Company-Coq: Taking Proof General one step closer to a real IDE

A tutorial on using Proof General and its new extension to write proofs more efficiently

Clément Pit-Claudel
MIT CSAIL
cpitcla@mit.edu

Pierre Courtieu
CNAM, Lab. Cédric
pierre.courtieu@cnam.fr

Abstract

Company-Coq is a new Emacs package that extends Proof General with a contextual auto-completion engine for Coq proofs and many additional facilities to make writing proofs easier and more efficient. Beyond fuzzy auto-completion of tactics, options, module names, and local definitions, company-coq offers offline in-editor documentation, convenient snippets, and multiple other Coq-specific IDE features. The system will be presented at CoqPL 2016, focusing on a live demo with an emphasis on writing proofs in Emacs more efficiently, and a discussion of desirable features of proof-oriented development environments.

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Introduction

Users of the Coq Proof Assistant [3] are roughly divided between two interactive development environments1: Proof General, an extension of Emacs written by David Aspinall [1], and CoqIDE, a Coq-specific development environment written from scratch by members of the Coq team and generally touted as more beginner-friendly (mostly due to Proof General’s dependence on Emacs). Both are powerful tools for writing proofs, and significantly improve the experience of proof authors when compared to Coq’s simple read-eval-print loop. Yet these tools do not offer advanced features typically found in IDEs, such as in-editor documentation or context-sensitive completion. In addition, when advanced features are in fact available (Proof General, for example, does support snippets and improved display of mathematics), they tend to lack discoverability: users do not explore the menus and miss convenient features that would make them more efficient.

Company-Coq is a new Emacs package that attempts to fix some of these limitations: we extend Proof General with many advanced IDE features (fuzzy completion, various Coq-specific snippets, and in-editor documentation for most of Coq’s 2000-odd tactics, options, and errors), and solve the discoverability issue by taking an “all-on” approach: the default distribution has most features automatically enabled2. In addition, company-coq comes with a comprehensive tutorial that showcases most of its features. Since it is not part of the core Proof General, company-coq can serve as a convenient experimentation area for new features and development directions, before they are merged into other IDEs.

Workshop description

The presentation will consist of a quick run through company-coq’s features, and a tutorial on using these and other Proof General features to write proofs more efficiently with emphasis on the lemma extraction feature. The workshop will also be a good occasion to showcase some features that Proof General inherits from Emacs, to discuss how much of this work could be used to enhance other Coq interfaces, and to ponder about desirable features for proof-oriented development environments.

Overview of some features of company-coq

Context-sensitive autocompletion with holes

Company-Coq implements a number of backends for the CompleteAnything Emacs package (company). Typing app in therefore suggests variants of the apply tactic (bold text indicates holes):

```
| app in | apply term in ident | ...<ref[2]> |
| app in | apply term,+ in ident | ...<ref[2]> |
| app in | apply term,& with bindings_list, & in ident .. |
| app in | apply term,& with bindings_list, & in ident as |
| app in | apply term,& in ident | ...<ref[2]> |
| app in | apply term,& in ident as intro_pattern ...<re |
```

Context-sensitive autocompletion with holes.

1 There also exist Coq interfaces for vim and Eclipse, though their use does not seem very widespread.

2 For example, although Proof General does support enhanced displaying of mathematics (non-destructively displaying fun (n m: nat) => forall p, p < n -> p + n >= m & (n m: nat) => forall p, p < n -> p >= n), few users seem to know about this feature. Company-Coq, on the other hand, enables a similar feature by default, and most users seem pleased with it.
Offline documentation  Part of the development of company-coq involved cross-referencing tactics and options from the user manual; this allows company-coq to display documentation for most completion entries, without querying INRIA’s website:

<table>
<thead>
<tr>
<th>appin</th>
<th>apply term in ident</th>
<th>...&lt;ref[2]&gt;</th>
</tr>
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<tr>
<td></td>
<td>apply term,+ in ident</td>
<td>...&lt;ref[2]&gt;</td>
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<td></td>
<td>apply term, &amp; with bindings_list, &amp; in ident</td>
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<td>apply term, &amp; with bindings_list, &amp; in ident as</td>
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<td>apply term, &amp; in ident</td>
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<tr>
<td></td>
<td>apply term, &amp; in ident as intro pattern ...&lt;re</td>
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</tr>
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</table>

Online documentation. (Coq 🕒)

9.2.5 apply term in ident

This tactic applies to any goal. The argument term is a term well-formed in the local context and the argument ident is an hypothesis of the context. The tactic apply term in ident tries to match the conclusion of the type of ident against a non-dependent premise of the type of term, trying them from right to left. If it succeeds, the statement of hypothesis ident is replaced by the conclusion of the type of term. The tactic also

*company-coq: documentation* (Help)

Lemma extraction  At any point in a proof, users may choose to extract the current goal, including some hypotheses, to a separate lemma. Instead of painstakingly copy-pasting bits of the proof context, company-coq offers a convenient interface to pick hypotheses and generate the statement of the extracted lemma:

| plus | plus : N → N → N |
|      | fix plus (n m : N) {struct n} : N := |
|      |  | match n with |
|      |  | | θ ⇒ m |
|      |  | | S p ⇒ S (plus p m) |
|      | end |
|      | : N → N → N |

Point and click documentation  Clicking on an identifier while pressing the control key opens an inline documentation window (which disappears when the mouse button is released):

Snippets  Company-Coq connects with YASnippet to make certain common Coq patterns quicker to write. For example, to write

\[
\text{match goal with} \\
| [ \text{H: ?a } \land \ ?b ] \Rightarrow \text{destruct H; assumption} \\
\text{end}
\]

the user only needs to type the following commands:

\[m \ g \ w \ d\]
\[\text{Alt}+\bar{0}+d\]
\[\text{Alt}+\bar{0}+d\]
\[?a \ \land \ ?b \ \Rightarrow \ ?a \ \Rightarrow \ ?a \ \Rightarrow \]
\[\text{destr} \ d\]
\[H; \text{ass} \ d\]

The key here is the \(\text{Alt}+\bar{0}+d\) shortcut, which introduces the pattern, leaving holes that the user can navigate between with TAB in place of each _.

Automatic named introduction  Scripts that depend on the names of hypotheses can often be made more robust by choosing names explicitly: company-coq leverages an existing feature of Proof General to let the user type

\[\text{intros}! \ d\]

to create an invocation of the intros tactic that explicitly mentions all introduced variables.

New features of Proof General  A number of new Proof General features are also useful for proof development:

Automatic indentation of bulleted proofs  Coq proofs can be structured with bullets and curly brackets, making proof structure more readily apparent, and helping with maintenance. Thanks to SMIE [2], Proof General implements an indentation routine based on structuring commands which makes proofs easier to format.

Automatic recompilation at Require  When developing a proof, one has to deal with several inter-dependent files. Proof General, thanks to a contribution of Hendrik Tews, can transparently and recursively recompile dependencies as it reaches Require commands, launching the required compilation jobs in the background.

Conclusion  Company-Coq has been well received by the community⁵, and we expect many of its features to find their way into other Coq development environments⁶; we hope that the CoqPL workshop will be a good venue to discuss it, and more generally to discuss the development of new editor features enhancing the experience of authors of Coq programs and proofs.

References


⁵ At this time, company-coq has accumulated 800 downloads.

⁶ Indeed, the architecture of company-coq should be amenable to such cross-pollination: none of its features are Emacs-specific, and the collection of pre-processing scripts that it relies on to offer documentation, completion and snippets is freely available (along with their output).