# FEAT 3 Practical FEAT 3 实操

This is the third FEAT practical. It leads you through some of the more advanced usage and concepts in both single-session and higher-level FEAT analyses. Feel free to do the latter three sections in a different order if you are particularly interested in any of them.

这是第三次 FEAT 实践。 它引导您完成单 session 和更高级 FEAT 分析中的一些更高级的用法和概念。如果您对后三个部分中的任意一个特别感兴趣，请随意以不同的顺序进行。

**Contents:**



**目录:**

## Optional extensions

There is far more to FEAT than we have time to cover here! There are a few more sections in the "Extras" practical, but we do not expect you to do these! However, if you think that any of the concepts outlined below are likely to be more relevant to you than what is in this practical, then feel free to substitute sections.

- **Custom Waveforms**

  An example of the options for setting up first-level FEAT analyses with simple designs that do not require timing files.

- **HRF Basis Functions**

  Create and use basis functions to model more general / flexible HRF shapes.

## 可选扩展

除了我们在这里讨论的内容之外，FEAT 还有更多的内容！“额外”实操中还有其他几节内容，但是我们不期待您去操作！除非您认为以下概念中的任何一个都可能比本实践更有意义。

- **自定义波形**

  一个用于设置简单设计第一级 FEAT 分析的选项示例，该设计不需要时序文件。

- **HRF 基函数**

  创建并使用基函数来建设更通用/灵活的 HRF 形状模型。

## Motion & Physiological Noise Correction

In this section, we look at the ways we can correct for structured noise within FEAT. By adding specific regressors to the GLM we can mitigate the effects of motion to some extent, and we can pursue a similar strategy using PNM to correct for physiological noise—provided physiological recordings were acquired during the scan!

## 运动和生理噪声校正

在本节中，我们介绍了在 FEAT 中校正结构噪声的方法。 通过在 GLM 中添加特定的回归变量，我们可以在某种程度上减轻运动的影响，并且我们可以使用 PNM 采取类似的策略来校正生理噪声-在此提供的生理记录是在扫描过程中采集的！

To demonstrate this we acquired two data sets: two repetitions of the pyramids & palm trees task (as seen in the FEAT 2 practical) in the same subject, but where in one scan the subject deliberately moved and breathed irregularly. These are referred to as the *naughty* and *nice* data from here on in.

为了证明这一点，我们获得了两个数据集：在同一被试中两次重复执行金字塔和棕榈树任务（如 FEAT 2 实用程序所示），但是在一次扫描中，被试故意移动并呼吸不规则。从现在开始，这些数据将分别称为顽皮的和良好的数据。

Note that we will deal with ICA-based clean-up strategies tomorrow, but these are a complementary approach.

请注意，我们明天将处理基于 ICA 的清理策略，但这些是一种补充方法。

**Data**

Take a moment to re-familiarise yourself with the key contrasts and typical responses under normal conditions, and satisfy yourself that the subject was still for the duration of the *nice* scan. Then look at the data contaminated by motion—the differences should be obvious!

**数据**

花点时间重新熟悉一下正常情况下的主要对比和典型响应，被试在整个扫描过程中均静止不动。然后查看被运动污染的数据-差异应该很明显！

```
cd ~/fsl_course_data/fmri3/motion/
firefox nice.feat/report.html &
firefox naughty.feat/report.html &
```

## Simple motion correction

The simplest form of motion correction we can apply is to add the estimated motion traces from MCFLIRT to the GLM as nuisance regressors. That ensures that any of the BOLD signal that correlates with the temporal dynamics of the motion can be treated as noise. To do this, we simply select **Standard Motion Parameters** from the drop-down menu in the **Stats** tab in FEAT. Take a look at how this changes the results below:

```
firefox naughty_motion.feat/report_poststats.html &
```

## 简单的运动校正

我们可以应用的最简单的运动校正形式是将估计的运动轨迹从 MCFLIRT 添加到 GLM 作为干扰回归指标。这样可以确保将与运动的时间动态相关的任何 BOLD 信号都被视为噪声。为此，我们只需从 FEAT 的 Stats 选项卡的下拉菜单中选择 Standard Motion Parameters 即可。 看一下它如何改变以下结果：

## Physiological noise correction

We are now going to use PNM to generate a set of EVs that relate to the physiological recordings we collected during the scans.

