The brandeis-problemset Document Class

Rebecca Turner* 2019/03/06 0.5.0

Abstract

Brandeis University's computer science ("COSI") courses often assign "problem sets" which require fairly rigorous formatting. The brandeis-problemset document class, which extends article, provides a simple way to typeset these problem sets in LTEX. Although brandeis-problemset is compatible with all LTEX flavors, XHLTEX or LuaTEX is recommended for fontspec support.

NOTE The brandeis-problemset document class should be considered experimental; the only stable API is that of the problem environment.

NOTE Browse the sources, contribute, or complain at github.com/9999years/brandeis-problemset

NOTE In roughly May 2021 I will graduate from Brandeis University and this package will become unmaintained. Although I'd like the computer science department to adopt this package, I'm not sure any professors have an interest in that maintenance. If you care about the extended future of this package, send some emails!

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1 Default behavior

brandeis-problemset provides packages and well-formatted constructs (notably the problem environment) for problem-set writers. brandeis-problemset will always render its body copy as a Times variant (stix for plain LATEX) or xits with XALATEX or LuaTEX) and always contains a useful header (which contains the page number, author's name, course, instructor, and assignment due date).

1.1 Default packages loaded

In general, brandeis-problemset will only load a feature if it's useful in more than one class; features like Gantt charts, Scheme code, assembly code, and so on, are loaded on demand.

- 1. hyperref, for a nicely-linked table of contents; \href{url}{label}.
- 2. geometry for page size and margins.
- 3. enumitem for better control over the margins and spacing of the enumerate, itemize, and description environments.
- 4. With any of the listings, scheme, pseudocode, or assembly options:
 - (a) listings, for verbatim code listings (including the assembly, java, and pseudocode environments).
 - (b) xcolor, for colored identifiers, strings, comments, and line numbers in listings; e.g. \color{gray}.
- 5. With the math option:
 - (a) amsmath for tons of useful math commands, including \text, \intertext, and \boxed as well as the bmatrix, multiline, gather, align, and alignat environments. See "User's Guide for the amsmath Package" for a more complete listing.
 - (b) mathtools for other useful/utilitarian commands.
 - (c) With X¬IET¬EX or LuaT¬EX, unicode-math to allow equations to be copy-pasted.
 - (d) The stix2-otf math fonts.
- 6. With the tabu option:
 - (a) multirow for cells spanning multiple rows.
 - (b) booktabs for beautiful-by-default tables and the \cline macro.
 - (c) tabu, the best table package with dynamically resizable columns, easy creation of new column types, and more.

2 Class configuration

2.1 Class options

Class options are limited to configuration options which require the loading of fonts or other packages; "string" settings like the assignment's due date are configured with the \bpsset command.

All class options can be negated with $no\langle option \rangle$; e.g. scheme can be disabled with noscheme. Later options override previous ones.

antonella

Only available in the brandeis-problemset document class. Use Dr. Antonella DiLillio's preferred styles (Courier for code)

tabu

Only available in the brandeis-problemset document class. Loads useful packages and defines commands for typesetting tables.

math

Only available in the brandeis-problemset document class. Loads utilities for typesetting mathematics. Because mathematics requires specialized fonts¹ as well as several other specialized packages,² this is disabled by default. Although I find myself needing mathematics fonts frequently, I know many students do not.

listings true

Enables code listings and enables default styles for colored keywords, pretty line numbers, and so on. While only this option enables the java environment, the scheme, assembly, and pseudocode options also load and style the listings package.

scheme

Enable Scheme language support, in particular for the R5RS dialect. Additionally, provides the scheme environment.

pseudocode

Enables the pseudocode environment, notably useful for COSI 21b (data structures).

assembly

Enables the assembly environment, notably useful for COSI 131a (operating systems).

solution

Show the content of solution environments; by default, they are excluded from compilation using the comment package.

gantt

Loads the ganttschedule environment.

maketitle true

Redefines \maketitle and defines \maketitlepage to include information about the course, instructor, assignment, and due date. If maketitle is set, then option is automatically enabled..

header true

Adds a header to the top of every page including information about the author, assignment, due date, and instructor. If header is set, then option is automatically enabled..

