00 00 80 d2 e8 03 40 f9 e1 03 19 aa e2 03 18 aa 03 00 80 d2
	00 01 3f d6 e0 03 00 f9 9c 22 40 f9 20 23 00 d1 e1 23 00 91 00 00 00 94 9c 22 00 f9 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 19 05 00 91 b5 22
	00 d1 38 00 80 52 05 00 00 14 39 07 00 d1 b5 22 00 d1 3f 07 00 f1 49 01 00 54 a0 02 40 f9 b8 02 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54
	00 00 00 94 f4 ff ff 17 28 00 80 52 88 db 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 88 7b 3a f8 f3 00
_SET_IP	00 37 68 02 40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b e9 03 40 f9 09 01 00 b4 28 0d 40 79 08 01 40 92 08 01 09 aa
_POP_TOP	a8 86 00 f8 fd 7b 46 a9 ff c3 01 91 00 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 00 c8 0e 40 f9 1f 1d 40 f2 40 01 00 54 fd 7b bf a9 fd 03 00 91 95 22 00 f9 e0
_CHECK_PERIODIC	03 16 aa 00 00 00 94 95 22 40 f9 fd 7b c1 a8 40 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00
_JUMP_TO_TOP	00 14 00

# Background

## Machine Code

_POP_TOP	a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
_CHECK_PERIODIC	00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
_JUMP_TO_TOP	41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
	00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
	95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
	00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
	00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
	82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
	00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
	90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
	e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
	00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a
	40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14
	00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8
	00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9
	a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20
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	05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00
	00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00
	54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8
	00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 08 00 00 90 08 01 40 f9 88 1e 00
	f9 00 00 00 14 00 ff c3 01 d1 fd 7b 06 a9 fd 83 01 91 08 00 00 90 08 01 40 f9 0a 3d 00 12 fb 03 2a 2a b7 da 7b f8 29 00 80 92 3a 21 28 cb b3 7a 7a f8 7c fa 7f 92
	e9 00 80 92 ff 06 00 f1 29 11 9f 9a 58 05 8a 1a 8a 07 40 f9 0b 00 00 90 6b 01 40 f9 5f 01 0b eb c1 02 00 54 8a 0b 40 f9 4b 11 40 b9 7f 09 02 71 41 02 00 54 a8 2e
	28 cb 95 22 00 f9 4a 05 40 f9 ea 03 00 f9 ea 23 00 91 00 01 09 8b 42 21 00 91 e1 03 18 aa 00 00 00 94 95 22 00 f9 40 01 00 b4 f9 03 00 aa 88 0b 40 f9 08 41 40 39
	28 06 28 37 80 0f 40 f9 30 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 18 05 00 91 b9 22 00 d1 3c 00
	80 52 05 00 00 14 18 07 00 d1 39 23 00 d1 1f 07 00 f1 49 01 00 54 20 03 40 f9 3c 03 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54 00 00 00 94
	f4 ff ff 17 28 00 80 52 a8 da 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 a8 7a 3a f8 f3 00 00 37 68 02
	40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b 40 00 00 14 00 00 80 d2 e8 03 40 f9 e1 03 19 aa e2 03 18 aa 03 00 80 d2
	00 01 3f d6 e0 03 00 f9 9c 22 40 f9 20 23 00 d1 e1 23 00 91 00 00 00 94 9c 22 00 f9 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 19 05 00 91 b5 22
	00 d1 38 00 80 52 05 00 00 14 39 07 00 d1 b5 22 00 d1 3f 07 00 f1 49 01 00 54 a0 02 40 f9 b8 02 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54
	00 00 00 94 f4 ff ff 17 28 00 80 52 88 db 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 88 7b 3a f8 f3 00
	00 37 68 02 40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b e9 03 40 f9 09 01 00 b4 28 0d 40 79 08 01 40 92 08 01 09 aa
	a8 86 00 f8 fd 7b 46 a9 ff c3 01 91 00 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 00 c8 0e 40 f9 1f 1d 40 f2 40 01 00 54 fd 7b bf a9 fd 03 00 91 95 22 00 f9 e0
	03 16 aa 00 00 00 94 95 22 40 f9 fd 7b c1 a8 40 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00
	00 14 00 _SET_IP

# Background

## Machine Code

	a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
	00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
	41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
	00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
	95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
	00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
	00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
	82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
	00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
	90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
	e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
	00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a
	40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14
	00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8
	00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9
	a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20
	03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09
	05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00
	00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00
	54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8
	00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 08 00 00 90 08 01 40 f9 88 1e 00
	f9 00 00 00 14 00 ff c3 01 d1 fd 7b 06 a9 fd 83 01 91 08 00 00 90 08 01 40 f9 0a 3d 00 12 fb 03 2a 2a b7 da 7b f8 29 00 80 92 3a 21 28 cb b3 7a 7a f8 7c fa 7f 92
	e9 00 80 92 ff 06 00 f1 29 11 9f 9a 58 05 8a 1a 8a 07 40 f9 0b 00 00 90 6b 01 40 f9 5f 01 0b eb c1 02 00 54 8a 0b 40 f9 4b 11 40 b9 7f 09 02 71 41 02 00 54 a8 2e
	28 cb 95 22 00 f9 4a 05 40 f9 ea 03 00 f9 ea 23 00 91 00 01 09 8b 42 21 00 91 e1 03 18 aa 00 00 00 94 95 22 00 f9 40 01 00 b4 f9 03 00 aa 88 0b 40 f9 08 41 40 39
	28 06 28 37 80 0f 40 f9 30 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 18 05 00 91 b9 22 00 d1 3c 00
	80 52 05 00 00 14 18 07 00 d1 39 23 00 d1 1f 07 00 f1 49 01 00 54 20 03 40 f9 3c 03 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54 00 00 00 94
	f4 ff ff 17 28 00 80 52 a8 da 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 a8 7a 3a f8 f3 00 00 37 68 02
	40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b 40 00 00 14 00 00 80 d2 e8 03 40 f9 e1 03 19 aa e2 03 18 aa 03 00 80 d2
	00 01 3f d6 e0 03 00 f9 9c 22 40 f9 20 23 00 d1 e1 23 00 91 00 00 00 94 9c 22 00 f9 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 19 05 00 91 b5 22
	00 d1 38 00 80 52 05 00 00 14 39 07 00 d1 b5 22 00 d1 3f 07 00 f1 49 01 00 54 a0 02 40 f9 b8 02 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54
	00 00 00 94 f4 ff ff 17 28 00 80 52 88 db 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 88 7b 3a f8 f3 00
	00 37 68 02 40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b e9 03 40 f9 09 01 00 b4 28 0d 40 79 08 01 40 92 08 01 09 aa
_POP_TOP	a8 86 00 f8 fd 7b 46 a9 ff c3 01 91 00 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 00 c8 0e 40 f9 1f 1d 40 f2 40 01 00 54 fd 7b bf a9 fd 03 00 91 95 22 00 f9 e0
_CHECK_PERIODIC	03 16 aa 00 00 00 94 95 22 40 f9 fd 7b c1 a8 40 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00
_JUMP_TO_TOP	00 14 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00