- Open PNM: `Pnm &`
- Select `pnm/naughty_recordings.txt` as the **Input Physiological Recordings** and the 4D data (`naughty.nii.gz`) as the **Input TimeSeries.**

## 生理噪声校正

现在，我们将使用 PNM 生成一组 EV，这些 EV 与我们在扫描期间收集的生理记录有关。

- 打开 PNM：Pnm &
- 选择 pnm / naughty_recordings.txt 作为 Input Physiological Recordings，选择 4D 数据（naughty.nii.gz）作为 Input TimeSeries。

- We need to set some extra information about the recordings too. Make sure the **Column numbers** are: 4−cardiac; 2−respiratory; and 3−scanner triggers. Then set **Sampling Rate** to 100 Hz and **TR** to 0.933 s.

- As this is multiband data, we need to explicitly provide slice timings, but for conventional sequences it is normally possible to use one of the defaults. Set **Slice Order** to **User Specified** and select pnm/slice_timings.txt. Note that if you are doing this using the pop up window, you will need to delete IMAGE in the **Filter** box at the top to display the text file.

- Set the output basename to pnm/mypnm. Under EVs, select RVT and then press **Go!** Once this has printed Done in the terminal, open the report using `firefox pnm/mypnm_pnm1.html &`

- 我们还需要设置一些有关记录的额外信息。 确保 Column numbers 是：4−cardiac; 2−respiratory; and 3−scanner triggers。 然后将 Sampling Rate 设置为 100 Hz，将 TR 设置为 0.933 s。

- 由于这是多频段数据，因此我们需要提供 slice timing，但是对于常规序列，通常可以使用默认值之一。将 Slice Order 设置为 User Specified，然后选择 pnm / slice_timings.txt。请注意，如果使用弹出窗口执行此操作，则需要在顶部的 Filter 框中删除 IMAGE 以显示文本文件。

- 将输出基本名称设置为 pnm / mypnm。 在 EVs 下，选择 RVT，然后按 Go！在终端上显示 Done 后，请使用 `firefox pnm/mypnm_pnm1.html &`打开报告。

Look at the report PNM generates. You should be able to see several unusual events in the respiratory trace!

查看 PNM 生成的报告。您应该能够看到呼吸道中的一些异常事件！

*Aside: If you don't see any plots at the top of the web page, right-click on the empty area, and select This Frame -> Reload Frame.

*备注：如果您在网页顶部没有看到任何图片，请右键单击空白区域，然后选择 This Frame -> Reload Frame。

The second step of PNM takes the processed physiological data and makes the EVs for FEAT—we will show you how to use these later. To generate these, run the command listed at the bottom of the web page or simply:

PNM 的第二步是获取经过处理的生理数据，并为 FEAT 制作 EV - 我们将在稍后向您展示如何使用它们。要生成这些文件，请运行网页底部列出的命令或简单地：

```
./pnm/mypnm_pnm_stage2
```

We ran an analysis for you that included the physiological confound EVs generated by PNM (either only using PNM, or using PNM in combination with the standard motion parameter approach described above). Have a look at how this changes the results:

我们为您进行了分析，其中包括由 PNM（仅使用 PNM 或将 PNM 与上述标准运动参数方法结合使用）生成的生理混淆 EV。看看这如何改变结果：

```
firefox naughty_pnm.feat/report_poststats.html &
firefox naughty_motion+pnm.feat/report_poststats.html &
```

**Motion outliers**

As a last resort, we can completely ignore volumes that have been irreparably corrupted by motion. This is very similar to the concept of 'scrubbing', which just deletes any particularly bad volumes. However, deleting volumes is problematic as it disrupts the modelling of temporal autocorrelations. Instead, we can add another set of EVs to the GLM that indicate which volumes we want to ignore. We use fsl_motion_outliers to do this using the command below:

**运动异常值**

作为最后的手段，我们可以完全忽略无法修复的运动污染体积。这与“清理”的概念非常相似，后者只是删除任何特别坏的体积。但是，删除体积是有问题的，因为它会破坏时间自相关的建模。所以取而代之地，我们可以向 GLM 添加另一组 EV，以指示我们要忽略的体积。我们使用 fsl_motion_outliers 通过以下命令执行此操作：

```
fsl_motion_outliers -i naughty.nii.gz -o my_outliers.txt -v
```

This may take a few minutes to run as this is multiband data. The -v flags simply prints some extra information, including the volumes that fsl_motion_outliers identifies as noisy. Open naughty.nii.gz in FSLeyes and check a few of these volumes.

