An important characteristic of an aspect is its crosscutting nature, which becomes perceivable through *scattering* and *tangling* of the source code constituting the aspect. Scattered code is found all over different modules of the software. Tangled code is closely intertwined with code constituting other aspects. Understanding these characteristics is crucial to understand the relevance of aspect-oriented mechanisms to improving modularity in software.

This paper puts forward an approach to introducing the concepts of scattering and tangling by means of a literary metaphor and an example from literature. Using this metaphor allows for introducing the aforementioned concepts not only to people with an understanding of software development, but to virtually anyone willing to use metaphors to grasp a concept.

The metaphor is centered around the idea of regarding a software concern as a *story* the application is telling. A clearly and cleanly modularised system tells each of its stories in a way that makes it easily conceivable. A module that contains tangled code of a crosscutting concern tells *numerous stories at a time*, blurring each single one. A concern that is scattered over several modules ends up being *torn apart*: a rough collection of allusions to the actual story.

The Irish author James Joyce has, most notably in his last two books, *Ulysses* [2] and *Finnegans Wake* [3], used writing techniques that strongly exhibit tangling and scattering characteristics. In his writing, Joyce assigns multiple meanings to chapters, paragraphs, phrases, even single words and protagonists [1]. That way, his writings tell multiple stories at a time, which is why they can well serve as literary examples for the metaphor described above, and used to explain the concepts of tangling and scattering. An example from the more easily amenable *Ulysses* shall be used to explain the analogies of tangling and scattering in literature.

Chapter fourteen of *Ulysses*, the “Oxen of the Sun” episode, takes place in a maternity clinic. The chapter simultaneously tells no less than six stories [1, 4]. The first one

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is immediately perceivable in the narrative: a woman is giving birth to a child. At the
end of the chapter, the boy is born.

The second story is also clearly visible but has a strong connection to the overall plot:
the two main protagonists of the novel, Leopold Bloom and Stephen Dedalus, meet and
realise for the first time their close relationship. In fact, Bloom represents the body and
Dedalus the soul, and the realisation of their mutual relevance for each other leads to
a fruitful connection. This is established at the end of the chapter (close to when the
narrative tells about the child’s birth).

The remaining stories tell about different processes that begin with a “conception”,
can be regarded as a “pregnancy” and end with a “birth”. The history of the English
language is told in the third, the act of conception being described by paragraphs written
in styles resembling Latin and Anglo-Saxon, the two languages at the roots of English.
The subsequent paragraphs show the evolution of English literature, being written in
different styles, ultimately leading to the language of the early 20th century and Joyce’s
modernist style—modern English literature is born.

There are forty such paragraphs, representing the forty weeks of pregnancy—the fourth
story is about pregnancy. This story can be regarded as a kind of wrap around all the
other stories dealing with pregnancy: all development takes place in the forty paragraphs.

The stories so far are all tangled with each other. The two remaining ones are different
in that they are also scattered over the entire chapter. They describe, in parallel, the
development of an embryo and evolution. Both of these stories are told by means of
single words that mention, on the one hand, the body parts of a human in the order
that they are formed during pregnancy, and, on the other, Latin denotations for animals
in the order they appeared during evolution.

While telling multiple stories at a time in the way described above may be the display
of skilful art, it is certainly undesired in software, where the different stories are to be
separated from each other. Conversely, telling each of the stories apart from each other
would make a text appear rather dull and dry.

The metaphor of telling multiple stories at a time, and the example of Joyce’s writing
are understandable not only to software engineers, but basically to anyone. It is not
required to have read Ulysses to understand the problems associated with scattering
and tangling; the book chapter serves as an example where their effects are immediately
visible. Roughly outlining the chapter, enumerating its important characteristics, is
sufficient for the purpose of bringing the metaphor to life by means of an example.

References


ated by D. Vanderbeke et al.