# Background

## Machine Code

	a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9
	00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25
	41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14
	00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54
	95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00
	00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41
	00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8
	82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00
	00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00
	90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb
	e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a
	00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a
	40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14
	00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8
	00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9
	a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20
	03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09
	05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00
	00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00
	54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8
	00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 08 00 00 90 08 01 40 f9 88 1e 00
	f9 00 00 00 14 00 ff c3 01 d1 fd 7b 06 a9 fd 83 01 91 08 00 00 90 08 01 40 f9 0a 3d 00 12 fb 03 2a 2a b7 da 7b f8 29 00 80 92 3a 21 28 cb b3 7a 7a f8 7c fa 7f 92
	e9 00 80 92 ff 06 00 f1 29 11 9f 9a 58 05 8a 1a 8a 07 40 f9 0b 00 00 90 6b 01 40 f9 5f 01 0b eb c1 02 00 54 8a 0b 40 f9 4b 11 40 b9 7f 09 02 71 41 02 00 54 a8 2e
	28 cb 95 22 00 f9 4a 05 40 f9 ea 03 00 f9 ea 23 00 91 00 01 09 8b 42 21 00 91 e1 03 18 aa 00 00 00 94 95 22 00 f9 40 01 00 b4 f9 03 00 aa 88 0b 40 f9 08 41 40 39
	28 06 28 37 80 0f 40 f9 30 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 18 05 00 91 b9 22 00 d1 3c 00
	80 52 05 00 00 14 18 07 00 d1 39 23 00 d1 1f 07 00 f1 49 01 00 54 20 03 40 f9 3c 03 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54 00 00 00 94
	f4 ff ff 17 28 00 80 52 a8 da 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 a8 7a 3a f8 f3 00 00 37 68 02
	40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b 40 00 00 14 00 00 80 d2 e8 03 40 f9 e1 03 19 aa e2 03 18 aa 03 00 80 d2
	00 01 3f d6 e0 03 00 f9 9c 22 40 f9 20 23 00 d1 e1 23 00 91 00 00 00 94 9c 22 00 f9 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 19 05 00 91 b5 22
	00 d1 38 00 80 52 05 00 00 14 39 07 00 d1 b5 22 00 d1 3f 07 00 f1 49 01 00 54 a0 02 40 f9 b8 02 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54
	00 00 00 94 f4 ff ff 17 28 00 80 52 88 db 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 88 7b 3a f8 f3 00
	00 37 68 02 40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b e9 03 40 f9 09 01 00 b4 28 0d 40 79 08 01 40 92 08 01 09 aa
	a8 86 00 f8 fd 7b 46 a9 ff c3 01 91 00 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 00 c8 0e 40 f9 1f 1d 40 f2 40 01 00 54 fd 7b bf a9 fd 03 00 91 95 22 00 f9 e0
_CHECK_PERIODIC	03 16 aa 00 00 00 94 95 22 40 f9 fd 7b c1 a8 40 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00
_JUMP_TO_TOP	00 14 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 _POP_TOP

# Background

## Machine Code

\_CHECK\_PERIODIC  
\_JUMP\_TO\_TOP

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
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# Background