由于这是多频段数据，因此可能需要几分钟才能完成运行。-v 标志仅输出一些额外的信息，包括 fsl_motion_outliers 标识为噪音的体积。在 FSLeyes 中打开 naughty.nii.gz 并检查其中一些体积。

**How many fsl_motion_outliers EVs will be added to the design matrix?**

- One EV will be added, that contains all timepoints that should be removed
- One EV per volume will be added, to encode whether or not that timepoint should be removed
- One EV per volume to be removed will be added

  Correct! Each of these EVs will have zeros at all timepoint and a 1 at the timepoint that should be removed.

Finally, we are ready to put this all together! Open FEAT and follow the instructions below to perform all the above motion corrections.

- Load naughty.feat/design.fsf. This is the first design with no noise correction.

- Open the **Stats** tab and select **Standard + Extended Motion Parameters** from the drop-down menu.

- We enter the PNM EVs in the **Voxelwise Confound List** box. Select pnm/mypnm_evlist.txt.

**设计矩阵中将添加多少 fsl_motion_outliers EV？**

- 将添加一个 EV，其中包含应删除的所有时间点
- 将为每个体积增加一个 EV，以编码是否应删除该时间点
- 将为每个应被删除的体积将增加一个 EV

  正确！这些 EV 都在所有时间点的值都为零，而在应删除的时间点上值为 1。

最后，我们准备将所有内容放在一起！打开 FEAT，然后按照以下说明执行上述所有运动校正。

- 加载 naughty.feat / design.fsf。这是没有噪声校正的第一个设计。

- 打开 Stats 选项卡，然后从下拉菜单中选择 Standard + Extended Motion Parameters。

- 我们在 Voxelwise Confound List 框中输入 PNM EV。选择 pnm / mypnm_evlist.txt。

- **DO NOT** press Go, as this will take too long to run.

- **不要按 Go 键**，因为这将花费很长的时间去运行。

We have run this analysis for you, so take a look with:

我们已经为您运行了此分析，因此请查看：

```
firefox naughty_kitchen+sink.feat/report.html &
```

Take a look at the design on the **Stats** page, which should now contain a smorgasbord of additional EVs. Finally, compare the results to both the *nice* data and the *naughty* data without any correction. Are the FSL tools for motion and physiological noise correction on Santa's naughty or nice list this year?

在 Stats 页面上查看设计，现在该页面应包含大量的附加 EV。最后，将结果与未进行任何校正的良好数据和顽皮数据进行比较。

## Contrasts in Parametric Designs

How can we investigate the way activation changes as a function of, for example, differing stimulus intensities? To demonstrate this, we will use a data set where words were presented at different frequencies. Sentences were presented one word at a time, at frequencies ranging from 50 words per minute (wpm) to 1250 wpm (see e.g. Zap Reader), and the participant just had to read the words as they were presented. This is an example of a parametric experimental design. The hypothesis is that certain brain regions respond more strongly to the optimum reading speed compared to the extremely slow and extremely fast word presentation rates (i.e. you might expect to find an inverted U-shape for the response to the five different levels).

**参数设计中的对比**

我们如何研究激活方式根据（例如）刺激强度的不同的而产生的变化？为了说明这一点，我们将使用一个数据集，其中单词以不同的频率出现。句子一次显示一个单词，频率范围为 50 个单词/分钟（wpm）到 1250 wpm（请参阅例如 Zap Reader），被试只需在单词呈现时阅读它们。这是参数化实验设计的示例。实验假设是，与极慢和极快的单词呈现速度相比，某些大脑区域对最佳阅读速度的响应更强烈（即您可能希望对五个不同级别的响应曲线呈倒 U 形）。

```
cd ~/fsl_course_data/fmri3/parametric/
firefox parametric.feat/report_stats.html &
```

To begin with, we perform the f-test based analysis described in the lecture. Familiarise yourself with the way this is set up in the design file (ignore contrasts 5 to 8 for now).

首先，我们执行课程中介绍的基于 f 检验的分析。熟悉设计文件中的设置方法（暂时忽略对比 5 到 8）。

F-test looks for any voxels where there is any significant change between either level 1-2, or level 2-3, or level 3-4, or level 4-5—or any combination thereof. In other words, this is sensitive to any deviation from a across word frequencies (this includes e.g. an inverted U-shape, a linear trend, a flat line with a single change at one end, etc).

