A 1,500 (!!) line switch statement powers your Python!



Allison Kaptur

github.com/akaptur @akaptur



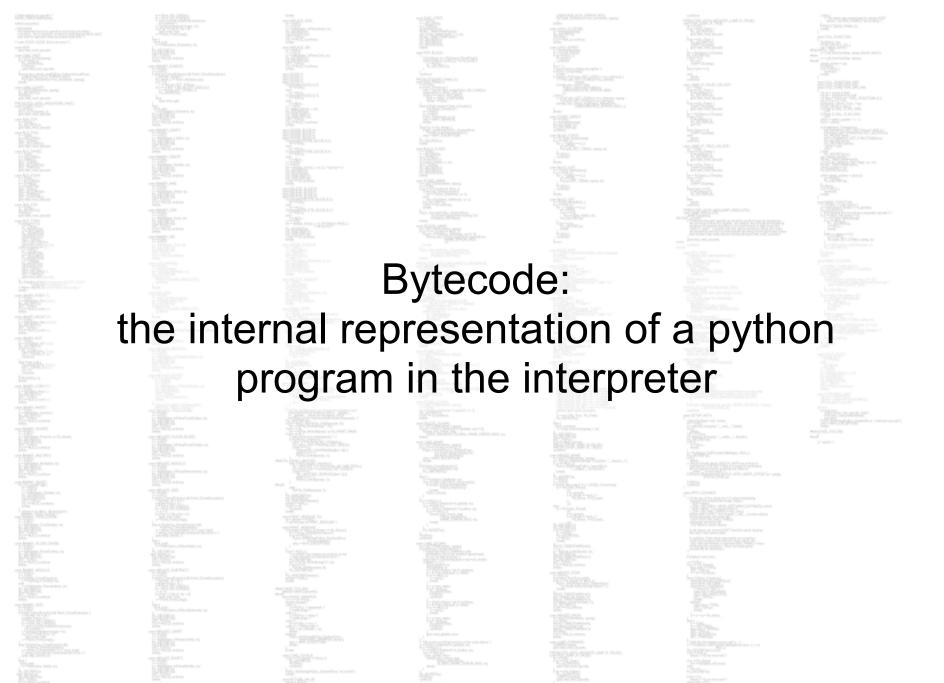
A 1,500 (!!) line switch statement powers your* Python!



Allison Kaptur

github.com/akaptur @akaptur





```
>>> def mod(a, b):
... ans = a % b
... return ans
```

```
>>> def mod(a, b):
    ans = a % b
    return ans
>>> mod.func_code.co_code
              Code
  Function
                     Bytecode
             object
```

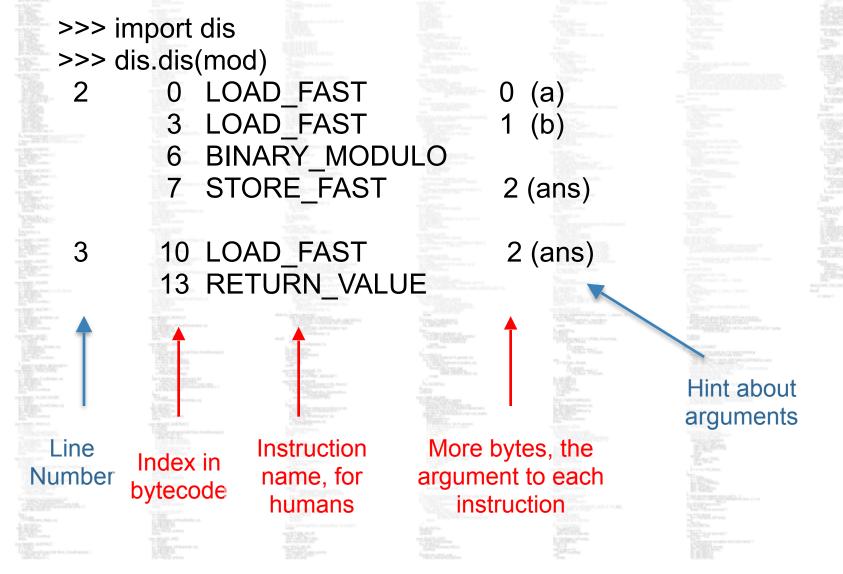
```
>>> def mod(a, b):
... ans = a % b
... return ans
>>> mod.func_code.co_code
'|\x00\x00|\x01\x00\x16}\x02\x00|\x02\x00S'
```