¹The STIX2 math font that this package loads weighs in at 740kb!

²Including amsmath, mathtools, and, with XqLATeX or LuaTeX, unicode-math.

config

Enables document metadata like the assignment's due date, name/number, instructor, and course through the \bpsset command, which supports \maketitle, page headers, and so on.

2.1.1 Class options or keyval options?

There's trade-offs to be made either way; class options greatly simplify the code (we don't have to worry about loading packages and defining commands in more than one place, for the most part), but are much less flexible and difficult to interface with when the package loading is hidden. At the moment, package/class options provide commands and keyval options define document-configuration data (like names, due dates, and the like; see section 2.2 for more information).

2.2 Configuring brandeis-problemset after loading

```
\begin{tabular}{l} \begin{tabu
```

Sets global brandeis-problemset options. Mnemonic: **B**randeis **p**roblem **s**et **set**up (this should feel familiar to users of the listings package).

NOTE \bpsset was renamed from \problemsetsetup in version 0.5.0. The \problemsetsetup command is deprecated and will be removed in a future release.

```
course = \langle course \ name \rangle
```

Course name in full.

```
coursenumber=⟨course number⟩
```

Course name shorthand; use 21a for "COSI 21a".

```
assignment = \(\alpha assignment name \)
```

Assignment name in full.

```
number=\(\rho\)problem set number\(\rangle\)
```

Assignment name shorthand; use 3 for "Problem Set 3".

```
duedate=\langle due \, date \rangle
```

Due date, e.g. 2018-10-18; not parsed at all, but ISO 8601 dates are highly recommended.

```
instructor=\(course instructor\)
```

Course instructor. With the antonella class-option, this is automatically set to Dr.~Antonella DiLillio.

```
author=\(\langle your name \rangle
```

Alternate interface for the \author command.

```
date = \langle document \ date \rangle
```

Alternate interface for the \date command.

```
codefont = \( \fontspec \font name \)
```

With X_HET_EX or LuaT_EX, pass the given font to \setmonofont and enable Unicode shortcuts for the pseudocode environment. (If you need to specify options to \setmonofont, use \setcodefont.)

```
\setcodefont[\langle fontspec\ options \rangle] \{\langle fontspec\ font\ name \rangle\}
```

Sets the monospaced font to $\langle fontspec font name \rangle$ and uses it for shortcuts in the pseudocode environment.

2.3 Practical usage

You may find it useful to define a customized document class for each course. There's no reason to install these to some system-wide directory; it makes sense for them to live in the same directory as the problem set source files. For instance, cosi21a.cls might read:

```
\LoadClass[antonella, pseudocode]{brandeis-problemset}
% pass all unknown options to brandeis-problemset
\DeclareOption*{\PassOptionsToClass
    {\CurrentOption}{brandeis-problemset}}
\ProcessOptions\relax
% set course/author data
\bpsset{
    coursenumber=21a,
    author=Rebecca Turner,
}
% get a prettier code font -- these can be pretty big so they're not
% loaded by default
\setcodefont[
  Extension = .otf,
  UprightFont = *-Regular,
  BoldFont = *-Bold.
1{FiraMono}
```

and then ps1.tex might read:

```
\documentclass{cosi21a}
% stuff specific to this assignment
\bpsset{
    number=1,
    duedate=2018-10-29,
}
\begin{document}
% etc.
\end{document}
```

Note that you could use e.g. \documentclass[math]{cosi21a} to add a specific per-document option. See section 5 for a more complete example.

3 User commands and environments

brandeis-problemset provides a number of commands for typesetting problems.

```
\begin{problem}[\langle options \rangle]...\end{problem}
```

Defines a problem. A problem is set 1 inch from the left margin (although this amount may be customized by modifying the \problemindent length) and begins a new page.

NOTE The problem and subproblem environments are typeset using \section and \subsection respectively, and as such can be customized with styling packages like titlesec; note, however, that they ignore and hide the usual section counters.