F检验查找在1-2级，或2-3级，或3-4级，或4-5级，或任意级间存在显著差异的任何体素。换句话说，这对于跨字词呈现评率的平坦响应的任何偏差都是敏感的（这包括，例如，倒U形，线性趋势，在一端具有单个变化的平坦线等）。

Looking at the Post-stats, the f-test passes significance in large swathes of the brain. But what shape of response is driving this result? To investigate this, we can inspect the raw parameter estimates (PEs) directly.

从 Post-stats 来看，f 检验在大脑的大片区域中均具有重要意义。 但是，什么形式的响应导致这一结果？为了对此进行调查，我们可以直接检查原始参数估计值（PE）。

```
fslmerge -t response_shapes.nii.gz parametric.feat/stats/pe[13579].nii.gz
```

pe1.nii.gz contains the beta values from the GLM for the 50 wpm stimuli. In other words, this is a map of the strength of the BOLD response to words presented at 50 wpm (before statistical correction). The above command concatenates the PEs for all 5 EVs (ignoring the even numbered EVs which represent the temporal derivatives). This allows us to explore the specific response shapes in more detail.

pe1.nii.gz 包含来自 GLM 的 50 wpm 刺激的 beta 值。换句话说，这是对以 50 wpm 呈现的单词的 BOLD 响应强度图（在统计校正之前）。上面的命令将所有 5 个 EV 的 PE 级联起来（忽略代表时间导数的偶数 EV）。 这使我们能够更详细地探讨特定的响应形状。

```
fsleyes parametric.feat/example_func.nii.gz \
            parametric.feat/thresh_zfstat1.nii.gz \
            response_shapes.nii.gz &
```

Open the timeseries display and turn on response_shapes only. Turn this off in the main view, and adjust the colour of thresh_zfstat1 so you have a representative view of the f-stats. As you click around within the brain, the time series should now display the responses at that voxel for each of the five word presentation rates. *Keep this FSLeyes window open!*

打开时间序列显示并仅打开 response_shapes。在主视图中将其关闭，并调整 thresh_zfstat1 的颜色，以便获得 f 统计量的代表性视图。现在，当您在大脑中四处单击时，时间序列应该显示该体素分别在五种字词呈现率下的响应。保持此 FSLeyes 窗口打开！

Can you find brain regions where the responses exhibit a U-shape? Or an inverted-U? How might one interpret these types of responses in light of the experimental paradigm?

您能找到响应呈 U 形或倒 U 形的大脑区域吗？根据实验范式，如何解释这些类型的反应？

Answer: For example, we might expect an inverted-U shape in language regions: at low frequencies, the sentences are presented so slowly that they are easy to process; as frequency rises, processing the sentences becomes more challenging, increasing the load and hence BOLD response; finally, at some frequency the words are presented too fast to comprehend the sentence structure and the response will start to tail off. Voxel [70, 59, 47] demonstrates this trend nicely.

答案：例如，我们可能期望语言区域呈倒 U 形：在低频时，句子的显示速度很慢，因此易于处理；随着频率的增加，处理句子变得更具挑战性，增加了负担并因此增加了 BOLD 响应；最后，单词出现的频率过高，以致于无法理解句子的结构，并且响应会逐渐减弱。体素 [70，59，47]很好地证明了这一趋势。

## Quantifying response shapes

It should be obvious that, in some regions, the parametric responses are very structured. How then, could we quantify these?

To begin with, reopen the FEAT report and look at the design again. Contrasts 5 to 8 encode two simple models for the response: linear and quadratic trends. Satisfy yourself with how we encode these as contrast weights.

**Which contrast describes the inverted U-shaped trend?**

- contrast 5
- contrast 6
- contrast 7
- contrast 8

  Correct! Contrast 8 is a inverted U-shaped quadratic trend with lower response at both extreme low and high word presentation frequencies, and a stronger response in middle presentation frequencies.