## Machine Code

\_JUMP\_TO\_TOP

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# Background

## Machine Code

\_JUMP\_TO\_TOP

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# Background

## Machine Code

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54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8
00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 08 00 00 90 08 01 40 f9 88 1e 00
f9 00 00 00 14 00 ff c3 01 d1 fd 7b 06 a9 fd 83 01 91 08 00 00 90 08 01 40 f9 0a 3d 00 12 fb 03 2a 2a b7 da 7b f8 29 00 80 92 3a 21 28 cb b3 7a 7a f8 7c fa 7f 92
e9 00 80 92 ff 06 00 f1 29 11 9f 9a 58 05 8a 1a 8a 07 40 f9 0b 00 00 90 6b 01 40 f9 5f 01 0b eb c1 02 00 54 8a 0b 40 f9 4b 11 40 b9 7f 09 02 71 41 02 00 54 a8 2e
28 cb 95 22 00 f9 4a 05 40 f9 ea 03 00 f9 ea 23 00 91 00 01 09 8b 42 21 00 91 e1 03 18 aa 00 00 00 94 95 22 00 f9 40 01 00 b4 f9 03 00 aa 88 0b 40 f9 08 41 40 39
28 06 28 37 80 0f 40 f9 30 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 18 05 00 91 b9 22 00 d1 3c 00
80 52 05 00 00 14 18 07 00 d1 39 23 00 d1 1f 07 00 f1 49 01 00 54 20 03 40 f9 3c 03 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54 00 00 00 94
f4 ff ff 17 28 00 80 52 a8 da 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b 40 00 00 14 00 00 80 d2 e8 03 40 f9 e1 03 19 aa e2 03 18 aa 03 00 80 d2
40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b 40 00 00 14 00 00 80 d2 e8 03 40 f9 e1 03 19 aa e2 03 18 aa 03 00 80 d2
00 01 3f d6 e0 03 00 f9 9c 22 40 f9 20 23 00 d1 e1 23 00 91 00 00 00 94 9c 22 00 f9 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 19 05 00 91 b5 22
00 d1 38 00 80 52 05 00 00 14 39 07 00 d1 b5 22 00 d1 3f 07 00 f1 49 01 00 54 a0 02 40 f9 b8 02 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54
00 00 00 94 f4 ff ff 17 28 00 80 52 88 db 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 88 7b 3a f8 f3 00
00 37 68 02 40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b e9 03 40 f9 09 01 00 b4 28 0d 40 79 08 01 40 92 08 01 09 aa
a8 86 00 f8 fd 7b 46 a9 ff c3 01 91 00 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 00 c8 0e 40 f9 1f 1d 40 f2 40 01 00 54 fd 7b bf a9 fd 03 00 91 95 22 00 f9 e0
03 16 aa 00 00 00 94 95 22 40 f9 fd 7b c1 a8 40 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00
00 14 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a0 8e 5f f8 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00
00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 c8 0e 40 f9 1f 1d 40 f2 40 01 00 54 fd 7b bf a9 fd 03 00 91 95 22 00
f9 e0 03 16 aa 00 00 00 94 95 22 40 f9 fd 7b c1 a8 40 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 _JUMP_TO_TOP
```

# Background

## Machine Code

a8 82 5f f8 08 f9 7f 92 08 05 40 f9 09 00 00 90 29 01 40 f9 1f 01 09 eb 40 00 00 54 00 00 00 14 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 09 0d 40 f9 c9  
00 00 b4 0a 09 40 f9 29 09 40 f9 5f 01 09 eb 62 00 00 54 00 00 00 14 00 00 00 14 09 00 80 92 09 09 00 f9 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 0a 25  
41 a9 29 0d 40 f9 4b 05 00 91 0b 09 00 f9 28 79 6a f8 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14  
00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 2e 40 f9 88 2e 00 f9 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54  
95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00  
00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 81 41 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41  
00 00 54 00 00 00 14 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09 05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8  
82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 09 00  
00 90 29 01 40 f9 2a 01 40 b9 ca 00 f8 37 4a 05 00 11 2a 01 00 b9 a9 a2 3f a9 b5 22 00 91 00 00 00 14 29 01 40 b2 a9 a2 3f a9 b5 22 00 91 00 00 00 14 00 08 00 00  
90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 08 00 00 90 08 01 40 f9 29 00 80 92 28 21 28 cb a8 7a 68 f8 08 f9 7f 92 09 05 40 f9 0a 00 00 90 4a 01 40 f9 3f 01 0a eb  
e1 00 00 54 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 00 08 00 00 90 08 01 40 f9 08 3d 00 12 e9 03 28 2a a9 da 69 f8 2a  
00 80 12 4a 01 08 4b aa da 6a f8 4a f9 7f 92 4a 19 40 f9 4a 35 40 b9 3f 05 00 f1 08 05 88 1a 5f 01 08 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 c8 7a  
40 f9 68 01 00 b4 09 00 00 90 29 01 40 f9 ca 7e 40 f9 48 01 08 cb 08 fd 43 93 1f c1 29 eb 8d 00 00 54 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14  
00 c8 32 40 b9 1f 05 00 71 4c 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8  
00 00 00 14 08 01 40 b2 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a8 8e 5f f8 80 32 40 f9 88 32 00 f9 95 22 00 f9  
a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00 00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20  
03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00 00 14 00 88 2e 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 a8 82 5f f8 08 f9 7f 92 09  
05 40 f9 29 11 40 f9 08 01 09 8b 08 0d 40 39 48 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 a8 82 5f f8 08 f9 7f 92 08 05 40 f9 08 b9 41 f9 08 0d 40 b9 09 00  
00 90 29 01 40 f9 1f 01 09 6b 41 00 00 54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 88 0a 40 f9 08 f9 7f 92 08 91 40 b9 09 00 00 90 29 01 40 f9 1f 01 09 6b 41 00 00  
54 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 09 01 40 b9 a9 00 f8 37 29 05 00 11 09 01 00 b9 a8 86 00 f8 00 00 00 14 08 01 40 b2 a8 86 00 f8  
00 00 00 14 1f 20 03 d5 00 28 00 80 52 a8 86 00 f8 00 00 00 14 1f 20 03 d5 00 88 32 40 f9 08 01 40 b2 a8 86 00 f8 00 00 00 14 00 08 00 00 90 08 01 40 f9 88 1e 00  
f9 00 00 00 14 00 ff c3 01 d1 fd 7b 06 a9 fd 83 01 91 08 00 00 90 08 01 40 f9 0a 3d 00 12 fb 03 2a 2a b7 da 7b f8 29 00 80 92 3a 21 28 cb b3 7a 7a f8 7c fa 7f 92  
e9 00 80 92 ff 06 00 f1 29 11 9f 9a 58 05 8a 1a 8a 07 40 f9 0b 00 00 90 6b 01 40 f9 5f 01 0b eb c1 02 00 54 8a 0b 40 f9 4b 11 40 b9 7f 09 02 71 41 02 00 54 a8 2e  
28 cb 95 22 00 f9 4a 05 40 f9 ea 03 00 f9 ea 23 00 91 00 01 09 8b 42 21 00 91 e1 03 18 aa 00 00 00 94 95 22 00 f9 40 01 00 b4 f9 03 00 aa 88 0b 40 f9 08 41 40 39  
28 06 28 37 80 0f 40 f9 30 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 18 05 00 91 b9 22 00 d1 3c 00  
80 52 05 00 00 14 18 07 00 d1 39 23 00 d1 1f 07 00 f1 49 01 00 54 20 03 40 f9 3c 03 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54 00 00 00 94  
f4 ff ff 17 28 00 80 52 a8 da 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 a8 7a 3a f8 f3 00 00 37 68 02  
40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b 40 00 00 14 00 00 80 d2 e8 03 40 f9 e1 03 19 aa e2 03 18 aa 03 00 80 d2  
00 01 3f d6 e0 03 00 f9 9c 22 40 f9 20 23 00 d1 e1 23 00 91 00 00 00 94 9c 22 00 f9 08 00 00 90 08 01 40 f9 1f 3d 00 72 60 02 00 54 08 3d 40 92 19 05 00 91 b5 22  
00 d1 38 00 80 52 05 00 00 14 39 07 00 d1 b5 22 00 d1 3f 07 00 f1 49 01 00 54 a0 02 40 f9 b8 02 00 f9 40 ff 07 37 08 00 40 b9 08 05 00 71 08 00 00 b9 c1 fe ff 54  
00 00 00 94 f4 ff ff 17 28 00 80 52 88 db 3b f8 f7 00 00 37 e8 02 40 b9 08 05 00 71 e8 02 00 b9 61 00 00 54 e0 03 17 aa 00 00 00 94 28 00 80 52 88 7b 3a f8 f3 00  
00 37 68 02 40 b9 08 05 00 71 68 02 00 b9 61 00 00 54 e0 03 13 aa 00 00 00 94 88 22 40 f9 15 0d 1a 8b e9 03 40 f9 09 01 00 b4 28 0d 40 79 08 01 40 92 08 01 09 aa  
a8 86 00 f8 fd 7b 46 a9 ff c3 01 91 00 00 00 14 fd 7b 46 a9 ff c3 01 91 00 00 00 14 00 c8 0e 40 f9 1f 1d 40 f2 40 01 00 54 fd 7b bf a9 fd 03 00 91 95 22 00 f9 e0  
03 16 aa 00 00 00 94 95 22 40 f9 fd 7b c1 a8 40 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 08 00 00 90 08 01 40 f9 08 89 40 39 48 00 00 37 00 00 00 14 00 00  
00 14 00 08 00 00 90 08 01 40 f9 88 1e 00 f9 00 00 00 14 00 a0 8e 5f f8 95 22 00 f9 a0 00 00 37 08 00 40 b9 08 05 00 71 08 00 00 b9 60 00 00 54 95 22 40 f9 00 00  
00 14 fd 7b bf a9 fd 03 00 91 00 00 00 94 fd 7b c1 a8 95 22 40 f9 00 00 00 14 1f 20 03 d5 00 c8 0e 40 f9 1f 1d 40 f2 40 01 00 54 fd 7b bf a9 fd 03 00 91 95 22 00  
f9 e0 03 16 aa 00 00 00 94 95 22 40 f9 fd 7b c1 a8 40 00 00 34 00 00 00 14 00 00 00 14 1f 20 03 d5 00 00 00 00 14 1f 20 03 d5 00

# Background

## Region Selection

# Region Selection