⟨options⟩ may include:

```
title=\(problem title\)
```

Displayed after "Problem" and the problem's number.

```
number = \langle problem number \rangle
```

If given, the problem-number counter will not advance. The number must be robust, because it goes inside a \section.

```
pagebreak=\langle true | false \rangle
```

true

Add a pagebreak before the problem?

```
label=\(problem label\)
```

Adds a custom label to the problem with \label that can be used with \ref. I recommend prefixing your problem labels with p: as in p:big-o-proofs.

```
toc=\langle true | false \rangle
```

true

Include this problem in the table of contents?

```
part = \langle part name \rangle
```

Indicates that this problem starts a new "part" of the assignment; actually calls \part under the hood.

```
partlabel=\( part label \)
```

Adds a custom label to this part in the same fashion as the label key.

Vertical material is allowed in a problem.

```
\begin{subproblem}[\langle options \rangle]...\end{subproblem}
```

Defines a subproblem. A subproblem is set 1 inch from the left margin (although this amount may be customized by modifying the \subproblemindent length) and begins a new page. Valid $\langle options \rangle$ are identical to the problem environment's, with the following exceptions:

```
pagebreak false
```

False by default.

part

partlabel

Not available in the subproblem environment.

EXAMPLE Note that although these examples are too short to display them, vertical material — including listings — is allowed in the problem and subproblem environments.

Problem 1

This is a problem in an assignment.

Some solution here...

Problem 1.1

This is a subproblem.

```
\begin{problem}
  This is a problem in an
        assignment.
\end{problem}

Some solution here\dots
\begin{subproblem}
  This is a subproblem.
\end{subproblem}
```

\begin{solution}...\end{solution}

Defines a solution for a problem; a solution prints in blue and is excluded from the compiled document entirely unless the solutions package option is given.

In this way, the same .tex file can serve as both a postable assignment prompt and an answer key.

NOTE The style of solutions is customizable by redefining \solutionstyle; it's defined to \color{blue} by default.

EXAMPLE The default solution style is shown below; note, however, that this document is compiled with the solution option passed to brandeis-problemset; without it, the typeset solution is entirely blank.

```
| Some solution here... | Some solution here \dots \end{solution}
```

$\Th[\langle column \, spec \rangle] \{\langle header \, text \rangle\}$

Typesets a table header in bold-face. $\langle column\ spec \rangle$ defaults to l. Useful for when a column is wrapped in a math environment; if you have a column >{\ttfamily}l, using \Th will not print the header in \ttfamily.

```
      Server IP
      juice 1.1.1.1
      \Th{\server} & \Th{\textsc{ip}} \\
        juice & 1.1.1.1 \\
        dogs & 2.2.2.2 \\
```

\begin{pseudocode}[\langle keywords \rangle]...\end{pseudocode}

Prints pseudocode.³

³Designed for COSI 21a as taught by Dr. Antonella DiLillo

Several "shortcuts," which replace a source-code sequence like → with a symbol like →, are shown in table 1.

These shortcuts display in \pseudocodesymbolfont (default: \ttfamily), which may be redefined if you prefer something else. The easiest way to change \pseudocodesymbolfont is with \setcodefont. If you use the antonella option with X_HM_{TE}X or LuaT_EX, brandeis-problemset will load lm-math and display the symbols seen in table 1, which look significantly better with Courier than stix' symbols.

The following words are treated as keywords in pseudocode, and will be bolded as appropriate: Input, Output, Complexity, while, do, return, for, to, if, then, else, True, False, None, and, or, nil, and len.

Table 1: Shortcuts provided by the pseudocode environment

Input	Command	Display	Codepoint
<-	\pseudocodeleftarrow	\leftarrow	U+2190
->	\pseudocoderightarrow	\rightarrow	U+2192
(/)	\pseudocodeemptyset	Ø	U+2205
inf	\pseudocodeinfty	∞	U+221E
! =	\pseudocodene	\neq	U+2260
>=	\pseudocodege	\geq	U+2265
<=	\pseudocodele	\leq	U+2264