## 量化响应形状

显而易见，在某些区域中，参数响应是非常结构化的。 那我们如何量化呢？

首先，重新打开 FEAT 报告并再次查看设计。 对比 5 到 8 编码了两个简单的响应模型：线性趋势和二次方趋势。让我们对如何将它们编码为对比权重感到满意。

**哪种对比描述了倒 U 形趋势？**

- 对比 5
- 对比 6
- 对比 7
- 对比 8

  正确！ 对比度 8 是倒 U 形的二次方趋势，在极低的单词呈现频率和极高的单词呈现频率下响应都较低，而在中等的呈现频率下响应较强。

Next, look at results in the **Post-stats** tab. Again, we can explore these s further by loading the negative quadratic z-stats into FSLeyes as a new overlay in the window we had opened (parametric.feat/thresh_zstat8.nii.gz). As you click around within the significant regions of this contrast, note the shape of the frequency response in the time series plot. If you have time, take a look at the linear contrasts too. Are different regions displaying different trends?

接下来，在 Post-stats 标签中查看结果。再次，我们可以通过将负二次方 z-stats 加载到 FSLeyes 窗口中作为新的覆盖层（parametric.feat / thresh_zstat8.nii.gz）来进一步探索这些 s。在此对比的显著区域内单击时，请注意时间序列图中的频率响应形状。 如果有时间，也可以看看线性对比。请问不同的区域有显示出不同的趋势吗？

Answer: Note how the visual regions tend to peak at a higher frequency than the language regions. In the language regions, the peak response will correspond in some sense to reading speed. However, the intensity of the visual stimulus, in terms of items simply flashing on and off screen, will increase even as it becomes difficult to read the individual words.

答案：请注意在更高频率下，视觉区域如何比语言区域趋于达到峰值。在语言区域中，峰值响应在某种意义上将对应于阅读速度。但是，就简单地在屏幕上闪现的项目而言，视觉刺激的强度会增加，即使被试很难阅读各个单词。

In summary, we have run an exemplar set of parametric analyses. We used an f-test to find any regions that showed different responses to different frequencies, and visualised what shape these responses took using the response time courses. We also quantified these responses in terms of a set of linear and quadratic trends to give an idea of the more complex analyses that can be run on this type of data.

总而言之，我们进行了一组示例性的参数分析。我们使用 f 检验来查找对不同频率显示不同响应的任何区域，并使用响应时程可视化这些响应的形状。我们还根据一组线性和二次方趋势对这些响应进行了量化，以给出可以在此类数据上进行的更复杂分析的想法。

**Interactions**

In this section we will look for interaction effects between a visual and a motor task condition. During the visual condition, subjects passively watched a video of colourful abstract shapes. The motor condition involved uncued, sequential tapping of the fingers of the right hand against the thumb. Subjects were scanned for 10 minutes, which contained twelve 30s task blocks: four visual blocks, four motor blocks, and four blocks containing both conditions.

**交互**

在本节中，我们将寻找视觉和运动任务条件之间的交互作用。在视觉条件下，被试被动观看了彩色抽象形状的视频。运动条件包括右手手指对拇指的无意的，连续的轻敲运动每位被试扫描 10 分钟，其中包含十二个 30 s 任务块：四个视觉块，四个运动块和四个包含两个条件的块。

To begin with, we have run a simple analysis in one subject that models the visual and motor conditions, but not the interaction between them. Take a look at the FEAT report and familiarise yourself with the task, the analysis, and the responses to the two conditions.

首先，我们对一个被试进行了简单的分析，该分析对视觉和运动条件进行了建模，但没有对它们之间的交互进行建模。查看 FEAT 报告并熟悉任务，分析和对这两种条件的响应。

```
cd ~/fsl_course_data/fmri3/interactions/
firefox 001/initial_analysis.feat/report.html &
```

We will now run an analysis looking for interactions using this subject's data. Open FEAT and follow the instructions below:

现在，我们将使用该被试的数据进行分析，以寻找交互作用。打开 FEAT，然后按照以下说明进行操作：

- Load 001/initial_analysis.feat/design.fsf (Note that if you are doing this using the pop up window, you may need to delete IMAGE in the Filter box at the top to display the text file) and change from a **Full analysis** to **Statistics** in the drop down box at the top. To save time, we will use the data that has already been preprocessed during the first analysis, and limit ourselves to a few slices.

- 加载 001 / initial_analysis.feat / design.fsf（请注意，如果使用弹出窗口执行此操作，则可能需要在顶部的 Filter 框中删除 IMAGE 以显示文本文件），然后在顶部下拉框中将 Full analysis 更改为 Statistics。为了节省时间，我们将使用在第一次分析过程中已进行过预处理的数据，并限制在几个 slices 内。

- In the **Data** tab choose 001/preprocessed_slices.nii.gz as the 4D data, and change the output name to interaction_analysis.feat. Ignore any warnings about BET and preprocessing options.

