Toward **"more"** efficient Ruby 2.1

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Agenda

- Ruby's rough history
- Ruby 2.1 new "internal" features
 - Internal object management hooks
 - Object allocation tracing
 - GC hooks
 - RGenGC: Restricted Generational Garbage Collection ← Today's main topic
- Ruby 2.1 expected "internal" features
 - Parallel sweeping
 - Sophisticated inline cache invalidation mechanism
 - Memory efficient string management

About this presentation

- This presentation is advanced version of my last presentation at RubyKaigi 2013 (May)
 - Talked in Japanese (with English slides)
 - Recycle presentation (≒ Good lazy programmer)

Slide PDF is <u>http://rvm.jp/t.pdf</u> (temporary URL)

- I'm poor at English speaking
 - All contents I want to say are written in my slides
 - Please give me a question with **slow/clear/easy** English ©

This presentation is NOT about

- Not about Rails application development
- Not about Programming language design
- Not about Mathematics
- •Not abou Functional programming languages
- •Not about Ruby programming language

Mainly about C programming language because it is about "C"Ruby

Who am I?

- Koichi Sasada a.k.a ko1
- •笹田耕一 in Kanji character
- Japanese lesson: "1"
 - One in English
 - Mono in Greece
 - Eins in German
 - Un in French
 - Uno in Italian, Spanish
 - "Ichi" ("—" in Kanji) in Japanese
- •I'm the first son of my parents

Who am I?

heroku

- Koichi Sasada
 - Matz team at Heroku, Inc.
 - Full-time CRuby developer
 - Working in Japan
 - •CRuby/MRI committer
 - Virtual machine (YARV) from Ruby 1.9
 - YARV development since 2004/1/1



programming Language

Matz team in Heroku



Matz team at Heroku Hierarchy

Matz @ Shimane Title collector



Communication with Skype

ko1 @ Tokyo EDD developer



Nobu @ Tochigi Patch monster



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Matz Title collector

- •He has so many (job) title
 - Chairman Ruby Association
 - Fellow NaCl
 - Chief architect, Ruby Heroku
 - Research institute fellow Rakuten
 - Chairman NPO mruby Forum
 - Senior researcher Kadokawa Ascii Research Lab
 - Visiting professor Shimane University
 - Honorable citizen (living) Matsue city
 - Honorable member Nihon Ruby no Kai
 - .
- This margin is too narrow to contain



•Great patch creator

























EDD: Event Driven Development

Brief history of Ruby

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Brief history of Ruby





A.D. 330 Constantinople founded A.D. 1453 The fall of Constantinople 2013/02 Ruby 20th & Ruby 2.0.0

B.C. 490 Battle of Marathon

B.C. 431 Peloponnesian War A.D. 1821 The Greek War of Independence

"20 years" is not so long!

(compare with Greece history)

ISO Ruby Standard

• Published at 2012/04

- ISO/IEC 30170:2012 Information technology --Programming languages – Ruby
- <u>http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_detail_ics.htm?ics1=35&ics2=060&ics3=&csnumber=59579</u>

"ISO/IEC 30170:2012 specifies the syntax and semantics of the computer programming language Ruby, and the requirements for conforming Ruby processors, strictly conforming Ruby programs, and conforming Ruby programs."

- Hybrid 1.8 and 1.9
 - Difference parts are "undefined"

Ruby 2.0 Stable version

Ruby 2.0

- New features
 - Keyword arugments
 - Refinements
 - Module#prepend
- Ruby 2.0.0-p195p247 was already released