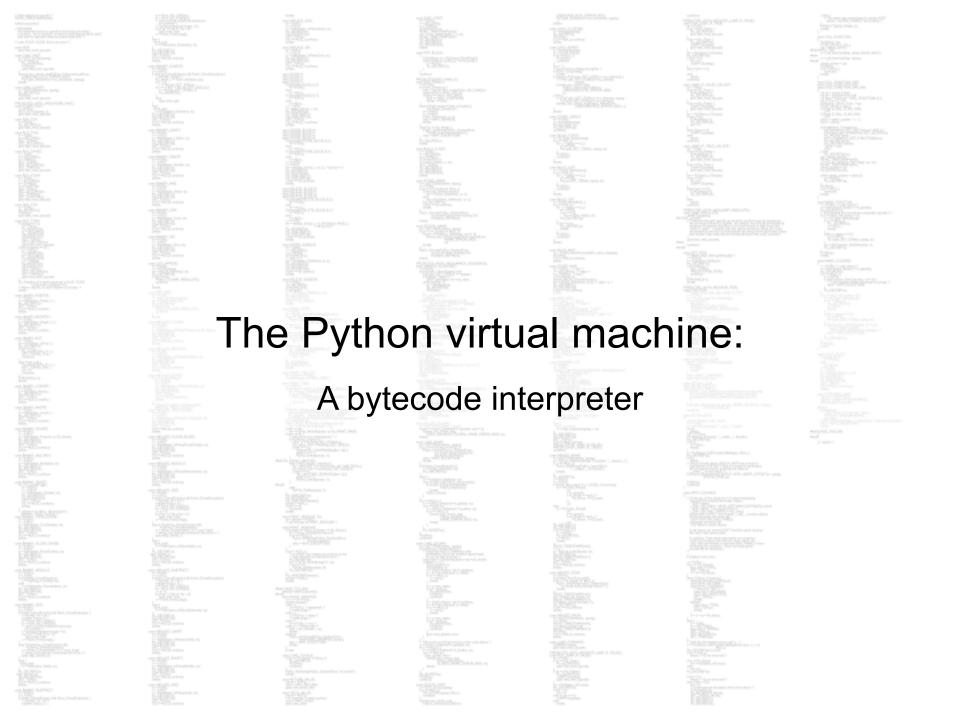
```
>>> def mod(a, b):
... ans = a % b
... return ans
>>> mod.func_code.co_code
'[\x00\x00[\x01\x00\x16]\x02\x00[\x02\x00S'
>>> [ord(b) for b in mod.func_code.co_code]
[124, 0, 0, 124, 1, 0, 22, 125, 2, 0, 124, 2, 0, 83]
```