- 在 Data 选项卡中，选择 001 / preprocessed_slices.nii.gz 作为 4D 数据，并将输出名称更改为 interact_analysis.feat。 忽略有关 BET 和预处理选项的任何警告。

- Open **Full model setup** under the **Stats** tab. Add a third EV and set its shape to **Interaction**. Add the appropriate contrasts for the positive and negative interaction effects.

- 在 Stats 选项卡下打开 Full model setup。 添加第三个 EV 并将其形状设置为 Interaction。为正和负的交互作用添加适当的对比。

- Press **Go!** This should only take a couple of minutes to run.

- 点击 **Go！** 这只需几分钟即可运行完成。

What interaction effects do you see in this subject? How do you interpret them?

您在本被试中看到什么交互作用？ 您如何解释它们？

Answer: The positive interaction shows regions that were more active during the combined condition than a simple linear combination of the visual and motor conditions would suggest. If you really squint, you can make an argument that this looks like the task-positive network… The negative condition is simply the opposite: regions where the activity in the combined condition was less than a simple linear combination of the visual and motor conditions.

答案：正性的交互作用表明，在组合条件比视觉和运动条件的简单线性组合有更多的激活。你可以说出它看起来像是任务阳性网络……而负性条件则恰恰相反：表明组合条件下的激活少于视觉和运动条件的简单线性组合。

**Group analysis**

We have run a straightforward group analysis of this data on a set of nine subjects. Familiarise yourself with the results by looking at the FEAT report:

**组分析**

我们对一组 9 被试的数据集进行了直接的组分析。通过查看 FEAT 报告来熟悉结果：

```
firefox group/group.gfeat/report.html &
```

And take a closer look at the results for the interaction contrasts in FSLeyes:

并仔细查看 FSLeyes 中的交互对比的结果：

```
fsleyes -std \
   group/group.gfeat/cope5.feat/thresh_zstat1.nii.gz -cm red-yellow -dr 3.1 6.0 \
   group/group.gfeat/cope6.feat/thresh_zstat1.nii.gz -cm blue-lightblue -dr 3.1 6.0 &
```

What interaction effects do we observe at the group level? How do you interpret them?

我们在组水平上观察到什么交互作用？ 您如何解释它们？

Answer: The interpretation of the effects is as before. Note how several of the regions of the default mode network are present in the negative condition—we can interpret this as the default mode being more deactivated by the more cognitively challenging combined condition.

答案：交互作用的解释与之前相同。请注意，默认模式网络中的几个区域是如何呈现为负性-我们可以将其解释为默认网络由于更具认知挑战性的组合条件而更加失活。

Note that in this case, the interaction contrast gave us a relatively straightforward set of results. However, this is primarily because we were looking at the interaction between two simple, distinct conditions in a relatively small data set in order to run things in this session. In targeted experiments, interaction based designs can be very powerful and the analysis pipeline is exactly as presented here.

请注意，在这种情况下，交互对比为我们提供了一组相对直接简单的结果。但是，这主要是因为我们正在研究相对较小的数据集中两个简单的不同条件之间的相互作用。在有针对性的实验中，基于交互的设计可能非常强大，并且分析流程与此处介绍的完全相同。

**Contrast Masking**

Differential contrasts and F-tests are sensitive to positive and negative changes in BOLD. To separate out positively driven from negatively driven results we use *Contrast Masking*. For example, in a differential contrast like $A - B$, a significant result occurs whenever $A - B > 0$, but this could be driven by either $A > B$ where both are positive, or by $B < A$ where both are negative (i.e. $B$ is more negative than $A$).