| # -*- rdoc -*- | * aliased method: | * incompatible changes: | * Mutex#sleep may spurious wakeup. Check after wakeup. | * added Thread#thread_variables for getting a list of the thread local | variable. See Net::HTTP::new for details. | * Support for "D/n" splitting of records as BEAST mitigation via | * rdoc has been updated to version 4.0 | * Shellwords#shellescape() now stringifies the given object using to_s. | * String#lines |
|--|--|---|--|--|---|--|--|--|--|
| | * ENV.to_h is a new alias for ENV.to_hash | * system() and exec() closes non-standard file descriptors | | variable keys. | * gzip and deflate compression are now requested for all requests by | O | | * Shellwords#shelljoin() accepts non-string | * String#chars |
| = NEWS for Ruby 2.0.0 | | (The default of :close others option is changed | * NilClass | * added Thread#thread variable? for testing to | default. See Net::HTTP for details. | OpenSSL:SSL:OP_DONI_INSERT_EMPTY_FRAGME NTS. | This version is largely backwards-compatible with previous rdoc versions. | objects in the given | * String#codepoints |
| | * Fiber | to true by default.) | * added method: | see if a particular thread | * SSL sessions are now reused across connections | * OpenSSL requires passwords for decrypting PEM-encoded files to be at least | The most notable change is an update to the ri | array, each of which is stringified using to_s. | * String#bytes |
| This document is a list of user visible feature changes made between | * incompatible changes: | returns false unless | * added nil.to_h which returns {} | * added Thread#backtrace_locations which | This speeds up connection by using a previously | four characters long. This led to awkward situations where an export with | be regenerated for gems shared across rdoc | * syslog | |
| releases except for bug fixes. | * Fiber#resume cannot resume a fiber which invokes "Fiber#transfer". | the second argument is true. | | returns similar information of | negotiated session. | a password with fewer than four characters was possible, but accessing the | versions). Further API changes | * Added Syslog::Logger which provides a Logger | These methods no longer return an Enumerator, although passing a |
| | | behavior, and now | * Process | * incompatible changes: | * Net::HTTP#local host | file afterwards failed. OpenSSL::PKey::RSA, | are internal and won carrect most users. | * Syslog:::Priority. Syslog:::Level. Syslog:::Option and | block is still supported for backwards compatibility. |
| Note that each entry is kept so brief that no reason behind or | * File | returns the called name but not the original name in an | * added method: | * Thread#join and Thread#value now raises a | * Net::HTTP#local_bost= | OpenSSL::PKey::DSA and | See | Syslog::Macros | |
| reference information is supplied with. For a full list of changes | * extended method: | aliased method. | added getsid for getting session id (unix only). | ThreadError if target thread | * Net::HTTP#local_port | same check when exporting a | https://github.com/rdoc/rdoc/blob/master/History .rdoc for a list of | are introduced for easy detection of available constants on a | Code like str.lines.with_index(1) { line, lineno } no longer |
| with all sufficient information, see the ChangeLog file. | * File.fnmatch? now expands braces in the pattern if | * Kernel#inspect does not call #to_s anymore | * Page - | a one canteric or many circaid. | * Net::HTTP#local_port= | private key to PEM with a password - it has to be at least four characters | changes in rdoc 4.0. | running system. | works because str.lines returns an array. Replace lines with |
| | File::FNM_EXTGLOB option is given. | (it used to call redefined #to_s). | * added method: | * Time | * extended method: | long. | | | each_line in such cases. |
| == Changes since the 1.9.3 release | | * LoadError | * added RangeRsize for lazy size evaluation. | * change return value: | *Net::HTTP#connect uses local_host and local_port if specified. | * SSL/TLS support for the Next Protocol Negotiation extension. Supported | * resow | * incompatible chanzes: | |
| | * improvements: | * added method: | * added Range#bsearch for binary search. | * Time#to_s returned encoding defaults to US- ASCII but automatically | | with OpenSSL 1.0.1 and higher. | * Resolv::DNS#timeouts= | * Dir.mktmpdir uses FileUtils.remove_entry | * Signal.trap |
| === C API updates | * introduced the bitmap marking which | * added LoadError#path method to return the | | enscodes to incoding.default_internal if it is | * net/imap | * OpenSSL::OPENSSL_FIPS allows client applications to detect whether OpenSSL | * Resolv::DNS::Config#timeouts= | Eliel bit remove entry resure. This means that | |
| * NUM2SHORT() and NUM2USHORT() added. They are similar to NUM2INT, but short. | suppresses to copy a memory page | loaded. | | fila / | | is running in DPS mode and to react to the special remembers this | | applications should not | See above. |
| * rb_newobj_of() and NEWOBJ_OF() added. They create a new object of a given class. | * introduced the non-recursive marking which | | * ter metho | TraceFint | t::IMdefault_port | | | change the permission of the created temporary directory to make | |
| | avoids unexpected stack overflow. | * Module | * added Signal signame which returns signal name | * new class. This class is replacement of set trace func | * Net::IMAP.default_imap_port | | * REXML::Document#write supports Hash arguments. | accessible from other users. | * Merge Onigmo. |
| === Library updates (outstanding ones only) | * GC-Profiler | * added method: | | Easy to use and efficient implementation. | * Net::IMAP.default_tls_port | * ostruct | * REXML::Document#write supports new :encoding option. It changes | | https://github.com/k-takata/Onigmo |
| | * added method: | * added Module#prepend which is similar to Module#include, | | | faatu | | XML document encoding. Without rencoding | * yaml | * The :close_others option is true by default for |
| * builtin classes | * added GC::Profiler.raw_data which returns | however a method in the prepended module overrides the | * gnavrap lise krguments or when SEGU VES, :11: :FP: .VTAL M | Vtoplevel I U U V | lealu | | XML declaration is used for XML document | depends on libyami being | system() and exec(). |
| | naw prome data for de | | are specified. | | | Opendia de Greatering an | encoding. | installed. | all new file descriptors. |
| | | corresponding method in the prepending | | * added method: | * objspace | * OpenStruct#epi? | | | |
| * Array | * Hash | corresponding method in the prepending module. | | * added method: * added main.define_method which defines a global function. | * objspace * new method: | * OpenStruct#eql? | | | This means file descriptors doesn't inherit to spawned process unless |
| * Array * added method: | * Hash | corresponding method in the prepending module. * added ModuleRrefine, which extends a class or module locally. | * String | added main.define_method which defines a global function. | * objspace * new method: * ObjectSpace.reachable_objects_from(obj) | * OpenStruct#eql? * OpenStruct#hash | * RubyGems | * dila | This means file descriptors doesn't inherit to spawned process unless explicitly requested such as system(, fd=>fd). |
| * Array * added method: * added Array@bsearch for binary search. | * Hach * added method: | corresponding method in the prepending module. * added Moduleistrefine, which extends a class or module locally. [experimental] | * String * added method: | * added main.define_method which defines a global function. | * objpace * new method: * ObjectSpace.reachable_objects_from(obj) | * OpenStructReg(? * OpenStructRhash * OpenStructRto_h converts the struct to a hash. | * RubyGems * Updated to 2.0.0 preview2 | * alib * Added streaming support for Zilo::inflate and Zilo::Deflate. This allows | This means file descriptors doesn't inherit to spawned process unless explicitly requested such as system(, fd+>fd). |
| * Array * added method: * added Arraytbourch for binary search. * incompatible changes: | * Hach * added method: * added Hashtto_h as explicit conversion method, like Arraytto_a. | corresponding method in the prepending module. • added Modulesterline, which extends a class or module locally. [experimental] • added Modulesterlinements, which returns referencements differed in the | * String * added method: * added Stringth returning a copied string whose encoding is ASCI-8817. | abased memoci: added main.define_method which defines a global function. * cgi * Add HTMLS tag maker. | * objepace * new method: * Objectigance reachable_objects_from(obj) * opensal | OpenStructRegi? OpenStructRegi? OpenStructRo_h converts the struct to a hash. extended method: | * RubyGens • Updated to 2.0.0 preview2 | alib *Added streaming support for Zib::snflate and Zib::deflate. This allows processing of a stream without the use of large amount: of money. | This means file descriptors doesn't inherit to aparent process unless explicitly requested such as system(, fd=>fd). • same/drespond_to? against a protected method now refurm the |