```
_ITER_CHECK_LIST
_GUARD_NOT_EXHAUSTED_LIST
_ITER_NEXT_LIST_TIER_TWO
_SET_IP
_STORE_FAST_1
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
```

```
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Region Selection

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

# Region Selection

## What?

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

# Region Selection

## What? Where?

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

# Region Selection

## What? Where? When?

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```



# Region Selection

## What? Where? When? Why?

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
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            sound += sound  
        print(sound)
```

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class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

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class Duck:  
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        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    sound = duck.quack()  
    if duck.echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
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            sound += sound  
        print(sound)
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```
class Duck:  
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```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    sound = duck.quack()  
    if duck.echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:
```

```
    if duck.echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
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            sound += sound  
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class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
  
        if duck.echo:  
            sound += sound  
        print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"
```

```
if duck.echo:  
    sound += sound  
print(sound)
```



# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
    else:  
  
    if duck.echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
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```
class Duck:  
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    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
    else:  
        sound = duck.quack()  
    if duck.echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
    else:  
        sound = duck.quack()  
    if duck.echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
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        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
  
    else:  
        sound = duck.quack()  
    if duck.echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
    elif duck.__class__ is RubberDuck:  
  
    else:  
        sound = duck.quack()  
    if duck.echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
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        print(sound)
```

```
class Duck:  
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        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
    elif duck.__class__ is RubberDuck:  
        if self.loud:  
            sound = "SQUEAK!"  
        else:  
            sound = "Squeak!"  
    else:  
        sound = duck.quack()  
    if duck.echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
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```
class Duck:  
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class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
    elif duck.__class__ is RubberDuck:  
        if self.loud:  
            sound = "SQUEAK!"  
        else:  
            sound = "Squeak!"  
    else:  
        sound = duck.quack()
```

```
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
    elif duck.__class__ is RubberDuck:  
        if self.loud:  
            sound = "SQUEAK!"  
        else:  
            sound = "Squeak!"  
    else:  
        sound = duck.quack()  
    if duck.__class__ is Duck:  
        __cached_duck_echo = False  
    elif duck.__class__ is RubberDuck:  
        __cached_duck_echo = True  
    else:  
        __cached_duck_echo = duck.echo  
    if __cached_duck_echo:  
        sound += sound  
    print(sound)
```



# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class Duck:  
    def quack(self):  
        return "Quack!"
```

```
class RubberDuck:  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
    elif duck.__class__ is RubberDuck:  
        if self.loud:  
            sound = "SQUEAK!"  
        else:  
            sound = "Squeak!"  
    else:  
        sound = duck.quack()  
    if duck.__class__ is Duck:  
        __cached_duck_echo = False  
    elif duck.__class__ is RubberDuck:  
        __cached_duck_echo = True  
    else:  
        __cached_duck_echo = duck.echo  
    if __cached_duck_echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
    elif duck.__class__ is RubberDuck:  
        if self.loud:  
            sound = "SQUEAK!"  
        else:  
            sound = "Squeak!"  
    else:  
        sound = duck.quack()  
    if duck.__class__ is Duck:  
        __cached_duck_echo = False  
    elif duck.__class__ is RubberDuck:  
        __cached_duck_echo = True  
    else:  
        __cached_duck_echo = duck.echo  
    if __cached_duck_echo:  
        sound += sound  
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```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
    elif duck.__class__ is RubberDuck:  
        if self.loud:  
            sound = "SQUEAK!"  
        else:  
            sound = "Squeak!"  
    else:  
        sound = duck.quack()  
    if duck.__class__ is Duck:  
        __cached_duck_echo = False  
    elif duck.__class__ is RubberDuck:  
        __cached_duck_echo = True  
    else:  
        __cached_duck_echo = duck.echo  
    if __cached_duck_echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def get_ducks(image):  
    for duck in detect_ducks(image):  
        yield duck
```