dis, a bytecode disassembler

3 10 LOAD_FAST 2 (ans) 13 RETURN_VALUE

dis, a bytecode disassembler





Virtual Machine stack

L

a

something

some other thing

whatever

ans

something

some other thing

whatever

Before

something

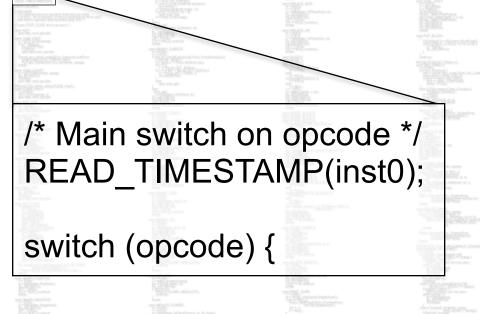
whatever

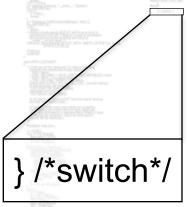
some other thing

After LOAD_FAST

After BINARY_MODULO

Samuel Co.						
SENSON.	F19.8686	TO SECURE	7:35C	grantes recursion	2000 pp. 400 mm r. mar.	"Acronomera.cog#"
Michigan China Control	CONSTRUCTOR "	March 1	Fee-	T. Contraction of the Contractio	2000 00 mm / no.	Egychol. Hex. or
Place STAR COST NAME BOOK	The same of the sa	St. St. water	1987	The state of the s	DOS.	0.000 (m. m. m
"Table ten sente	2488u	7:307	may Not Auton	TOP	gradiation. In this graph was	35550
T-95.05	D-90		DOMEST STREET, THE COLOR		Colonia con Coloni	And control territories were
SPR manin	Total control to before		Acres 1	Contract of the last of the la	Secriptor 6.	350
TRANSPORTER AND AND	Participation for Indiana.	<u> </u>	F. F. S.	THE SERVICE SHEET	Ties.	E01886
T. Station on	The State of the S	- Orași brant v	"ECSTENIONS" ** LINES	"Married Street, see	1586	particular and the control of the co
SAME AND ADDRESS OF THE PARTY O	*Service:	Trees	H-H-lover	200000000000000000000000000000000000000	Participation Comments	HANGE A
Edward.	Total property of	5 65 62.	Statement Committee	Enth.	THE SERVE	TOGET DE TOLEMA
The state of the s	Me	Mar.	55 guerre	1507	Englana.	100 - 100 prom n - 1
2000 C000000000000000000000000000000000	THE SHEET LINES	FILH	200000000000000000000000000000000000000	230e/s	7970Au	The River state.
196_	Figure .	The state of the s	Au SCHOOL	TANK Offices To July - Co. Transfer - Commences on	Date	Control of the Contro
185	District order	THE PERSON NAMED IN	A -	Distriction and or	1588	Vaccon
175C.	on the contract	17000	100000		20 Section .	1900
Distriction of the Control of the Co	Jun	INC.	13004	T-000 (Section 1)	Telephone.	PARKE
The .	7.00	22222	17-125-000 man	Facility Free years	g - togers i hero Edifferent	Killian and
E85-	C Sprane	則則以	PROFESSION	Control Control	Tribula.	Total .
go not make a	Figure.	"Opposite Character	Profession of a	TANK Commercial Commer	Tests	
THE .	19 000 AV	- THE BUTCHER	April Agentify Specification	100 mm	PERMITTEE :	CARDO CATALOGO AND
**************************************	F80	7140- 1100-1100-1100-1100-1100-1100-1100-	TORREST AND THE PARTY OF THE PA	SIR-	REPOSITACIONO CON PROP-	C 2000-
2390	Direct new	1,896.	TANKS OF THE PARTY	Care		Section 19
FRS-	Tillian	WHITE STATE OF THE PARTY OF THE	THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TRANSPORT	lean.	man distributes depths and states.	Elife St. (Dec. are on Elife St. (Dec. are on
7-	Febru.	T.Br.	Anni Sandri de Anni S	The state of the s	THE PERSON NAMED IN	Table 1
2,500	residence.	E wilder brown a c	Distributor come	Clare to the	CONTRACTOR OF THE PARTY OF THE	percent colorer.
H-46-	E SERVICE		*1910 Stoten Mary 1	The lates of the	Salar and	Control of the Control
Particular Company Victoria	Section Assessments	19894	Editor	EDITOR MANAGEMENT		Transportation .
Land about the contract of the	75.07	N. S. State States of	10000	Bear.	The second secon	Automy .
	CHECKET		Laboratory Company	7,000 7-	And the second second	Conference .
UL-encour	Table Committee Committee	Total Spinishers	L'Albert	Programme of the second	High Street, Street,	https://dis
		774).	the state of the same	P. SECOND.	Walter Street,	United States of the Control of the
Har Olivania		Table town	And the state of t	Lane Committee C	State State County,	A CONTRACTOR OF THE PARTY OF TH
TO THE PARTY OF	Section were		September 1	7.00	CHARLES CO.	Pages Pages
Selectr	Committee of the Commit	King Stance	10 (25 cline, per	Control of the Control	The second second	79607
"Melhan		hgene.		12.10(E)(C,10)	Total Confession	200
ST Securior	District news	700070K	3,2483	Paragraphic leading	STATE OF THE PARTY	Library
Inperior	7(5)2(40)	models, the	The Control of the Co	25628 mm	EEDE	DE.
Total Control		Total State of the	And Publishers (Indigence of State of S		"CONTRACTOR "	PER CONTRACT
His Williams			Supplied States and Control of States and Co	新聞意記技器	Fallen Application and artists were	Ball Som
E STATE OF THE PARTY OF THE PAR	- 400 do 100 m	The State of the S	E-Margaret ann e-s	CONTRACTOR CONTRACTOR	uncil Selection	"Bibusan"
Til Alliana		No. 100 Factor (March 1970)	T.205602.prins.ort		proper or one	ALC: STORY STORY
	All agency constraints	The second section of the second	The County of the contract of the contract of	Marian	Company on the	Married Tracks
1.50	C Springer, primarizations on	Commission of Street		Million an	5,0000	1" min "
my toggi ancidos		10 m Series on 1	E SECTION OF THE PERSON OF THE	100 MODEL (2015)	Chillips of territorisms with	
L. Mary Marie vi		And the Control of th	Andromens	T-BOOK AND	The state of the s	
A Comment		San State Control of the Control of	,52808sar	h postin	September 2012 September 2012 Charles Septemb	
40000	The second		TOTAL STREET	LOSS AND STATE OF THE PERSON NAMED IN COLUMN TO PERSON NAMED IN COLUMN	CORN	
Fig.	7.50	To a season of the season of t	MEChan)	12,000-100-in	garantin digitalis.	
E/SEC-	THE ROOM	1000c-	Total Species Comments	*S-regardoon	SERVICE STATE	
- ARE NOT THE	100 miles	756596 hour	G-2 63 No. 10	[2,000]-each	STATISTICS OF THE PARTY OF THE	
	In Valory-Emilians*	Participation appears		Reserve	CONTRACTOR AND ADDRESS OF THE PARTY AND ADDRES	
The same	CHECK STREET,	AND AND ASSESSMENT	h. worru. Gillon	200 Mars	A Company of the control of the cont	
The second secon	The state of the state of		- 100m		William Edward -	
F. State Comment	1981.	College State of the College of the	Control of the Park Street Woman or other Park S		Palmer red. (etc.)	
TO Williams	Directions.	D. State State of the Control of the	Basic	The second second	1982	
Tolkierieri.	The Continues for Indiana	5,0000	Section 2	TANK TO AND THE PARTY OF THE PA	Participan .	
CASSIS Anneanous	(1678) News		5.30%	No Selection Control	HE SE	
Disk Killington	16255	**************************************	CORRE	bro-sections:	E.	
-9.500 AT	Total and the second of the se	Telon I manus I	Eddinge.	September 1	The same of the sa	
Fig. Sportogram ben, Continues 1	b-9800 to	Table	1200	17.10(6)-22(1)		
The second secon	748an	To Paris.	520		182	
CONTROL OF THE PARTY OF THE PAR	Committee Contract of A Section 1	-E-manthalanta	promot productor	The state of the s	目 日本	
in Marchinellani		Mr. and State of Street or other	The Contract of the Contract o	process and the same	Contracting policy and an area	
Carlo Confession		**************************************	To different	120 GT-MT-100 PT-100 PT	See Street	
Total Comments	Carried Control	76399	ton 200/2002 broken st	578/05	TATAMENT AND ADDRESS OF THE PARTY OF THE PAR	
NE_		high introduction from the	Section 2000	5805	Selvent (Selvent)	
PARTICIPATE AND ADDRESS OF THE	7.70	TERRAL .	Table	C30847	The state of the s	
To the latter of the continues of the latter	The same of the sa	1200 mm	Marie Communication	Energy Filter		
400,4070	Fig-900 area	distant.	*WOODOW	The Control of the Co	1.5000	
V150 11	30.000	44.5.5	17 25	*	1.7.27	