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| * Array * added method: * added ArrayHisearch for binary search. * incompatible changes: * random gazameter of Arrayshaffel and Arrayshaffel non: * and the called with one argument, maximum value. | * Hash * added method: * added Hashito, 1 as neplicit conversion method, las Aropiton * extended method: * Hashitdefault, grocy: can be passed nil to clear the default proc. | comparison method in the propending model. • added Modulaterline, which extends a class or module locally. (experimental) • added Modulaterlinements, which returns reforments: to define in the • reserve (reperimental) • added Modulaterline, mich imports reforments: the receiver. | * String * added method: * added method: * damage returning a copied string whose encoding is ASD BitT. * change return value: * StringBittes now returns an aray instead of an enumerator. | access memory: *access memory and the method which defines a global function. * egi *Acd HTMLS tag mahar, * (CGBhetz) hadder has been renamed to CGBhetader. | • objeste • cover method: • ObjectSpece.machable_objects_from(obj) • opensal • Consustently raise an encore when trying to encode of waters. All instance. of OpenSSL_SQNL_SPinistive new raise TypeEntror | * OpenStructBeg? * OpenStructBeg.h converts the struct to a hash. * obendStructBeg.h converts the struct to a hash. * obendStructBeg.h converts the struct to a hash. * obendStructBeg.h converts the struct to a hash. | * RubyGems * Updated to 2.0.0 preview2 RubyGem 2.0.0 (natures the following improvements: | Added increasing support for 2th-inflate and the define. This allow: The support for the new define training of added in support for the new define training inc .4.Added support for the new define training inc .1.bib means an enw processed without the OV. | The means file decriptions doesn't inherit to gavened process unless explicitly requested such as system(, 16-46). * Kennellerespood, 107 against a protected method row neturns file unless the second argument is true. |
| Array added method: added method: added Arrayfbacerch for binary search. decomparable changes: Arraysbace/bite and decomparable changes: will be called with one argument, maximum walker. Area gener Barge arguments, maximum gener | *Hash *added method: *added Fuhlitio, 1 a sniplicit conversion method, like Arrayetto, a: *estended method: *Assistedefault, groce can be passed nil to clear the default proc. | companding method in the propending model. • added blockbetteries, which extends a class of module locally. (experimental receiver: (experimental • added blockbetterionmeters) • added blockbetterionmeters receiver: (experimental (experimental) | Sung added method: | Social network: * data function. * cpi * Add HTML5 tag maker. * Catalabadar has been remained to catalabadar has been remained has | | | * RubyGems * Updated to 2.0.0 provine2 RubyGems 2.0.0 features the following improvements: * Improved support for default gems shapping with naty 2.0.0* | Added streaming upgord for Dis-influe and able charter. This allows processes processes processes processes able Att and Dis-influe able State and Dis-influe able that and Dis-influe default streams are now processed without the GWL. but allow points default streams to be processed in parallel. | This means file decriptions doesn't inherit to generate process unless: explicitly requested such as system(, r6-v6). * Konneltrespood, typ? against a protected method new returns file? unless the second argument is true. |
| *kray *adda mathat: *adda mathat: *adda Maraythaanch for binary search. *krayshaufbel change: *krayshaufbel change: *des calified with one argument, maximum *uke the search of anger, search of anger, search of anger, *uke that is search of anger. | * Hash * added method: * added nethod: * added hub/top) a snglicit conversion method, like Arrytho_a. * extended method: * kesheldefungt_gracs-can be passed nil to clear the default proc. * Kennel | composition method in the propending model. | Sung Saded method: Added method: Added stringth returning a capited string whose encoding tables Hattin Added Stringth return value: Addingt return value: Addingt return value: Addingt harm nove returns an array instead of an enumerator. Addingt harm nove returns an array instead of | addet manadring, method which defines a global function. egit Add influit5 tag maker. CGBintigheder and and CGBintigheder and alaset to CGBinsader. Vinflem KTAGS tagnaler called, oerwrite CGBinder, Kr. | * objeste * new method: * ObjectSpace reachable_objects_from(obj) * opensal Considently raise an encr when trying to encode nit values. All instances of OpenSSL-XNL: Thrittle-more raise TypeStrord motance-whose value is nit. All instances of OpenSSL-XNL:Communitie | | RubyGems Updated to 2.0.0 proview2 RubyGems 2.0.0 features the following monocentration Insprovements: Insprovements: Agenci can be aphibit any metadata through Gens-Specific can submetadata | tab tab tab tab tab table determine support for 2bb: influite and table. table determine of a target multitude the use of larget montant of memory. table determine are may present determines table allow apport for the new defente arranget table. table determines are may present determines table allow apport for the new defente arranget table determines are may present determines table determines are may present determines table determines are may present determines table allow apport for the new defente arranget table determines are may present determines table determines are may present determines table determines table determines defause tartermines to be processed in parallel. | This means file decryption doesn't inherit to general process unless: wighted y requested such a system(, (d-v/d). * Semalerspood jo2* against a protected method over enterns fals: unless the second argument is true. |
| Array adde method: adde method: | * Hush * saded method: * saded method: * saded method: * standed method: * standed method: * Kennel * aded method: * aded method: | composing method in the propending model. • added blockbetterline, which extends a class or module boally. (experimental) • celements defined in the receiver, (experimental) • added blockbetterlinements, which imports reformental into the receiver. (experimental) • extended methods: • cetterded me | Sing ded mithod: | adder mankadning method which defines a stadeet mankadning method which defines a globa function. cgli Adder HTMLS tag melær. cGloBheader has been renamed to CGloBheader has been renamed to CGloBheader and alsastetto CGloBheader. tVMes HTMLS tagsaster called, overwrite GloBheader function is to create a dheader- eference. | • objects output outpu | OpenSituations(?) | RubyGems 'Updated to 2.0.0 process2 RubyGems 2.0.5 features the following microcenters: 'Introprocel support for default gems shapping with ndgr 2.0.8* 'Segment on the with Stary metadata through Cent_Scotf calculationetesidata | tab tabe tabe tabe tabe tabe tabe tabe tabe tabe tabe tabe | This means file decryption doesn't inherit to generation process unless: depicting requested such as system(dowd), devices there socied a ground a protected method were therein failer unless the second argument is true. devices the second argument is true. See above. |
| * kray * akar mathati: * akar karayabateath for thanaya suratu. * una suratu bateath and and * akarabateath and and ang suratu suratu suratu * akarabateath and ang surgements. A surayabateath and * akarabateath and suratu suratu * akarabateath and suratu suratu * akarabateath and suratu suratu * akarabateath and suratu s | * Hash * dede method: * added method: * desmethod: * desmethod: * added method: * added method | | Sing | adder minischling method which defines a diede hundton. egt Adder HMLS tag maker. Collitikesder has been resamed to Collitikesder has been resamed to Collitikesder hander and alsasetto Collitikesder. When HMLS tagsaler called, overwrite Collitikesder function is to create a -deaders element. | • objapae • new method: • ObjectSpace.reachable_slipetts_from(obj) • openst • openst • openst of OpenSS_ASSI:-Statuses of openst reacher and objects_from ope | OpenStructUneg? OpenStructUneg. o | * RubyGems * Updated to 2.0.0 preview2 RubyGems 2.0.0 factures the following minorevenents:: * reproved support for default gens strepping * updated to 2.0.0 * agens can have arbitrary metadatas through enclosed in gens arbitrary metadatas through enclosed in gens arbitrary metadatas through * agens can have arbitrary metadatas through enclosed in gens arbitrary metadatas through * agens can have arbitrary metadatas through * agens can have arbitrary metadatas through enclosed in gens arbitrary metadatas through * agens can have arbitrary metadatas * agens can hav | <text></text> | This means file decription doesn't linkerit to gament process unless: meplicity requested such as system(do-vdg,do-vd, |
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Euruko 2013 Toward more efficient Ruby 2.1 by Koichi Sasada