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
    elif duck.__class__ is RubberDuck:  
        if self.loud:  
            sound = "SQUEAK!"  
        else:  
            sound = "Squeak!"  
    else:  
        sound = duck.quack()  
    if duck.__class__ is Duck:  
        __cached_duck_echo = False  
    elif duck.__class__ is RubberDuck:  
        __cached_duck_echo = True  
    else:  
        __cached_duck_echo = duck.echo  
    if __cached_duck_echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def get_ducks(image):  
    for duck in detect_ducks(image):  
        yield duck  
        yield from duck.ducklings(ugly=True)
```

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
    elif duck.__class__ is RubberDuck:  
        if self.loud:  
            sound = "SQUEAK!"  
        else:  
            sound = "Squeak!"  
    else:  
        sound = duck.quack()  
    if duck.__class__ is Duck:  
        __cached_duck_echo = False  
    elif duck.__class__ is RubberDuck:  
        __cached_duck_echo = True  
    else:  
        __cached_duck_echo = duck.echo  
    if __cached_duck_echo:  
        sound += sound  
    print(sound)
```

# Region Selection

## Entire Functions

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
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# Region Selection

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        sound = duck.quack()  
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        print(sound)
```

```
class Duck:  
    echo = False  
  
    def quack(self):  
        return "Quack!"
```

# Region Selection

## Linear Traces

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
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            sound += sound  
        print(sound)
```

```
class Duck:  
    echo = False  
  
    def quack(self):  
        return "Quack!"
```



# Region Selection

## Linear Traces

```
def simulate_ducks(ducks):  
    for duck in ducks:  
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```

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class Duck:  
    echo = False  
  
    def quack(self):  
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```

```
for duck in ducks:
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# Region Selection

## Linear Traces

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    for duck in ducks:  
        sound = duck.quack()  
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        print(sound)
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    echo = False  
  
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# Region Selection

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class Duck:  
    echo = False  
  
    def quack(self):  
        return "Quack!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:
```

# Region Selection

## Linear Traces

```
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class Duck:  
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# Region Selection

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    if duck.__class__ is Duck:  
        sound = "Quack!"  
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# Region Selection

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class RubberDuck:  
    echo = True  
  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
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    if duck.__class__ is Duck:  
        sound = "Quack!"  
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# Region Selection

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# Region Selection

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        if self.loud: ...  
        sound = "Squeak!"  
        sound += "Squeak!"  
    else: ...
```

# Region Selection

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        sound = duck.quack()  
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```
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    echo = True  
  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
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for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
        print(sound)  
    elif duck.__class__ is RubberDuck:  
        if self.loud: ...  
        sound = "Squeak!Squeak!"  
  
else: ...
```

# Region Selection

## Linear Traces

```
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    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)  
  
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    echo = True  
  
    def quack(self):  
        if self.loud:  
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for duck in ducks:  
    if duck.__class__ is Duck:  
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    elif duck.__class__ is RubberDuck:  
        if self.loud: ...  
        sound = "Squeak!Squeak!"  
        print(sound)  
    else: ...
```

# Region Selection

## Linear Traces

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class RubberDuck:  
    echo = True  
  
    def quack(self):  
        if self.loud:  
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```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
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        if self.loud: ...  
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        print(sound)  
    else: ...
```

# Region Selection

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```
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        sound = duck.quack()  
        if duck.echo:  
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```
class RubberDuck:  
    echo = True  
  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
        print(sound)  
    elif duck.__class__ is RubberDuck:  
        if self.loud: ...  
        sound = "Squeak!Squeak!"  
        print(sound)  
    else: ...
```

# Region Selection

## Linear Traces

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)  
  
class RubberDuck:  
    echo = True  
  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
        print(sound)  
    elif duck.__class__ is RubberDuck:  
        if self.loud: ...  
        sound = "Squeak!Squeak!"  
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```



# Region Selection

## Linear Traces

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class RubberDuck:  
    echo = True  
  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
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```
for duck in ducks:  
    if duck.__class__ is Duck:  
        sound = "Quack!"  
        print(sound)  
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        if self.loud: ...  
        sound = "Squeak!Squeak!"  
        print(sound)  
    else: ...
```

# Region Selection

## Linear Traces

```
def simulate_ducks(ducks):  
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        sound = duck.quack()  
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```
class RubberDuck:  
    echo = True  
  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

# Region Selection

## Meta Traces

```
def simulate_ducks(ducks):  
    for duck in ducks:  
        sound = duck.quack()  
        if duck.echo:  
            sound += sound  
        print(sound)
```

```
class RubberDuck:  
    echo = True  
  
    def quack(self):  
        if self.loud:  
            return "SQUEAK!"  
        return "Squeak!"
```

# Region Selection

## Meta-Traces

- ...just ask Chat about the "first Futurama projection".

# Region Selection

## Meta-Traces

- ...just ask Chat about the "first Futamura projection".

