# Basic Equations in LaTeX

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July 2, 2010

# Equations in LaTeX

Equations may be the best reason to use LaTeX.

Basic LaTeX equations are extended by $\mathcal{AMS}$-TeX and $\mathcal{AMS}$-LaTeX.

- $\mathcal{AMS}$ stands for the American Mathematical Society
- can be used by including the `amsmath` package
- $\mathcal{AMS}$-LaTeX will be covered in a separate presentation

Two types of equations:

- inline
- displayed

# Inline Equations

```
The goal is to recover an estimate
$\hat{x}$ of $x$ given only $y$ and $A$.
```

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**Comparison to PowerPoint**

PPT is a massive pain!

# Displayed Equations

```
\begin{equation}\|y - Ax\|^{2}
   + \alpha \|Lx\|^{2}
\label{eq:reg}
\end{equation}
The minimizer of (\ref{eq:reg}) is given
by \ldots
```

$$\|y - Ax\|^2 + \alpha\|Lx\|^2 \tag{1}$$

The minimizer of (1) is given by ...

# Equation Numbering and Referencing

- The equation environment automatically numbers equations.
- Equations may be referenced if they are labeled as `\label{name}`
- The reference can be anywhere in the body, with the form `\ref{name}`

# Suppressing Equation Numbering

Sometimes we may want to display an equation without numbering:

```
\begin{equation*}
\|y - Ax\|^{2} + \alpha \|Lx\|^{2}
\label{eq:reg}
\end{equation*}
```

or

```
\[ \|y - Ax\|^{2} + \alpha \|Lx\|^{2} \]
```

$$\|y - Ax\|^{2} + \alpha \|Lx\|^{2}$$

# Multi-line Equation Derivations

```
\begin{eqnarray}
\hat{x}_{\alpha} & = &
BA^Ty + Ba_a^T[I - a_aBa_a^T]^{-1}a_aBA^Ty
    \nonumber \\
& = &  BA^Ty + Ba_a^Tw \nonumber \\
& = &  BA_c^TP^T \left[\begin{array}{r} y \\
                         w \end{array}\right]
\label{eq:solsplit}
\end{eqnarray}
```

$$\begin{aligned}
\hat{x}_{\alpha} &= BA^Ty + Ba_a^T[I - a_aBa_a^T]^{-1}a_aBA^Ty \\
&= BA^Ty + Ba_a^Tw \\
&= BA_c^TP^T \left[\begin{array}{r} y \\ w \end{array}\right] \qquad (2)
\end{aligned}$$

# Multi-line Equation Derivations

Things to note:

- `& = &` lines up the equal signs
- `\\` ends each line
- must use `\nonumber` on each line where numbering is to be suppressed
- `eqnarray*` form suppresses all numbering

Arrays are probably best covered in $\mathcal{AMS}$-LaTeX.

# Fractions and Delimiters



```
\[ \frac{1 + x}{3+x^2} \]
```

$$\frac{1+x}{3+x^2}$$

```
\[ \left(\frac{1 + x}{3+x^2}\right)^2 \]
```

$$\left(\frac{1+x}{3+x^2}\right)^2$$

# Symbols

- Symbol guide (linked from web site) contains 178 pages of LaTeX symbols!
- Use drop-down menu for symbols, but you'll memorize the common ones.

```
\[ \int \cos x\,dx = \sin x + C \]
```

$$\int \cos x \, dx = \sin x + C$$

oops: `cos x` renders $cos x$