「Rubyは言語として2.0でほぼ完成」、まつもと ゆきひろ氏が講演

2013/02/14 **安東 一真=日経Linux**

記事一覧へ >>

🗗 いいね! < 108

「Rubyはバージョン2.0で、言語としてほ ぼ完成した」――。東京・目黒雅叙園で2月 15日まで開催している「Developers Summit 2013」で、Rubyの生みの親である まつもとゆきひろ氏(写真)はこう宣言し た。

Ruby 2.0は、Ruby生誕20周年を記念し て、2013年2月24日にリリースする予定の新 バージョン。まつもと氏は講演の中で、バー ジョン2.0の新機能を披露するとともに、



写真●まつもとゆきひろ氏 [画像のクリックで拡大表示]

ッイート 257

Matz said "Ruby is almost matured as a programming language with 2.0"

http://itpro.nikkeibp.co.jp/article/NEWS/20130214/456322/

Ruby versions

• Which version of Ruby (MRI) do you use?

- 1. Ruby 1.8.7
- 2. Ruby 1.9.2
- 3. Ruby 1.9.3
- 4. Ruby 2.0.0 p0
- 5. Ruby 2.0.0 p195
- 6. Ruby 2.0.0 p247

Ruby 2.0.0 is default at Heroku

heroku blog

Account

Ruby 2.0.0 Now Default on All New Ruby Applications

Posted 7 days ago by Richard

Heroku provides an opinionated platform in order to help you build better applications. We give you a default version of Ruby to get you started, and give you a way to declare your version for total control. In the past creating an application would give you 1.9.2, starting today the default is 2.0.0.

Ruby 2.0.0 is fast, stable, and works out of the box with Rails 4. Applications running on 2.0.0 will have a longer shelf life than 1.9.3, giving you greater <u>erosion resistance</u>.

https://blog.heroku.com/archives/2013/6/17/ruby-2-default-new-aps

Rubyist Magazine Ruby 2.0 Special articles



1

Ruby 2.0.0 Release special articles

About Ruby 2.0.0 Release special articles

- Messages from Rubyists
 - Message from Matz
 - Ruby 2.0 on Rails
 - <u>Change something silently</u>
 - Message from Dave Thomas
 - Message
 - Favorite Feature
 - Message from Charles Oliver Nutter
 - Message from Thomas E Enebo

http://magazine.rubyist.net/?Ruby200SpecialEn

Ruby 2.1 Next version

Ruby 2.1 release plan announcement

"I, Naruse, take over the release manager of Ruby 2.1.0 from mame. <u>Ruby 2.1.0 is planed to release</u> <u>in 2013-12-25.</u> I'm planning to call for feature proposals soon like 2.0.0 [ruby-core:45474], so if you have a suggestion you should begin preparing the proposal."

> - [ruby-core:54726] Announce take over the release manager of Ruby 2.1.0 by NARUSE, Yui

2013/12/25!



http://www.flickr.com/photos/htakashi/5285103341/ by Takashi Hososhima



Events are important for EDD (Event Driven Development) Developers

Ruby 2.1 release plan announcement

"I, Naruse, take over the release manager of Ruby 2.1.0 from mame. Ruby 2.1.0 is planed to release in 2013-12-25. <u>I'm planning to call for feature</u> proposals soon like 2.0.0 [ruby-core:45474], so if you have a suggestion you should begin preparing the proposal."

> - [ruby-core:54726] Announce take over the release manager of Ruby 2.1.0 by NARUSE, Yui



https://bugs.ruby-lang.org/projects/ruby-trunk/wiki/ReleaseEngineering210



Ruby 2.1

•New features

-*- rdoc -*-

= NEWS for Ruby 2.1.0

This document is a list of user visible feature changes made between releases except for bug fixes.

Note that each entry is kept so brief that no reason behind or reference information is supplied with. For a full list of changes with all sufficient information, see the ChangeLog file. == Changes since the 2.0.0 release

=== Language changes === Core classes updates (outstanding ones only)

* GC * added environment variable: * RUBY_HEAP_SLOTS_GROWTH_FACTOR: growth rate of the heap.

* IO * extended methods: * IO#seek accepts symbols (:CUR, :END, :SET) for 2nd argument.

* Kernel * New methods: * Kernel#singleton_method

* Mutex * misc * Mutex#owned? is no longer experimental.

String
 New methods:
 StringBicrub and StringBicrub I verify and fix invalid byte sequence.
 exclined methods:
 et invalid:-register is specified for StringBencode, replace
 Initial byte sequence even if the destination encoding equals to
the source encoding.

* pack/unpack (Array/String) * Q! and q! directives for long long type if platform has the type.

=== Core classes compatibility issues (excluding feature bug fixes)

* IO * incompatible changes: * open ignore internal encoding if external encoding is ASCI-8BIT.