# Region Selection

# **Region Selection**

## **Memory Management**

# Memory Management



# Memory Management

Readable Data

# Memory Management

## Readable Data

```
const char data[4] = {0xc0, 0x03, 0x5f, 0xd6};
```

# Memory Management

## Readable / Writable Data

```
const char data[4] = {0xc0, 0x03, 0x5f, 0xd6};
```

# Memory Management

## Readable / Writable Data

```
char data[4];
```

0xc0

0x03

0x5f

0xd6

# Memory Management

## Readable / Writable Data

```
char data[4];
```

```
data[0] = 0xc0;
```

```
data[1] = 0x03;
```

```
data[2] = 0x5f;
```

```
data[3] = 0xd6;
```

# Memory Management

## Readable / Writable Data

```
char *data = malloc(4);
```

```
data[0] = 0xc0;
```

```
data[1] = 0x03;
```

```
data[2] = 0x5f;
```

```
data[3] = 0xd6;
```

```
free(data);
```

# Memory Management

## Readable / Writable Data

```
char *data = malloc(4);
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```
data[0] = 0xc0;  
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free(data);
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# Memory Management

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```
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# Memory Management

## Readable / Writable / Executable Data

```
char *data = malloc(4);
```

```
data[0] = 0xc0;
```

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data[2] = 0x5f;
```

```
data[3] = 0xd6;
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free(data);
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char *data = malloc(4);
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```
data[0] = 0xc0;
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```

```
data[2] = 0x5f;
```

```
data[3] = 0xd6;
```

```
free(data);
```

# Memory Management

## Readable / Writable / Executable Data

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE | PROT_EXEC,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);  
  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;
```

```
munmap(data, 4096);
```

# Memory Management

## Readable / Writable / Executable Data

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE | PROT_EXEC,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);  
  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;
```

```
munmap(data, 4096);
```

# Memory Management

## Readable / Writable / Executable Data

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE | PROT_EXEC,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);  
  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;
```

```
munmap(data, 4096);
```

# Memory Management

## Readable / Writable / Executable Data

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE | PROT_EXEC,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);  
  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;
```

```
munmap(data, 4096);
```

# Memory Management

## Readable / Writable / Executable Data

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE | PROT_EXEC,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);  
  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;
```

```
munmap(data, 4096);
```

# Memory Management

## Readable / Writable / Executable Data

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE | PROT_EXEC,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);  
  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;  
  
typedef int (*function)(int);  
  
munmap(data, 4096);
```



# Memory Management

## Readable / Writable / Executable Data

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE | PROT_EXEC,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);  
  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;  
  
typedef int (*function)(int);  
data;  
  
munmap(data, 4096);
```

# Memory Management

## Readable / Writable / Executable Data

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE | PROT_EXEC,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);  
  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;  
  
typedef int (*function)(int);  
(function)data;  
  
munmap(data, 4096);
```

# Memory Management

## Readable / Writable / Executable Data

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE | PROT_EXEC,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);  
  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;  
  
typedef int (*function)(int);  
(function)data;  
  
munmap(data, 4096);
```

# Memory Management

## Readable / Writable / Executable Data

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE | PROT_EXEC,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);  
  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;  
  
typedef int (*function)(int);  
((function)data)(42);  
  
munmap(data, 4096);
```

# Memory Management

Readable / Writable / **Executable Data**

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE | PROT_EXEC,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);
```

```
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;
```

```
typedef int (*function)(int);  
((function)data)(42);
```

```
munmap(data, 4096);
```

# Memory Management

Readable / Writable / **Executable Data**

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE | PROT_EXEC,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);
```

```
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;
```

```
typedef int (*function)(int);  
(function)data(42);
```

```
munmap(data, 4096);
```

# Memory Management

Readable / Writable / **Executable Data**

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);
```

```
data[0] = 0xc0;
```

```
data[1] = 0x03;
```

```
data[2] = 0x5f;
```

```
data[3] = 0xd6;
```

```
mprotect(data, 4096, PROT_READ | PROT_EXEC);
```

```
typedef int (*function)(int);
```

```
((function)data)(42);
```

```
munmap(data, 4096);
```

# Memory Management

## Readable / Writable / Executable Data

```
char *data = mmap(NULL, 4096,  
                  PROT_READ | PROT_WRITE,  
                  MAP_ANONYMOUS | MAP_PRIVATE, -1, 0);  
  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;  
mprotect(data, 4096, PROT_READ | PROT_EXEC);  
  
typedef int (*function)(int);  
((function)data)(42);  
  
munmap(data, 4096);
```



# Memory Management

## Readable / Writable / Executable Data

```
char *data = (NULL, 4096,  
  
);  
  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;  
    (data, 4096, );  
  
typedef int (*function)(int);  
(function)data(42);  
  
    (data, 4096);
```

# Memory Management

## Readable / Writable / Executable Data

```
char *data = VirtualAlloc(NULL, 4096, MEM_COMMIT | MEM_RESERVE,  
                           PAGE_READWRITE);  
  
int old;  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;  
VirtualProtect(data, 4096, PAGE_EXECUTE_READ, &old);  
  
typedef int (*function)(int);  
((function)data)(42);  
  
VirtualFree(data, 0, MEM_RELEASE);
```

# Memory Management

## Readable / Writable / Executable Data

```
char *data = VirtualAlloc(NULL, 4096, MEM_COMMIT | MEM_RESERVE,  
                           PAGE_READWRITE);  
  
int old;  
data[0] = 0xc0;  
data[1] = 0x03;  
data[2] = 0x5f;  
data[3] = 0xd6;  
VirtualProtect(data, 4096, PAGE_EXECUTE_READ, &old);  
  
typedef int (*function)(int);  
((function)data)(42);  
  
VirtualFree(data, 0, MEM_RELEASE);
```

# Memory Management

# Memory Management

## Debugging and Profiling

# Debugging and Profiling

# Debugging and Profiling

## Python Profilers

# Debugging and Profiling

## Python Profilers

```
FOR_ITER_LIST
STORE_FAST
LOAD_FAST_BORROW
LOAD_ATTR_METHOD_WITH_VALUES
CALL_PY_EXACT_ARGS
STORE_FAST
LOAD_FAST_BORROW
LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES
TO_BOOL_BOOL
POP_JUMP_IF_FALSE
LOAD_FAST_BORROW
LOAD_FAST_BORROW
BINARY_OP_INPLACE_ADD_UNICODE
STORE_FAST
LOAD_GLOBAL_BUILTIN
LOAD_FAST_BORROW
CALL_BUILTIN_FAST_WITH_KEYWORDS
POP_TOP
JUMP_BACKWARD
```