**对比遮掩**

差异对比和 F 检验对 BOLD 的正负变化敏感。为了区分正性驱动的结果和负性驱动的结果，我们使用了“对比遮掩”。例如，在像 A-B 这样的差异对比中，只要 A-B> 0，就会产生显著的结果，但是这可能是由于 A>B（两者均为正）或 B <A（两者均为负）(即 B 比 A 负性更大）。

We will look at the *Shad* > *Gen* contrast (word shadowing *greater than* generation) from the fMRI fluency dataset (from the first FEAT practical) in order to see if the result is associated with positive or negative shadowing and generation responses. In contrast_masking you will see a copy of the analysis we asked you to run in an earlier practical. Back up these results with the command:

我们将查看 fMRI fluency 数据集（来自第一个 FEAT 实操）的 Shad> Gen 对比（word shadowing 大于 word generation），以查看结果是否与正性或负性的 shadowing 以及 generation 响应相关。 在 contrast_masking 中，您将看到我们要求您在较早的实操中运行的分析副本。使用以下命令备份这些结果：

```
cd ~/fsl_course_data/fmri3/contrast_masking
cp -r fmri.feat fmri_orig.feat
```

Quickly review the results of this analysis (and in particular, the *Shad* > *Gen* contrast) to refresh your memory.

快速查看此分析的结果（尤其是 Shad> Gen 对比）以刷新您的记忆。

We can apply contrast masking without re-running the whole analysis by starting the FEAT GUI and doing the following:

通过启动 FEAT GUI 并执行以下操作，我们可以应用遮掩而无需重新运行整个分析：

- Change the type of analysis in the top right pull-down menu from **Full analysis** to **Statistics**.

- 将右上角下拉菜单中的分析类型从 Full analysis 更改为 Statistics。

- In the **Data** tab, click on the **Input is a FEAT directory** checkbox. Use the **Select FEAT directory** button to choose the fmri.feat directory. Ignore any warnings.

- Go to the **Post-stats** tab and click on the **Contrast masking** button. In the window that pops up you can select which contrasts to mask with which others. In this case we will click on buttons in the row *Mask real Contrast 4 with:* and the columns **C1** and **C2** (as Contrast 4 = Shad > Gen; C1 = Generation; C2 = Shadowing). Also click on the Mask using (Z>0) instead of (Z stats pass thresholding) because we are not interested in the individual components (C1 and C2) being significant, but we do want to know if they were positive.

- This contrast masking setup is now complete and will show the results where Shad > Gen **and** Gen > 0 **and** Shad > 0. Now click **OK**.

Once you have done all this, click on Go and wait for a couple of minutes to see the result.

- 在 Data 选项卡中，单击 Input is a FEAT directory 复选框。 使用 Select FEAT directory 按钮选择 fmri.feat 目录。 忽略任何警告。

- 转到 Post-stats 选项卡，然后单击 Contrast masking 按钮。 在弹出的窗口中，您可以选择用于遮掩的对比。在这种情况下，我们将单击 Mask real Contrast 4 with:行中的按钮和列 C1 和 C2（因为对比 4 =阴影> Gen； C1 = Generation; C2 = Shadowing）。 还点击 Mask using (Z>0)而不是（Z stats pass thresholding），因为我们对单个分量（C1 和 C2）是否显著并不感兴趣，但我们确实想知道它们是否为正。

- 对比遮掩置现已完成，将在 Shad> Gen 和 Gen> 0 和 Shad> 0 的位置显示结果。现在，单击 OK。

完成所有这些操作后，单击 Go，然后等待几分钟以查看结果。

**You should see that the cluster associated with contrast 4 (Shad > Gen) no longer appears. What is the explanation for this?**

- The result we saw previously was primarily driven by deactivations in the word generation condition compared to word shadowing.

  Correct! The results that were previously found were not in regions that showed a positive effect for both word generation and word shadowing, meaning that the effect was driven by a deactivation.

- The result we saw previously was primarily driven by larger activation in the word shadowing condition compared to word generation

Note that it is difficult to determine this directionality in other ways, such as looking at timeseries plots. However, it can be confirmed by loading the appropriate COPE images into FSLeyes, as these will show negative values in the stats/cope1 image (the Generation condition) in the area associated with the medial posterior cluster.

**您应该看到与对比 4（Shad > Gen)关联的聚类不再出现。这该如何解释？**

- 我们先前看到的结果主要是由 word generation 条件相比 word shadowing 条件的去激活引起的。

  正确！ 先前发现的结果不在 word generation 和 word shadowing 都产生正效应的区域中，这意味着该效应是由去激活引起的。

- 我们之前看到的结果主要是由于与 word generation 相比，word shadowing 条件下的激活更大

请注意，很难通过其他方式（例如查看时间序列图）来确定此方向性。但是，可以通过将合适的 COPE 图像加载到 FSLeyes 中来确认，因为这些图像会在 stats/cope1 image (the Generation 条件)中与内后侧群集相关的区域中显示负性值。

**—— THE END ——**