* Module#ancestors The ancestors of a singleton class now include singleton classes, in particular itself.

=== Stdlib updates (outstanding ones only)

* Digest * extended methods: * Digest::Class.file takes optional arguments for its constructor

* Matrix * Added Vector#cross_product.

* Net::SMTP * Added Net::SMTP#rset to implement the RSET command

* Pathname * New methods: * Pathname#write * Pathname#binwrite

* OpenSSL::BN * extended methods: * OpenSSL::BN.new allows Fixnum/Bignum argument.

* open-uri * Support multiple fields with same field name (like Set-Cookie).

* Resolv * New methods: * Resolv::DNS.fetch_resource * One-shot multicast DNS support * Support LOC resources

* Rinda::RingServer, Rinda::RingFinger * Rinda now supports multicast sockets. See Rinda::RingServer and Rinda::RingFinger for details.

* Socket * New methods: * Socket.getifaddrs

* StringScanner * extended methods: * StringScanner#[] supports named captures.

* Tempfile * New methods: * Tempfile.create

=== Stdlib compatibility issues (excluding feature bug fixes)

URI
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=== C API updates

See NEWS file

Now, much smaller than Ruby 2.0
Ruby 2.1 features

• Refine m17n introduced from Ruby 1.9

- String#scrub, String#scrub!
 - Verify and fix invalid byte sequence.
- I heard Matz has some ideas.
- Refine features introduced from Ruby 2.0
 - Keyword arguments
 - Refinements
 - Module#prepend

Back to Ruby 2.0

Quote about Ruby 2.0 from Heroku blog

How it Works Pricing Add-ons Dev Ce Blog Matz on Ruby 2.0 at Heroku's Waza by Craig - Mar 06

Matz, the creator of Ruby, spoke at Waza for the 20th anniversary of the language and the release of Ruby 2.0. If you weren't in the sold out crowd, not to worry. Information should flow free and experiences should be shared; in line with those concepts you can watch Matz's talk right here, then read about what's



With slides available on speakerdeck

20 years of simplicity, elegance, and programmer happiness

Heroku, since its founding, has been aligned with the key values of Ruby – simplicity, elegance, and programmer happiness. Heroku still believes in the power and flexibility of Ruby, and we've invested in the language by hiring Yukihiro "Matz" Matsumoto, Koichi Sasada and Nobuyoshi Nakada. We would like to thank them and the whole Ruby core team for making the release happen. Join us in celebrating Ruby's successes and in looking forward to the next twenty years by trying Ruby 2.0 on Heroku today.

Me!

Ruby apps are running using 1.8.7, you should upgrade. Ruby 1.8.7 is approaching End of Life (EOL) in three months on June 2013. EOL for Ruby 1.8.7 means no security or bug patches will be provided by the maintainers. Not upgrading means you're potentially opening up your application and your users to vulnerabilities. Don't wait till the final hour, upgrade now to be confident and secure.

Speed

Ruby 2.0 has a faster garbage collector and is **Copy on Write** friendly. Copy on Write or COW is an optimization that can reduce the memory footprint of a Ruby process when it is copied. Instead of allocating duplicate memory when a process is forked, COW allows multiple processes to share the same memory until one of the processes needs to modify a piece of information. Depending on the program, this optimization can dramatically reduce the amount of memory used to run multiple processes. Most Ruby programs are memory bound, so reducing your memory footprint with Ruby 2.0 may allow you to run more processes in fewer dynos.

If you're not already running a concurrent backend consider trying the Unicorn web server.

Features

In addition to running faster than 1.9.3, and having a smaller footprint, Ruby 2.0 has a number of new features added to the language including:

Mention about "Speed" of 2.0

Ruby 2.0 has a faster **garbage collector** and is <u>Copy on Write</u> friendly. Copy of reduce the men copied. Instead marking and CoW friendly process is forked, and the marking process to once

the same memory until one of the processes needs to modify a piece of information. Depending on the program, this optimization can dramatically reduce the amount of memory used to run multiple processes. Most Ruby programs are memory bound, so reducing your memory footprint with Ruby 2.0 may allow you to run more processes in fewer *If you're not alread Short summary: Let's try Unicorn! trying the Unicorn web server.*

Only mention about GC?

I DON'T work on GC! People love GC performance

· +. · \(*>∀<*)/. . + ·

Let's consider about GC/memory management!

Ruby 2.1 development

Ruby 2.1 internal features

- Internal hooks for memory management
- RGenGC: Restricted generational garbage collection

Today's topic

Ruby 2.1 Internal hooks for memory management

Internal hooks for memory management What's nice?

- You can collect more detailed analysis
- •Examples
 - Collect object allocation site information
 - Collect usage of allocated objects
 - Measure GC performance from outside

Internal hooks for memory management

Added events

- RUBY_INTERNAL_EVENT_NEWOBJ
 - When object is created
- RUBY_INTERNAL_EVENT_FREEOBJ
 - When object is freed
- RUBY_INTERNAL_EVENT_GC_START
 - When GC is started
- RUBY_INTERNAL_EVENT_GC_END
 - When GC is finished



Internal hooks for memory management *Caution*

- •You can *NOT* trace these events using TracePoint (introduced from 2.0)
- •You need to write C-ext to use them, because events are invoked during GC, etc

Internal hooks for memory management Sample features

- ObjectSpace. trace_object_allocations
 - Trace object allocation and record allocation-site
 - Record filename, line number, creator method's id and class
 - Usage:

```
ObjectSpace.trace_object_allocations{ # record only in the block
```

```
o = Object.new
```

```
file = ObjectSpace.allocation_sourcefile(o) #=> __FILE___
```

```
line = ObjectSpace.allocation_sourceline(o) #=> __LINE__ -2
```

}

Demonstration

Internal hooks for memory management Postponed job

- You may want to write hooks in Ruby
 - \rightarrow Use 'Postponed job'
 - 'Postponed jobs' run at same timing as finalizers
 - Usage: rb_postponed_job_register(func, data)
 - `func(data)' will be called at a safe-point
- See an sample code in "ext/objspace/gc_hooks.c"
 - ObjectSpace.after_gc_(start|end) = proc{GC.start}
 - Proc is called after GC

Ruby 2.1 RGenGC: new garbage collection

RGenGC: Summary

- •RGenGC: Restricted Generational GC
 - New GC algorithm allows mixing "Write-barrier protected objects" and "WB unprotected objects"
 - No (mostly) compatibility issue with C-exts
- •Inserting WBs gradually
 - We can concentrate WB insertion efforts for major objects and major methods
 - Now, Array, String, Hash, Object, Numeric objects are WB protected
 - Array, Hash, Object, String objects are very popular in Ruby
 - Array objects using **RARRAY_PTR()** change to WB unprotected objects (called as Shady objects), so existing codes still works.