# Debugging and Profiling

## Python Profilers

```
INSTRUMENTED_FOR_ITER
STORE_FAST
INSTRUMENTED_LINE
LOAD_ATTR_METHOD_WITH_VALUES
INSTRUMENTED_CALL
STORE_FAST
INSTRUMENTED_LINE
LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES
TO_BOOL_BOOL
INSTRUMENTED_POP_JUMP_IF_FALSE
INSTRUMENTED_LINE
LOAD_FAST_BORROW
BINARY_OP_INPLACE_ADD_UNICODE
STORE_FAST
INSTRUMENTED_LINE
LOAD_FAST_BORROW
INSTRUMENTED_CALL
POP_TOP
INSTRUMENTED_JUMP_BACKWARD
```

# Debugging and Profiling

## Python Profilers

INSTRUMENTED_FOR_ITER	_ITER_CHECK_LIST	_GUARD_KEYS_VERSION
STORE_FAST	_GUARD_NOT_EXHAUSTED_LIST	_CHECK_FUNCTION
INSTRUMENTED_LINE	_ITER_NEXT_LIST_TIER_TWO	_LOAD_CONST_INLINE
LOAD_ATTR_METHOD_WITH_VALUES	_SET_IP	_PUSH_NULL
INSTRUMENTED_CALL	_STORE_FAST_1	_LOAD_FAST_BORROW_2
STORE_FAST	_CHECK_VALIDITY	_SET_IP
INSTRUMENTED_LINE	_LOAD_FAST_BORROW_1	_CALL_BUILTIN_FAST_WITH_KEYWORDS
LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES	_GUARD_TYPE_VERSION	_CHECK_PERIODIC
TO_BOOL_BOOL	_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT	_CHECK_VALIDITY
INSTRUMENTED_POP_JUMP_IF_FALSE	_GUARD_KEYS_VERSION	_SET_IP
INSTRUMENTED_LINE	_LOAD_ATTR_METHOD_WITH_VALUES	_POP_TOP
LOAD_FAST_BORROW	_SET_IP	_CHECK_PERIODIC
BINARY_OP_INPLACE_ADD_UNICODE	_CHECK_FUNCTION_VERSION	_JUMP_TO_TOP
STORE_FAST	_CHECK_FUNCTION_EXACT_ARGS	
INSTRUMENTED_LINE	_CHECK_STACK_SPACE_OPERAND	
LOAD_FAST_BORROW	_CHECK_RECURSION_REMAINING	
INSTRUMENTED_CALL	_LOAD_CONST_INLINE	
POP_TOP	_SET_IP	
INSTRUMENTED_JUMP_BACKWARD	_STORE_FAST_2	
	_CHECK_VALIDITY	
	_LOAD_FAST_BORROW_1	
	_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT	

# Debugging and Profiling

## Python Profilers

INSTRUMENTED_FOR_ITER	_ITER_CHECK_LIST	_GUARD_KEYS_VERSION
STORE_FAST	_GUARD_NOT_EXHAUSTED_LIST	_CHECK_FUNCTION
INSTRUMENTED_LINE	_ITER_NEXT_LIST_TIER_TWO	_LOAD_CONST_INLINE
LOAD_ATTR_METHOD_WITH_VALUES	_SET_IP	_PUSH_NULL
INSTRUMENTED_CALL	_STORE_FAST_1	_LOAD_FAST_BORROW_2
STORE_FAST	_CHECK_VALIDITY	_SET_IP
INSTRUMENTED_LINE	_LOAD_FAST_BORROW_1	_CALL_BUILTIN_FAST_WITH_KEYWORDS
LOAD_ATTR_NONDESCRIPTOR_WITH_VALUES	_GUARD_TYPE_VERSION	_CHECK_PERIODIC
TO_BOOL_BOOL	_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT	_CHECK_VALIDITY
INSTRUMENTED_POP_JUMP_IF_FALSE	_GUARD_KEYS_VERSION	_SET_IP
INSTRUMENTED_LINE	_LOAD_ATTR_METHOD_WITH_VALUES	_POP_TOP
LOAD_FAST_BORROW	_SET_IP	_CHECK_PERIODIC
BINARY_OP_INPLACE_ADD_UNICODE	_CHECK_FUNCTION_VERSION	_JUMP_TO_TOP
STORE_FAST	_CHECK_FUNCTION_EXACT_ARGS	
INSTRUMENTED_LINE	_CHECK_STACK_SPACE_OPERAND	
LOAD_FAST_BORROW	_CHECK_RECURSION_REMAINING	
INSTRUMENTED_CALL	_LOAD_CONST_INLINE	
POP_TOP	_SET_IP	
INSTRUMENTED_JUMP_BACKWARD	_STORE_FAST_2	
	_CHECK_VALIDITY	
	_LOAD_FAST_BORROW_1	
	_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT	

# Debugging and Profiling

## Python Debuggers

```
_ITER_CHECK_LIST
_GUARD_NOT_EXHAUSTED_LIST
_ITER_NEXT_LIST_TIER_TWO
_SET_IP
_STORE_FAST_1
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Debugging and Profiling

## Python Debuggers

(Pdb)

```
_ITER_CHECK_LIST
_GUARD_NOT_EXHAUSTED_LIST
_ITER_NEXT_LIST_TIER_TWO
_SET_IP
_STORE_FAST_1
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```

# Debugging and Profiling

## Python Debuggers

```
(Pdb) duck = Goose()
```

```
_ITER_CHECK_LIST
_GUARD_NOT_EXHAUSTED_LIST
_ITER_NEXT_LIST_TIER_TWO
_SET_IP
_STORE_FAST_1
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_TYPE_VERSION
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_LOAD_ATTR_METHOD_WITH_VALUES
_SET_IP
_CHECK_FUNCTION_VERSION
_CHECK_FUNCTION_EXACT_ARGS
_CHECK_STACK_SPACE_OPERAND
_CHECK_RECURSION_REMAINING
_LOAD_CONST_INLINE
_SET_IP
_STORE_FAST_2
_CHECK_VALIDITY
_LOAD_FAST_BORROW_1
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
_GUARD_KEYS_VERSION
_CHECK_FUNCTION
_LOAD_CONST_INLINE
_PUSH_NULL
_LOAD_FAST_BORROW_2
_SET_IP
_CALL_BUILTIN_FAST_WITH_KEYWORDS
_CHECK_PERIODIC
_CHECK_VALIDITY
_SET_IP
_POP_TOP
_CHECK_PERIODIC
_JUMP_TO_TOP
```