EXAMPLE Note how the option [Bar] argument makes Bar appear bold like any other keyword in the typeset listing.

```
\begin{pseudocode}[Bar]
                                           Bar(a, n)
Bar(a, n)
                                               Input: two integers, a and n
    Input: two integers, a and n
                                               Output: a^n
    Output: a^n
                                               k <- n # k is a counter
    k \leftarrow n # k is a counter
                                               b <- inf
    b \leftarrow \infty
                                               c <- a
    c \leftarrow a
                                               while k >= 0 do
    while k \ge 0 do
                                                    if k \mod 2 = 0 then
         if k mod 2 = 0 then
                                                         k <- k / 2
              k \leftarrow k / 2
                                                         c <- c * c
              c \leftarrow c * c
                                                    else
         else
                                                         k <- k - 1
              k \leftarrow k - 1
                                                         b <- b * c
              b \leftarrow b * c
                                               return b
    return b
                                           \end{pseudocode}
```

\begin{assembly}[\langle listings options \rangle]...\end{assembly}

Typesets assembly code.⁴ Several considerations are taken into account; most notably, line numbers are printed as x + n, where n starts at 0 and counts by 4; the line number actually indicates the instruction's location in memory as an offset from the program start. Additionally, all valid instructions are treated as keywords and styled appropriately.

(*listings options*) is passed directly to the listings package.

⁴Designed for COSI 131a as taught by Dr. Liuba Shrira

```
LOAD R4, $200
                                                                          ; sum addr
x + 0 LOAD R4, $200
                           ; sum addr
                                                      LOAD
                                                            R1, =0
                                                                          ; sum
                           ; sum
x + 4 LOAD R1, =0
                                                      LOAD
                                                            R2, =0
                                                                          ; i
x + 8 LOAD R2, =0
                           ; i
                                                      LOAD
                                                            R3, =0
                                                                          ; j
x + 12 LOAD R3, =0
                           ; j
                                                                          ; we know i < 10
                                                      BR
                                                            OUTER
             OUTER
x + 16 BR
                           ; we know i < 10
                                                      INNER:
X + 20 INNER:
                                                      ADD
                                                            R1, R3
                                                                          ; sum += j
       ADD
           R1, R3
X + 24
                           ; sum += j
                                                      INC
                                                                          ; j++
                                                            R3
       INC
x + 28
            R3
                           ; j++
                                                      OUTER:
       OUTER:
X + 32
                                                            R3, R2, INNER; while j < i goto inner
                                                      BLT
       BLT R3, R2, INNER; while j < i goto inner
x + 36
                                                      INC
                                                            R2
                                                                          ; i++
                     ; i++
X + 40 INC
             R2
                                                      LOAD
                                                            R3, =0
                                                                          ; j = 0
x + 44 LOAD R3, =0
                           ; j = 0
                                                      BLT
                                                            R2, =10, OUTER; while i < 10 goto
x + 48 BLT R2, =10, OUTER; while i < 10 goto outer
                                                          outer
x + 52 STORE R1, @R4 ; store sum
                                                      STORE R1, @R4
                                                                          ; store sum
x + 56 HALT
                                                      HALT
                                                      \end{assembly}
```

\begin{assembly}

\begin{java}[\langle listings options \rangle]...\end{java}

Tragically-common shorthand environment for a listing of Java code. *(listings options)* is passed directly to the listings package.

```
\begin{scheme}[\langle listings options \rangle]...\end{scheme}
```

Shorthand environment for a listing of Scheme code, useful for COSI 121b. Requires the scheme package option to be loaded.

(*listings options*) is passed directly to the listings package.

```
\begin{ganttschedule}[\langle totalcellcount \rangle]...\\end{ganttschedule}
```

An environment for drawing Gantt charts indicating process scheduling. The mandatory argument indicates how small the grid should be; 19 subdivides the line into 19 cells.

To use the ganttschedule environment, make sure to use the gantt package option. Within a ganttschedule, use the \burst command to indicate an active process (i.e. a process burst).

NOTE The charts ganttschedule draws aren't actually really proper Gantt charts, which can indicate parallel activities; however, that's what Liuba calls them, so that's what they're called here.

$\left\langle pid\left\langle pid\right\rangle \right\} \left\langle burst\ length\right\rangle \right\}$

Draw a burst for process $\langle pid \rangle$ of time length $\langle burst \, length \rangle$.