RGenGC: Agenda

- Background
 - Generational GC
 - Ruby's GC strategy
- Proposal: RGenGC
 - Separating into normal objects and shady objects
 - Shady objects at marking
 - Shade operation
- Implementation

RGenGC: Background Current CRuby's GC

- Mark & Sweep
 - Conservative
 - Lazy sweep
 - Bitmap marking
 - Non-recursive marking
- C-friendly strategy
 - Don't need magical macros in C source codes
 - Many many C-extensions under this strategy

RGenGC: Background Mark & Sweep

Root objects



Mark reachable objects from root objects

 Sweep <u>unmarked</u> objects (collection and de-allocation)

RGenGC: Background Generational GC (GenGC)

- Weak generational hypothesis: Most objects die young → Concentrating reclamation effort on the youngest objects
- •Separate young generation and old generation
 - Create objects as young generation
 - Promote to old generation after surviving *n-th* GC
 - In CRuby, *n* == 1 (after 1 GC, objects become old)
- •Usually, GC on young space (minor GC)
- •GC on both spaces if no memory (major/full GC)

RGenGC: Background Generational GC (GenGC)

- Minor GC and Major GC can use different GC algorithm
 - Popular combination
 - \rightarrow Minor GC: Copy GC, Major GC: M&S
 - On the CRuby's: both <u>Minor&Major GCs should</u> <u>be M&S</u> because CRuby's GC (and existing codes) based on conservative M&S algorithm

RGenGC: Background: GenGC [Minor M&S GC]



- Mark reachable objects from root objects.
 - Mark and promote to old generation
 - Stop traversing after old objects
- → Reduce mark overhead
- Sweep not (marked or old) objects
- Can't collect Some unreachable objects

Sasada

RGenGC: Background: GenGC [Minor M&S GC]



- Mark reachable objects from root objects.
 - Mark and promote to old generation
 - Stop traversing after old objects
- → Reduce mark overhead
- Sweep not (marked or old) objects
- Can't collect Some unreachable objects

RGenGC: Background: GenGC [Major M&S GC]



- Normal M&S
- Mark reachable objects from root objects
 - Mark and promote to old gen
- Sweep unmarked objects
- <u>Sweep all unreachable</u> (unused) objects

RGenGC: Background: GenGC Problem: mark miss



- Old objects refer young objects
- \rightarrow Ignore traversal of old object

→ Minor GC causes

marking leak!!

 Because minor GC ignores referenced objects by old objects

Can't mark new object! → Sweeping living object! (Critical BUG)

RGenGC: Background: GenGC Introduce Remember set (Rset)



- <u>Detect</u> creation of an [old->new] type reference
- Add an [old object] into <u>Remember set</u> (<u>RSet</u>) if an old object refer new objects

RGenGC: Background: GenGC [Minor M&S GC] w/ RSet



- Mark reachable objects from root objects
 - <u>Remembered objects</u> <u>are also root objects</u>

2. Sweep not (marked or old) objects

RGenGC: Background: GenGC Write barrier

To detect [old→new] type references, we need to insert <u>"Write-barrier"</u> into interpreter for all "Write" operation



RGenGC: Background: GenGC Write barriers in Ruby

- Write barrier (WB) example in Ruby world
 - (Ruby) old_ary[0] = new0 # [old_ary → new0]
 - (Ruby) old_obj.foo = new1 # [old_obj → new1]



RGenGC: Background

Difficulty of inserting write barriers

- To introduce generational garbage collector, WBs are necessary to detect [old→new] type reference
- "Write-barrier miss" causes terrible failure
 - 1. WB miss
 - 2. Remember-set registration miss
 - 3. (minor GC) marking-miss
 - 4. Collect live object → Terrible GC BUG!!

RGenGC: Problem

Inserting WBs into C-extensions (C-exts)

- All of C-extensions need perfect Write-barriers
 - C-exts manipulate objects with Ruby's C API
 - C-level WBs are needed
- Problem: How to insert WBs into C-exts?
 - There are many WB required programs in C-exts
 - Example (C): RARRAY_PTR(old0)[0] = new1
 - Ruby C-API doesn't require WB before
 - CRuby interpreter itself also uses C-APIs
- How to deal with?
 - We can rewrite all of source code of CRuby interpreter to add WB, with huge debugging effort!!
 - We can't rewrite all of C-exts which are written by 3rd party

RGenGC: Problem Inserting WBs into C-extensions (C-exts)

Two options

| | | Performance | Compatibility | Current |
|---|---|-------------|--------------------------------|------------------------|
| 1 | Give up GenGC | Poor | Good (No problem) | conservative choice |
| 2 | GenGC with re- writing all of C exts | Good | Most of C-exts doesn't work | - |

Trade-off of Speed and Compatibility

RGenGC:

Related work on Ruby's GenGC

- Kiyama, et. al. GenGC for CRuby
 - Straightforward implementation for Ruby 1.6
 - Need WBs in correct places
 - High development cost
 - Can't keep compatibility → Drop all C-exts
- •Nari, et.al longlife GC for CRuby
 - Introduce GenGC only for Node object
 - No compatibility issues because C-exts don't use node
 - Now CRuby doesn't use many number of node objects
 - High development cost (to guarantee WBs)

RGenGC: Related work on Ruby's GenGC

- Make interpreter with other language infrastructures which have GC
 - JRuby, IronRuby
 - Can't keep compatibility with current C-exts
- •Separate core heap and CRuby C-ext heap
 - High development cost
RGenGC: Challenge