# Debugging and Profiling

## Python Debuggers

```
(Pdb) duck = Goose()  
(Pdb) ducks.clear()
```

```
_ITER_CHECK_LIST  
_GUARD_NOT_EXHAUSTED_LIST  
_ITER_NEXT_LIST_TIER_TWO  
_SET_IP  
_STORE_FAST_1  
_CHECK_VALIDITY  
_LOAD_FAST_BORROW_1  
_GUARD_TYPE_VERSION  
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT  
_GUARD_KEYS_VERSION  
_LOAD_ATTR_METHOD_WITH_VALUES  
_SET_IP  
_CHECK_FUNCTION_VERSION  
_CHECK_FUNCTION_EXACT_ARGS  
_CHECK_STACK_SPACE_OPERAND  
_CHECK_RECURSION_REMAINING  
_LOAD_CONST_INLINE  
_SET_IP  
_STORE_FAST_2  
_CHECK_VALIDITY  
_LOAD_FAST_BORROW_1  
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT  
_GUARD_KEYS_VERSION  
_CHECK_FUNCTION  
_LOAD_CONST_INLINE  
_PUSH_NULL  
_LOAD_FAST_BORROW_2  
_SET_IP  
_CALL_BUILTIN_FAST_WITH_KEYWORDS  
_CHECK_PERIODIC  
_CHECK_VALIDITY  
_SET_IP  
_POP_TOP  
_CHECK_PERIODIC  
_JUMP_TO_TOP
```

# Debugging and Profiling

## Python Debuggers

```
(Pdb) duck = Goose()  
(Pdb) ducks.clear()  
(Pdb) jump 6
```

```
_ITER_CHECK_LIST  
_GUARD_NOT_EXHAUSTED_LIST  
_ITER_NEXT_LIST_TIER_TWO  
_SET_IP  
_STORE_FAST_1  
_CHECK_VALIDITY  
_LOAD_FAST_BORROW_1  
_GUARD_TYPE_VERSION  
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT  
_GUARD_KEYS_VERSION  
_LOAD_ATTR_METHOD_WITH_VALUES  
_SET_IP  
_CHECK_FUNCTION_VERSION  
_CHECK_FUNCTION_EXACT_ARGS  
_CHECK_STACK_SPACE_OPERAND  
_CHECK_RECURSION_REMAINING  
_LOAD_CONST_INLINE  
_SET_IP  
_STORE_FAST_2  
_CHECK_VALIDITY  
_LOAD_FAST_BORROW_1  
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
```

```
_GUARD_KEYS_VERSION  
_CHECK_FUNCTION  
_LOAD_CONST_INLINE  
_PUSH_NULL  
_LOAD_FAST_BORROW_2  
_SET_IP  
_CALL_BUILTIN_FAST_WITH_KEYWORDS  
_CHECK_PERIODIC  
_CHECK_VALIDITY  
_SET_IP  
_POP_TOP  
_CHECK_PERIODIC  
_JUMP_TO_TOP
```



# Debugging and Profiling

## Python Debuggers

```
(Pdb) duck = Goose()  
(Pdb) ducks.clear()  
(Pdb) jump 6  
(Pdb) continue
```

```
_ITER_CHECK_LIST  
_GUARD_NOT_EXHAUSTED_LIST  
_ITER_NEXT_LIST_TIER_TWO  
_SET_IP  
_STORE_FAST_1  
_CHECK_VALIDITY  
_LOAD_FAST_BORROW_1  
_GUARD_TYPE_VERSION  
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT  
_GUARD_KEYS_VERSION  
_LOAD_ATTR_METHOD_WITH_VALUES  
_SET_IP  
_CHECK_FUNCTION_VERSION  
_CHECK_FUNCTION_EXACT_ARGS  
_CHECK_STACK_SPACE_OPERAND  
_CHECK_RECURSION_REMAINING  
_LOAD_CONST_INLINE  
_SET_IP  
_STORE_FAST_2  
_CHECK_VALIDITY  
_LOAD_FAST_BORROW_1  
_GUARD_DORV_VALUES_INST_ATTR_FROM_DICT
```

```
_GUARD_KEYS_VERSION  
_CHECK_FUNCTION  
_LOAD_CONST_INLINE  
_PUSH_NULL  
_LOAD_FAST_BORROW_2  
_SET_IP  
_CALL_BUILTIN_FAST_WITH_KEYWORDS  
_CHECK_PERIODIC  
_CHECK_VALIDITY  
_SET_IP  
_POP_TOP  
_CHECK_PERIODIC  
_JUMP_TO_TOP
```

# Debugging and Profiling

## Native Profilers and Debuggers

- ...it's complicated.

# Debugging and Profiling

## Looking Forward

- ...it's complicated.

# Looking Forward

## Python 3.13

- Build-your-own: `--enable-experimental-jit`

# Looking Forward

## Python 3.14 (beta)

- Windows & macOS: `PYTHON_JIT=1`
- Build-your-own: `--enable-experimental-jit`

# Looking Forward

## Python 3.15 (pre-alpha)

- GH-126910: Supporting stack unwinding in the JIT compiler.
- GH-133171: Make the JIT thread-safe.
- ...and a whole lot of ongoing performance work!
- Fast progress and larger projects will depend on resource availability.

# Looking Forward

## Python 3.15 (pre-alpha)

- GH-126910: Supporting stack unwinding in the JIT compiler.
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# Looking Forward

## Python 3.15 (pre-alpha)

- GH-126910: Supporting stack unwinding in the JIT compiler.
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# **PEP 659: Specializing Adaptive Interpreter**

# PEP 744: JIT Compilation

**PyCon US 2023:  
Inside CPython 3.11's new specializing,  
adaptive interpreter**

# **PyCon US 2024: Building a JIT compiler for CPython**

**Thank you!**

**Thank you!**

**@brandtbucher**

# **Thank you!**

**@brandtbucher | brandt@python.org**