NOTE The Gantt chart packages (notably tikz) don't play nicely with ltxguidex, the package this documentation is written in; for a typeset example, see section 5.

```
1 \begin{ganttschedule}{19}
2 \pid{2}{1}
```

```
3  \pid{4}{1}
4  \pid{3}{2}
5  \pid{5}{5}
6  \pid{1}{10}
7  \end{ganttschedule}
```

NOTE Because ganttschedule relies on tikz, fp, and calc, it can add significantly to document compile times. If you intend to use the ganttschedule environment, make sure to use the gantt class option or set gantt in \bpsset. If you fail to include the gantt option, you will see an error message:

```
! Package brandeis-problemset Error: ganttschedule enviornment
    not loaded in preamble.

See the brandeis-problemset package documentation for
    explanation.

Type H <return> for immediate help.

1.4 \burst
    {1}{1}

? H

Did you mean to use the 'gantt' option for the
    brandeis-problemset document class?
```

3.1 General formatting commands

Creates a new acronym. If $\langle command \rangle$ isn't given, the text of the macro will be used instead; $\newacronym\{cfg\}$ would define a command \cfg which typesets as "CFG". If the resulting command already exists, it will be redefined. For \newacronyms , the $\langle acronym \ list \rangle$ is a comma-delimited list of acronyms.

A CFG describes a context-free language... The SPARC had a unique CPU...

```
\newacronym[\xyz]{cfg}
A \xyz\ describes a context-free
    language\dots
\newacronyms{sparc, cpu}
The \sparc\ had a unique
```

\cpu\dots

$\ac{\langle acronym \rangle}$

Typesets an acronym. The $\langle acronym \rangle$ should be lowercase (e.g. $ac\{cpu\}$ rather than $ac\{CPU\}$). Currently, $ac\$ simply delegates to textsc. In the future, I'd like to support a bit of letterspacing; "for abbreviations and acronyms in the midst of normal text, use spaced small caps."

⁵The Elements of Typographic Style by Robert Bringhurst, 2nd. ed, § 3.2.2

```
\Sc{\langle text \rangle}
```

An abbreviation for \textsc.

```
\mathbb{R}m\{\langle text \rangle\}
```

An abbreviation for \textrm.

 $\mathsf{Up}\{\langle text \rangle\}$

An abbreviation for \textup.

 $\Bf\{\langle text\rangle\}$

An abbreviation for \textbf.

An abbreviation for \textit.

 $\mathsf{Tt}\{\langle text \rangle\}$

An abbreviation for \texttt.

4 A class and a package

As a user, you'll likely only need the brandeis-problemset document class. However, a *package* named brandeis-problemset is also provided. The class styles an entire document, while the package only provides commands. This allows — for example — loading the package for the examples in this document without messing up our titles, headers, and so on.

5 Example

A brief example usage of brandeis-problemset follows. For a longer, more in-depth example, see example.tex in the brandeis-problemset repository.

```
1 \documentclass[gantt]{brandeis-problemset}
   \author{Rebecca Turner}
   \bpsset{
 3
 4
        coursenumber=21a,
 5
        instructor=Dr.\ Liuba Shrira,
       duedate=2018-10-20,
 6
 7
       number=3,
8
   \newcommand{\io}{\ac{io}}}
10 \newcommand{\cpu}{\ac{cpu}}
   \begin{document}
```

```
12
13 \begin{problem}
       Write an assembly program!
14
   \end{problem}
15
16
17 \begin{assembly}
                             ; A = (program location) + 200
           LOAD R1, $200
18
           LOAD R2, =1
                                ; i = 1
19
20 \end{assembly}
21
   \begin{problem}
22
       What does this algorithm do? Analyze its worst-case running time
23
       express it using big-O notation.
24
25
   \begin{pseudocode}[Foo]
26
   Foo(a, n)
27
       Input: two integers, a and n
28
       Output: a^n
29
       k <- 0
30
       b <- 1
31
       while k < n do
32
           k < -k + 1
33
           b <- b * a
34
35
       return b
36 \end{pseudocode}
   \end{problem}
37
38
   Rm{Foo}(a, n) computes a^n, and will run in 0(n) time always.
39
40
   \begin{problem}[number=5.4]
41
        Consider the following set of processes, with the length of the
42
       \cpu\ burst given in milliseconds:
43
44
       \begin{center}
45
            \begin{tabu} to 0.25\linewidth{X[1,$]rr}
46
                \Th{Process} & \Th{Burst time} & \Th{Priority} \\
47
48
                P_1 & 10 & 3 \\
49
                P_2 & 1 & 1 \\
                P_3 & 2 & 3 \\
50
                P_4 & 1 & 4 \\
51
                P_5 & 5 & 2 \\
52
           \end{tabu}
53
       \end{center}%$
54
55
       Draw a Gantt chart to illustrate the execution of these processes
56
57
       using the \ac{sjf} scheduling algorith.
   \end{problem}
58
59
   \begin{ganttschedule}{19}
60
61
        \pid{2}{1}
        \pid{4}{1}
62
```

```
63  \pid{3}{2}
64  \pid{5}{5}
65  \pid{1}{10}
66  \end{ganttschedule}
67  \end{document}
```