- Trade-off of Speed and Compatibility
 - Can we achieve both <u>speed-up w/ GenGC</u> and <u>keeping compatibility</u>?
- •Several possible approaches
 - Separate heaps into the WB world and non-WB world
 - Need to re-write whole of Ruby interpreter
 - Need huge development effort
 - WB auto-insertion
 - Modify C-compiler
 - Need huge development effort

RGenGC: Our approach

 Create new generational GC algorithm permits WB protected objects AND WB unprotected object in the same heap

RGenGC: Restricted Generational Garbage Collection

RGenGC: Invent 3rd option

| | | Performance | Compatibility | |
|---|--|-------------|--------------------------------|--------------------|
| 1 | Give up GenGC | Poor | Good (No problem) | |
| 2 | GenGC with re- writing all of C codes | Good | Most of C-exts doesn't work | |
| 3 | Use new RGenGC | Good | Most of C-exts works!! | Ruby 2.1 choice |

Breaking the trade off. You can praise us!!

RGenGC: Key idea

Introduce <u>Shady object</u>

- I use the word "Shady" as questionable, doubtful, ...
- Something feeling dark
- •日陰者, in Japanese



RGenGC: **Key Idea**

- Separate objects into two types
 - Normal Object: WB Protected

Shady: doubtful, questionable, ...

Shady Object: WB <u>Unprotected</u>



Shady (´•ω·`)

- •We are not sure that a shady object points new objects or not
- Decide this type at creation time
 - A class care about WB \rightarrow Normal object
 - A class don't care about WB \rightarrow Shady object

RGenGC: **Key Idea**

- Normal objects can be changed to Shady objects
 - "Shade operation"
 - C-exts don't care about WB, objects will be shady objects
 - Example
 - ptr = RARRAY_PTR(ary)
 - In this case, we can't insert WB for ptr operation, so VM shade "ary"



RGenGC Key Idea: Rule

- Treat "Shady objects" correctly
 - At Marking
 - 1. Don't promote shady objects to old objects
 - 2. Remember shady objects pointed from old objects
 - At Shade operation for old normal objects
 - 1. Demote objects
 - 2. Remember shaded shady objects

RGenGC [Minor M&S GC w/Shady object]



- Mark reachable objects from root objects
 - Mark shady objects, and <u>*don't promote*</u> to old gen objects
 - If shady objects pointed from old objects, then remember shady objects by RSet.

→ Mark shady objects every minor GC!!

RGenGC [Minor M&S GC w/Shady object]

2nd MinorGC



- Mark reachable objects from root objects
 - Mark shady objects, and *don't promote* to old gen objects
 - If shady objects pointed from old objects, then remember shady objects by RSet.

 \rightarrow Mark shady objects every minor GC!!

RGenGC [Shade operation]



- •Anytime Object can give up to keep write barriers
 - \rightarrow [Shade operation]
- •Change old normal objects to shade objects
 - Example: RARRAY_PTR(ary)
 (1) Demote object (old → new)
 (2) Register it to Remember Set

RGenGC Timing chart



RGenGC Number of objects



RGenGC Number of objects



| | Marking space | Number of unused, uncollected objs | Sweeping space |
|-------------------|------------------------|---------------------------------------|-------------------|
| Mark&Swep GC | # of Living objects | 0 | Full heap |
| Traditional GenGC | #new + (a) | (a) | #new |
| RGenGC | #new + (a) + (b) + (c) | (a) + (b) | Full heap |

RGenGC Discussion: Pros. and Cons.

- Pros.
 - Allow WB unprotected objects (shady objects)
 - 100% compatible w/ existing extensions which don't care about WB
 - A part of CRuby interpreter which doesn't care about WB
 - Inserting WBs step by step, and increase performance gradually
 - We don't need to insert all WBs into interpreter core at a time
 - We can concentrate into popular (effective) classes/methods.
 - We can ignore minor classes/methods.
 - Simple algorithm, easy to develop (already done!)

RGenGC Discussion: Pros. and Cons.

• Cons.

- Increasing "unused, but not collected objects until full/major GC
 - Remembered normal objects (caused by traditional GenGC algorithm)
 - Remembered shady objects (caused by RGenGC algorithm)
- WB insertion bugs (GC development issue)
 - RGenGC permit shady objects, but sunny objects need correct/perfect WBs. But inserting correct/perfect WBs is difficult.
 - This issue is out of scope. We have another idea against this problem (out of scope).
- Can't reduce Sweeping time
 - But many (and easy) well-known techniques to reduce sweeping time (out of scope).

RGenGC Implementation: WB support status

| Type name | Status | Comment |
|------------|-------------|---|
| T_OBJECT | Supported | |
| T_CLASS | Supported | Possible to change into shady |
| T_ICLASS | Supported | Possible to change into shady |
| T_MODULE | Supported | Possible to change into shady |
| T_FLOAT | Supported | |
| T_STRING | Supported | |
| T_REGEXP | Supported | |
| T_ARRAY | Supported | Possible to change into shady / more efforts are needed |
| T_HASH | Supported | Possible to change into shady |
| T_STRUCT | Supported | |
| T_BIGNUM | Supported | |
| T_FILE | Unsupported | |
| T_DATA | Supported | Only InstructionSequence objects are supported |
| T_MATCH | Unsupported | Most of MatchData objects are short-lived |
| T_RATIONAL | Supported | |
| T_COMPLEX | Supported | |
| T_NODE | Unsupported | Most of Node objects are short-lived |

RGenGC

Implementation

- Introduce two flags into RBasic
 - FL_KEEP_WB: WB protected or not protected
 - 0 \rightarrow unprotected \rightarrow Shady object
 - 1 \rightarrow protected \rightarrow Sunny object
 - Usage: NEWOBJ_OF(ary, struct RArray, klass, T_ARRAY | FL_KEEP_WB);
 - FL_OLDGEN: Young gen or Old gen?
 - 0 \rightarrow Young gen
 - 1 \rightarrow Old gen
 - Don't need to touch by user program
- Remember set is represented by bitmaps
 - Same as marking bitmap
 - heap_slot::rememberset_bits
 - Traverse all object area with this bitmap at first

