# Title

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# Contents



# 1 | Tuesday, September 22

Review: Regular functions. Given an affine variety $X$ and $U \subseteq X$ open, a *regular function* $\varphi : U \to k$ is one locally (wrt the zariski topology) a fraction. We write the set of regular functions as $\mathcal{O}_X$.

**Example 1.1.**
$X = V(x_1x_4 - x_2x_3)$ on $U = V(x_2, x_4)^c$, the following function is regular:

$$\begin{aligned}
\varphi : U &\to k \\
x &\mapsto \begin{cases} \dfrac{x_1}{x_2} & x_2 \neq 0 \\ \\ \dfrac{x_3}{x_4} & x_4 \neq 0 \end{cases}.
\end{aligned}$$

Note that this is not globally a fraction.

**Definition 1.0.1** (Distinguished Open Sets)**.**
A *distinguished open set* $D(f) \subseteq X$ for some $f \in A(X)$ is $V(f)^c := \left\{ x \in X \;\middle|\; f(x) \neq 0 \right\}$.

These are useful because the $D(f)$ form a base for the zariski topology.

**Proposition 1.1*(?)*.**
For $X$ an affine variety, $f \in A(X)$, we have

$$\mathcal{O}_X(D(f)) = \left\{ \frac{g}{f^n} \;\middle|\; g \in A(X), n \in \mathbb{N} \right\}.$$

*Proof .*
The first reduction we made was that $\varphi \in \mathcal{O}_X(D(f))$ is expressible as $\frac{g_a}{f_a}$ on distinguished opens $D(f_a)$ covering $D(f)$. We also noted that $\dfrac{g_a}{f_a} = \dfrac{g_b}{f_b}$ on $D(f_a) \cap D(f_b)$, so $f_b g_a = f_a g_b$ in $A(X)$.

The second step was writing $D(f) = \cup D(f_a)$, and so $V(f) = \cap_a V(f_a)$ implies that $f \in I(V(\left\{ f_a \;\middle|\; a \in U \right\}))$. By the Nullstellensatz, $f \in \sqrt{\left\langle f_a \;\middle|\; a \in U \right\rangle}$, so $f^N = \sum k_a f_a$ for some $N$. So construct $g = \sum k_a g_a$, then compute

$$g f_b = \sum_a k_a g_a f_b = \sum_a k_a g_b f_a = g_b \sum k_a f_a = g_b f^N.$$

Thus $g/f^N = g_b/f_b$ for all $b$, and we can thus conclude

$$\varphi \coloneqq \left\{ \frac{g_b}{f_b} \text{ on } D(f_b) \right\} = g/f^N.$$

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