6 Changelog

Coming soon... Rebecca Turner

Added

• Support for COSI 130b, including regular expressions and context-free grammars.

0.5.0 Rebecca Turner (2019-03-06)

Added

- \newacronym and \newacronyms commands.
- Added toc option to the problem and subproblem environments.

Changed

- Cleaned up internals; improved option system, split brandeis-problemset into a class and a package, renamed commands and lengths to use the bps@ prefix more consistently.
- brandeis-problemset now has a modular and much more conservative approach; far fewer packages are loaded and features are loaded only upon request to a much greater extent.
- subproblem is now an environment, not a command, with an interface matching the problem environment.
- The assembly and pseudocode options now define languages for the listings package, rather than just providing environments to use the languages.

Removed

- The following commands have been removed in favor of the \bpsset command, which encompasses their functionality entirely: $\langle aate \rangle$, $\langle name \rangle$, assignment $\langle name \rangle$, and $\langle name \rangle$.
- Removed dependencies: environ and titlesec. No longer unconditionally loaded: hyperref, xcolor, comment, listings, multirow, booktabs, longtable, tabu.

Deprecated

• The \problemsetsetup command, which has been renamed \bpsset.

0.4.4 Rebecca Turner (2019-02-14)

Changed

- Changed Times body copy font from tex-gyre's Termes to the newer stix2-otf (for XqLTeX or LuaTeX) and stix2-type1 (for other TeX engines) the STIX2 fonts are somewhat unique amongst Times-likes in that they contain small caps.
- Redefined \Re to print in blackboard-bold.
- **0.4.3** Rebecca Turner (2019-01-20) Fixed typos in license file, fixed distributed documentation .pdf.
- **0.4.2** Rebecca Turner (2019-01-19)

Added

 author and date keys added to \problemsetsetup to simplify class-wide configuration.

Fixed

• Fixed definitions for \duedate, \instructor, etc. to avoid spurious errors due to undefined commands.

Changed

- Translated documentation to the new ltxguidex document class for added beauty.
- Re-licensed brandeis-problemset to the LPPL v1.3c for easy transfer of maintenence in the future.
- **0.4.1** Rebecca Turner (2019-01-03) Updated scheme environment to properly recognize all primitive functions, added syntax coloring to all code.
- **0.4.0** Rebecca Turner (2018-12-20)

Added

- solution environment and solutions class option.
- scheme shorthand environment and scheme class option.

Fixed

- Boolean class options being overwritten by keys defined for \problemsetsetup.
- · Title-formatting errors

Removed

 Assignment- and course-specific class options duedate, assignment, instructor, and course. These settings should be configured with either \problemsetsetup or their specific commands. (\duedate, \instructor, etc.).

0.3.0 Rebecca Turner (2018-10-24)

Added

- · This changelog.
- Support for \parts and referencing problems.
- Options to problem environment: part, label, and partlabel.

• \maketitle (contrast with \maketitlepage).

0.2.0 Rebecca Turner (2018-10-20)

Changed

• Class renamed to from problemset to brandeis-problemset.

Added

- A license header.
- ganttschedule environment.
- Additional keywords for pseudocode environment: and, or, nil, and len.
- \ac command for acronyms.
- An example document.

0.1.0 Rebecca Turner (2018-10-19) — Initial beta as problemset.