RGenGC Implementation: WB operation API

- •OBJ_WRITE(a, &a->x, b)
 - Declare 'a' aggregates 'b'
 - Write: *&a->x = b
 - Write barrier
 - OBJ_WRITE(a, b) returns "a"
- •OBJ_WRITTEN(a, oldv, b)
 - Declare 'a' aggregates 'b' and old value is 'oldv'
 - Non-write operation
 - Write barrier



RGenGC

Implementation: WB operation API

- •T_ARRAY
 - <u>RARRAY_PTR(ary) causes shade operation</u>
 - Can't get RGenGC performance improvement
 - But works well 🙂
- •Instead of RARRAY_PTR(ary), use alternatives
 - RARRAY_AREF(ary, n) → RARRAY_PTR(ary)[n]
 - RARRAY_ASET(ary, n, obj) → RARRAY_PTR(ary)[n] = obj w/ Write-barrier
 - •RARRAY_PTR_USE(ary, ptrname, {...block...})
 - Only in block, pointers can be accessed by `ptrname' variable (VALUE*).
 - **Programmers need to insert collect WBs (miss causes BUG)**.

RGenGC Incompatibility

- Make RBasic::klass "const"
 - Need WBs for a reference from an object to a klass.
 - Only few cases (zero-clear and restore it)
 - Provide alternative APIs
 - Now, RBASIC_SET_CLASS(obj, klass) and RBASIC_CLEAR_CLASS(obj) is added. But they should be internal APIs (removed soon).
 - rb_obj_hide() and rb_obj_reveal() is provided.

RGenGC Implementation

•RGENGC_CHECK_MODE in gc.c

- 1: Enable assertions
- 2: Enable "WB checking" mode
- •WB checking mode
 - •(1) do minor GC
 - •(2) do major/full GC
 - (3) compare result with (1) and (2)
 - If living objects in (2) but not living in (1) it should be BUG!!
 - Not a perfect (implementation limitation), but a good method to detect bugs

RGenGC Performance evaluation

- Ideal micro-benchmark for RGenGC
 - Create many old objects at first
 - Many new objects (many minor GC, no major GC)
- RDoc
 - Same RDoc generation as Ruby's trunk

RGenGC Performance evaluation (micro)



RGenGC Performance evaluation (RDoc)



Euruko 2013 Toward more efficient Ruby 2.1 by Koichi Sasada

RGenGC Performance evaluation (RDoc)



RGenGC Performance evaluation (RDoc)



RGenGC: Summary

- •RGenGC: Restricted Generational GC
 - New GC algorithm allow mixing "Write-barrier protected objects" and "WB unprotected objects"
 - No (mostly) compatibility issue with C-exts
- Inserting WBs gradually
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RGenGC Future work

• Minor GC / Major GC timing tuning

- Too many major GC \rightarrow slow down
- Too few major GC \rightarrow memory consumption issue
- •Inserting WBs w/ application profiling
 - Profiling system
 - Benchmark programs
- Debugging/Detecting system for WBs bugs
- Improve sweeping performance

Ruby 2.1 Other internal features

Ruby 2.1 expected "internal" features

- <u>Parallel sweeping</u>
- <u>Sophisticated inline cache invalidation mechanism</u>
- Memory efficient string management & Symbol GC
- Fine-grain memory protection to detect WB insertion miss
- Signal thread
- More efficient inter-process migration technique
- JIT compilation for small part of Ruby code
- Introduce fastpath C-methods
- Inlined Proc.call invocation
- AOT Compiler and extending "require" behavior
- Useful debugger

Parallel sweeping Background

- RGenGC improve performance only for "marking" phase
- RGenGC doesn't improve "sweeping phase" performance

Parallel sweeping Background (revisit Rdoc evaluation)



Parallel sweeping Background (revisit RGenGC Timing chart)



Parallel sweeping Introduce sweeping threads (ideal)



Parallel sweeping Ideal

•Hide most of sweeping time

Parallel sweeping Real

- Increase synchronization cost
- Increase program complexity
- Our preliminary evaluation (implemented in one night, buggy one) doesn't show good score
- •To be continued...
- •From Ruby 1.9 (YARV), inline cache technique is used in several codes
 - Inline method caching ← Huge opportunity
 - Constant lookup
 - .
- Cache invalidation with only one variable "global_state_version"
- Invalidate inline cache, other non-related inline caches are also invalidated

Invalidate all classes' method cache



"This patch adds class hierarchy method caching to CRuby. This is the algorithm used by JRuby and Rubinius."

> [ruby-core:55053] [ruby-trunk - Feature #8426][Open] Implement class hierarchy method caching by Charlie Somerville

Invalid only sub-classes under effective class



Each string has their string body (space acquired by malloc())



•For some strings have same "string body", they has own string body each other.



• It can be shared by strings w/ dirty bit.

ptr

\rightarrow Reduce memory consumption!!

"String body" (shared by 5 places)

+ Sharing string body is implemented now
if a string object is duped.
This technique is more aggressive approach.

•This mechanism can work with Symbol management



Questions and answers

Questions and Answers RGenGC and CoW friendly

 No problem because only touch flags for oldgen and shady

Questions and Answers GC + Threads

- Parallel GC
 - Run GC process in parallel (simultaneously)
 - Parallel marking
 - Parallel sweeping (in today's talk)
- •Concurrent GC / Incremental GC
 - Run ruby threads (mutator threads) and GC threads concurrently
 - Major GC consumes huge time (same as current GC) → Need concurrent GC to reduce pause time
 - New WB API is also designed for concurrent GC

Agenda

- Ruby's rough history
- Ruby 2.1 new "internal" features
 - Internal object management hooks
 - Object allocation tracing
 - GC hooks
 - RGenGC: Restricted Generational Garbage Collection ← Today's main topic
- Ruby 2.1 expected "internal" features
 - Parallel sweeping
 - Sophisticated inline cache invalidation mechanism
 - Memory efficient string management

Summary

- •We are implementing new features and improving Ruby's quality for Ruby 2.1
- Especially introducing new "Generational garbage collector" will achieve huge performance improvement
- Ruby 2.1 is currently scheduled on Dec 25, 2013. Don't miss it!

Thank you

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