/* Turn this on if your compiler chokes on the big switch: */
/* #define CASE_TOO_BIG 1 */

#ifdef CASE_TOO_BIG
 default: switch (opcode) {
#endif

Back to that bytecode

```
>>> dis.dis(mod)
```

2 0 LOAD_FAST 0 (a)

3 LOAD_FAST 1 (b)

6 BINARY_MODULO

7 STORE_FAST 2 (ans)

3 10 LOAD_FAST 2 (ans) 13 RETURN_VALUE

```
case LOAD FAST:
  x = GETLOCAL(oparg);
  if (x != NULL) {
    Py INCREF(x);
    PUSH(x);
    goto fast_next_opcode;
  format_exc_check_arg(PyExc_UnboundLocalError,
    UNBOUNDLOCAL ERROR_MSG,
    PyTuple_GetItem(co->co_varnames, oparg));
  break;
```

```
case BINARY_MODULO:
      w = POP();
      v = TOP();
      if (PyString_CheckExact(v))
        x = PyString_Format(v, w);
      else
        x = PyNumber_Remainder(v, w);
      Py_DECREF(v);
      Py_DECREF(w);
      SET_TOP(x);
      if (x != NULL) continue;
      break;
```

It's "dynamic"

```
>>> def mod(a, b):
... ans = a % b
... return ans
>>> mod(15, 4)
```

"Dynamic"

```
>>> def mod(a, b):
... ans = a % b
... return ans
>>> mod(15, 4)
3
>>> mod("%s%s", ("!!", "Con"))
```

"Dynamic"

```
>>> def mod(a, b):
... ans = a % b
... return ans
>>> mod(15, 4)
3
>>> mod("%s%s", ("!!", "Con"))
'!!Con'
```

"Dynamic"

```
>>> def mod(a, b):
... ans = a % b
... return ans
>>> mod(15, 4)
3
>>> mod("%s%s" ("!!", "Con"))
'!!Con'
>>> print "%s%s" % ("!!", "Con")
!!Con
```

```
case BINARY_MODULO:
      w = POP();
      v = TOP();
      if (PyString_CheckExact(v))
        x = PyString_Format(v, w);
      else
        x = PyNumber_Remainder(v, w);
      Py_DECREF(v);
      Py_DECREF(w);
      SET_TOP(x);
      if (x != NULL) continue;
      break;
```

```
>>> class Surprising(object):
...    def __mod__(self, other):
...    print "Surprise!"

>>> s = Surprising()
>>> t = Surprsing()
>>> s % t
Surprise!
```

"In the general absence of type information, almost every instruction must be treated as INVOKE_ARBITRARY_METHOD."

 Russell Power and Alex Rubinsteyn, "How Fast Can We Make Interpreted Python?"

More!

An awesome blog! http://tech.blog.aknin.name/category/my-projects/
pythons-innards/

A Python interpreter in pure Python! (Contribute!) https://github.com/nedbat/byterun

A plug for my blog! akaptur.github.io